The Effect of Algebra Support Classes on EOCT Scores and SGP Data

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ABSTRACT

Schools are having to find innovative ways to increase the instructional time in the school day to not only address deficiencies in students' mathematical knowledge but to also increase the academic rigor and prepare students for college and careers. The most popular approach is double-dosing, where students give up an elective class in order to take an additional mathematics class. Whereas this is a popular approach, there have not been very many studies on the effectiveness of this practice. This study adds to the body of knowledge on double-dosing by analyzing the effectiveness of the support class through student achievement on the state End of Course Coordinate Algebra test as well as through Student Growth Percentiles. Analysis of Covariance (ANCOVA) was used for all analyses. Criterion-Referenced Competency Test scores were used as the covariate. The participants in this study were first-time freshmen enrolled in Coordinate Algebra in an urban district of approximately 25,000 total students. Data indicated that the interaction between support classes and school year were trending toward significance for both the End of Course scores ($p = .056$) as well as Student Growth Percentiles ($p = .068$). In the second year of the study, students enrolled in the Mathematics Support class scored higher on the End of Course test and had higher Student Growth Percentiles. Additionally, there was a significant main effect for support class on the Student Growth Percentiles ($p = .028$). Students in the support class did achieve significantly higher growth than students who were not concurrently enrolled in the support class. Whereas increases in mathematical growth do not necessarily result in increases in achievement scores, as evidenced by the data in this study, the Mathematics Support classes are effective in increasing student learning in mathematics.

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DEDICATION

This dissertation is dedicated to my dad. He always knew I had it in me. His quiet but unwavering support meant more to me than he will ever know.

Daddy, I did it!!

Chapter I

THE EFFECT OF ALGEBRA SUPPORT CLASSES ON EOCT SCORES AND SGP DATA

Prior to 2005, Georgia's curriculum was the Quality Core Curriculum described by many as a mile wide and an inch deep (GaDOE, 2012a). In 2005, the Georgia Department of Education implemented the Georgia Performance Standards greatly increasing the rigor of the mathematics curriculum (GaDOE, n.d. g; GaDOE, 2007a). Then in 2012, the Georgia Department of Education once again increased the rigor of the curriculum by implementing the Common Core Georgia Performance Standards (CCGPS). The CCGPS focus on engaging students in constructing their own mathematical understanding of concepts using manipulatives and other representations, while either working independently or with other students (GaDOE, 2011). Gone are the days of rote memorization (Barbour, Evans, & Ritter, 2007). Students need to learn to think critically, apply skills to problem-solving situations, and communicate effectively about mathematics (GaDOE, 2011). Most teachers still teach in a teacher-centered classroom, dispensing knowledge to the students (Thompson, 2009; White-Clark, DiCarlo, & Gilchriest, 2008). The new curriculum requires teachers to teach at a deeper level and students to perform at a higher level (Barbour et al., 2007; Nomi & Allensworth, 2013).

Achieve (2010) reports that by 2010, 20 states and the District of Columbia had adopted college and career-ready graduation requirements, which include 4 years of *challenging* mathematics. At the same time that expectations are increasing, student preparation for these classes is decreasing. Approximately 55% of the freshmen entering ninth grade in America's largest urban public school districts are performing below grade level in mathematics (Council of the Great City Schools, 2009). The increased expectations place demands on high school mathematics teachers that they have not had to face in the past. The level of performance "required of all students is rising faster than our ability to provide everyone with high quality K-8 schooling. As a result, there is a considerable need to develop effective extra help strategies, approaches, and organizational structures for high school students" (Balfanz, McPartland, & Shaw, 2002, p. 23). Traditionally, high schools handled the differing levels of middle school preparation by having tiers of course offerings (Nomi & Allensworth, 2009). But with the No Child Left Behind Act (NCLB) of 2001 requiring that all students have access to high quality education no matter the background, income level, or prior preparation, many schools now have to offer extra assistance and support to students to help them catch-up and accelerate their learning (Balfanz et al., 2002).

The freshman year is one of the most critical years students will face (Hughes, Copley, & Baker, 2005). They must transition from a middle school environment which has them grouped in teams with their peers for all of their academic classes to a high school environment with a much larger and more diverse student body, in addition to less individual contact time with teachers and increased academic demands (Kerr, 2002; Lampert, 2005). Ninth graders experience a change in schools along with all of the physical, emotional, and psychological changes that come with adolescence (Hughes et al., 2005). Not only that, they must go from being the *top dog* of the middle school campus, to being the *bottom dog* of the high school campus (Kerr, 2002). This sudden change in social status can be very stressful for ninth graders (Hughes et al., 2005). During the transition year from middle school to high school, there is typically a high failure rate (Lampert, 2005; Nomi & Allensworth, 2013), and this failure is directly linked to the probability of students dropping out of school (Kerr, 2002; Nomi & Allensworth, 2009), particularly in urban districts (Oriheula, 2006; Silver, Sanders, & Zarate, 2008). Poor prior preparation is one of the root causes of ninth grade failure (Legters, 2005; Nomi & Allensworth, 2013). Combine the stress of freshman year, the lack of prior preparation, and the requirement that students must pass all 4 years of high school mathematics in order to graduate and the increased rigor of the Georgia mathematics curriculum, and it becomes evident that students need help in order to be successful and graduate on time.

Extra help provided to students needs to be thought of as support to help them be successful in more rigorous high school mathematics courses (Balfanz et al., 2002). In order to help promote student success with the implementation of a more rigorous mathematics curriculum, the GaDOE created a Mathematics Support class that is to be taught concurrently with a student's regular mathematics class and counts as an elective credit for graduation (GaDOE, 2012b). According to the GaDOE (2012), students placed in this class are those at risk for failing mathematics. The majority of the extra help needed by high school students is not remediation as much as it is providing accelerated learning opportunities that will prepare them for, and support them in, mastering rigorous course work (Balfanz et al., 2002). The Mathematics Support class follows the design recommended by the National Council of Teachers of Mathematics (2006) where remediation should not only build the basic or foundational skills, but also provide them with access to grade level content. The Georgia Mathematics Support class is designed to give students more time to successfully complete the course without failing, while focusing on skills the students have not yet mastered and previewing future content of the regular mathematics class (GaDOE, 2012b).

Statement of the Problem

Freshmen students have the option of enrolling in the Mathematics Support class based on their prior mathematics achievement. Recommendations are made at the end of the eighth grade year as students are registering for their high school mathematics class. The students who enroll in the support class along with the regular mathematics class will have two mathematics classes each day. In the 2012-2013 school year, approximately 46% of the freshman students were enrolled in a mathematics support class. This tends to cause a strain on the school system by requiring more mathematics teachers to handle the increased class load caused by students taking two mathematics classes each day. The Mathematics Support class was created by the GaDOE in order to help students be successful in a more rigorous mathematics curriculum, but there have been no studies on the effectiveness of this intervention on students' mathematics achievement. Thus, support classes may place an unnecessary fiscal strain on districts to accommodate the additional need for mathematics teachers while there is no evidence to validate or support that this practice is effective in increasing student achievement in mathematics.

Purpose of the Study

The purpose of this study is to investigate the effectiveness of the Mathematics Support class by analyzing student performance on the End of Course Test (EOCT), and

Student Growth Percentiles (SGP). Due to the recent implementation of the support class for struggling high school mathematics students, there is no data on the effectiveness of the class. Determining the effectiveness of the class has implications for schools as well as for students. Students who are placed in a support class give up an opportunity for an elective class. If the support class is found to be ineffective in helping students experience more growth in mathematical knowledge or to be more successful on the EOCT, then allowing students to take a class in which they are interested may help them socially during their transition to high school. If the support class is found to be effective in helping students experience more growth in mathematical knowledge and to be more successful on the EOCT, then placing students in this class will help them be more successful in completing the mathematics requirements for graduation within 4 years. Thus, the effectiveness of the support classes is a very important issue for the district as well as for the students in the district.

Research Questions

For the purpose of this study, the following research questions will be tested. These questions will be used to evaluate the relationship between mathematics support courses and student achievement as measured by the EOCT and SGP.

1. Do students enrolled in a Mathematics Support class achieve at a significantly higher rate than students who are not enrolled in a Mathematics Support class as measured by the EOCT?
2. Are scores on the mathematics EOCT significantly higher for the 2013–2014 school year as compared to the 2012–2013 school year?

3. Do students enrolled in a Mathematics Support class demonstrate more growth than students who are not enrolled in a Mathematics Support class as measured by the SGP?
4. Are the SGP in mathematics significantly higher for the 2013–2014 school year as compared to the 2012–2013 school year?

Significance of the Study

The state and federal governments are holding schools accountable for teaching students more rigorous curriculum and ensuring that students who graduate from high school are college and/or career ready (Allensworth, Nomi, Montgomery, & Lee, 2009; Cortes, Goodman, & Nomi, 2013; Foegen, 2008; GaDOE, 2014b; Nomi & Allensworth, 2009). Some schools are struggling with options that will both meet the current needs of their students and then take them to the level that is required. Georgia has created a class, Mathematics Support, to fill this void (GaDOE, 2012b). However, there have been no studies to date on the effectiveness of this class for these students. This quantitative study is designed to determine what relationship exists between enrollment in a mathematics support class and student achievement. This research will provide the district with information regarding accountability, effectiveness, and resource allocation. Armed with information on the effectiveness of the support class, school and district leaders will be able to make informed decisions regarding scheduling options for freshmen students in high school. Additionally, the research will provide the district with information that will assist in making informed hiring decisions regarding the number of mathematics teachers and/or elective teachers that schools may need. Finally, the research has potential to provide evidence about the effectiveness of the extra mathematics classes that numerous students are taking each year. The results of this study will help the district to make informed decisions regarding allocation of time, student scheduling, and staffing.

Conceptual Framework for the Study

The conceptual framework for the study is grounded in the P21 Framework, which "presents a holistic view of 21st century teaching and learning that combines a discrete focus on 21st century student outcomes (a blending of specific skills, content knowledge, expertise and literacies) with innovative support systems to help students master the multi-dimensional abilities required of them in the 21st century and beyond," (Partnership, n.d., para.1). According to the Partnership for 21st Century Skills website, the P21 Framework is an education standards and reform movement (Partnership, n.d.). The site states that there are two parts to the P21 Framework: student outcomes and support systems. The student outcomes have been identified as core subjects, 21st century themes, learning and innovation skills, life and career skills, as well as information, media, and technology skills. These outcomes represent the essential skills and knowledge that students need to be successful in both work and life in the 21st century. To ensure student mastery of 21st century skills, there are critical support systems that must be in place. These critical support systems are standards and assessment, curriculum and instruction, professional development, and learning environments.

Definition of Terms

Double-dosing

Struggling students are provided with twice as much instructional time as other students (Cavanagh, 2006; Nomi & Allensworth, 2009).

End of Course Tests (EOCT)

State tests administered at the end of eight high school courses. The tests in these eight subjects are administered at the end of the course and account for 20% of the student's final grade in the course (GaDOE, 2013b).

College and Career Readiness Performance Index (CCRPI)

CCRPI is the new accountability system developed by the state of Georgia in 2010 as a part of the waiver to the provisions of the federal No Child Left Behind Act of 2001. Specifically, the CCRPI is a comprehensive school improvement, accountability, and communication platform for all educational stakeholders that promotes college and career readiness for all Georgia public school students (GaDOE, 2014c).

Student Growth Percentiles (SGP)

A number from one to 99 which describes a student's growth relative to other students statewide with similar prior achievement, i.e., students who have a similar score history (GaDOE, n.d. f).

Criterion Reference Competency Tests (CRCT)

Tests designed to measure how well students acquire, learn, and accomplish the knowledge and skills set forth in Georgia's curriculum standards (GaDOE, 2013a).

Annual Yearly Progress (AYP)

Annual measure of student participation and achievement on statewide assessments and other academic indicators under the provisions of the federal No Child Left Behind Act of 2001 (USDOE, 2001).

Summary of Methodology

This research was a quantitative design as mathematical models were used to analyze the results. This research was quasi-experimental because I had no control over the placement of students into the two groups. The dependent variables were EOCT scores and SGP. One independent variable was placement in a mathematics support class, and a second independent variable was the school year. Scores on the eighth grade CRCT in mathematics served as a covariate.

The data utilized to address Research Questions 1 and 2 were student EOCT scores and were analyzed using a 2 x 2 ANCOVA. SGP data were utilized to address Research Questions 3 and 4 were and were analyzed using a 2 x 2 ANCOVA.

Mertler and Vannatta (2005) stated that an analysis of covariance allows group differences to be determined while controlling for the effect of a concomitant variable, in this case prior mathematics achievement. The use of an ANCOVA improved the efficiency of the research design by adjusting for the effect of a variable that was related to the dependent variable. Because the dependent variables in this study, EOCT and SGP scores, can be partially influenced by prior mathematics achievement, the use of an ANCOVA was selected to analyze the data.

Chapter II

LITERATURE REVIEW

The purpose of this literature review was to examine how mathematics achievement is measured, trends in mathematics achievement, and strategies that have been used to increase mathematics achievement. The literature review began with a discussion of standardized testing from a historical perspective followed by a discussion of recent legislation regarding standardized testing and school accountability measures in Georgia. The next section included a discussion of trends in mathematics achievement, and the following section of the literature review focused on extended time as a strategy to increase mathematics achievement. Finally, the last section of the literature review will addressed local considerations and implications.

Standardized Testing

Historical Perspective

Assessments, in some form or another, have been around as long as education itself (Dangler, 1994). These assessments not only let students and parents know how they were doing, but the assessments also gave teachers valuable information to help improve instruction and student learning (Camel & Chung, 2002). Until the middle of the 20th century, the public education system in the United States appeared to be successful. However, in 1983, with the publication of *A Nation at Risk* by the National Commission for Excellence in Education, Americans became convinced that the nation's public education system was failing (Dangler, 1994). This spurred the educational accountability movement, as taxpayers wanted proof that their educational tax dollars were being spent wisely, and many states enacted laws requiring high school graduates to pass proficiency tests (Camel & Chung, 2002; Dangler, 1994). These results were published by the local media (Dangler, 1994) and became the basis, not only for determining effectiveness, but also for the allocation of funds (Camel & Chung, 2002).

Recent Legislation

The federal No Child Left Behind Act of 2001 (NCLB) was signed by President Bush in January 2002 (Mathis, 2003). It ushered in many changes for schools across the nation. NCLB was the cornerstone of President Bush's administration and with it he changed the culture of America's schools (USDOE, 2005). Accountability, as measured by Adequate Yearly Progress (AYP), was the key to NCLB (GaDOE, n.d. a). The GaDOE identified three components to AYP: test participation in Reading/Language Arts and Mathematics, academic performance in Reading/Language Arts and Mathematics, and either graduation rate for high schools or attendance rate for elementary and middle schools. One goal of the NCLB Act of 2001 was to have all students reach proficiency on these state tests in Reading/Language Arts and Mathematics by 2014 (GaDOE, n.d. a). Schools failing to make AYP for two or more years in a row were placed in a *Needs Improvement* (NI) status, with each successive year of NI status bringing increasing consequences (GaDOE, n.d. a).

Accountability in Georgia

In February 2012, Georgia was one of ten states granted a waiver from NCLB (GaDOE, 2014c). In the Georgia Elementary and Secondary Education Act Flexibility Request submitted to the U.S. Department of Education it stated:

> Since the enactment of No Child Left Behind (NCLB) legislation, Georgia has approached the accountability expectations of NCLB with fidelity and dedication. Although NCLB has served as an impetus for focusing our schools on disaggregated subgroup performance, it has fallen short in serving as a school improvement tool, a teacher-leader quality tool, a catalyst for ensuring a more comprehensive delivery of college and career readiness, and has limited focus to adequacy in specific subject areas…Therefore, *Georgia is making this waiver request in order to strengthen accountability by replacing current AYP calculations to reflect the definitions of Priority, Focus, and Reward Schools. This will allow Georgia to increase emphasis on the state's very lowest performing schools in all subject areas and highlight subgroup achievement gaps. This plan will serve to increase the quality of instruction in all subject areas for all students and define a system that will support continued improvement of student achievement* (p. 16, emphasis in original).

Georgia has developed its own more comprehensive accountability system, the College and Career Ready Performance Index, commonly referred to as CCRPI (GaDOE, 2014b). The CCRPI promotes college and career readiness for all public school students in Georgia (GaDOE, 2014b). Not only does the CCRPI serve as a measure for accountability, it is also a comprehensive school improvement tool (GaDOE, 2014b). According to the GaDOE (2014b), the three areas measured by CCRPI have included Achievement, Achievement Gap, and Progress and the weighted average of these three areas have comprised a school's overall CCRPI score. A companion set of *Exceeding the*

Bar indicators have been included in the CCRPI to promote best practices associated with college and career readiness, and these indicators have allowed schools to earn up to 10 bonus points (GaDOE, 2014c). Hence, the CCRPI has provided a broad picture of each school's achievement across subject areas, achievement gaps within schools, achievement gaps between school and state averages, student progress and subgroup performance (GaDOE, 2014c).

In the Progress section of the CCRPI, scores have been based on student growth as measured by Student Growth Percentiles or SGPs (GaDOE, 2014c). The addition of a growth model has helped to move accountability from a single focus on attaining proficiency towards a dual focus on both proficiency and student progress (GaDOE, 2014c).

According to the GaDOE (n.d. f), SGPs, reported as percentiles, have been calculated by comparing a student to his or her statewide academic peers. These academic peers have been defined as all students in the state with the same prior achievement. The percentiles range from 1 to 99 and have allowed all students to demonstrate growth regardless of their academic achievement (GaDOE, n.d. f). With these percentiles, the lower percentiles have indicated lower academic growth and the higher percentiles have indicated higher academic growth. For example, a student who had an SGP of 70 on the sixth grade mathematics test indicated that the student had demonstrated more progress, or growth, than 70% of his or her academic peers.

Mathematics Achievement

There have been two components of the National Assessment of Educational Progress (NAEP)–the main assessment and the long-term trend assessment (Rampey, Dion, & Donahue, 2009). The main assessments have been updated to reflect changes in curricula, whereas the long-term trend assessments have measured approximately the same content as they did on the first administration in the 1970s. Both assessments have continued to be important and to provide valuable data, but the two cannot be compared. Thus, data from both assessments have been examined.

2009 National Assessment of Educational Progress

The Nation's Report Card was prepared by the National Center for Education Statistics (NCES) and communicated findings of the National Assessment of Educational Progress (NAEP). Not only did the NAEP mathematics assessment measure students' knowledge and skills, but it also measured students' ability to apply their mathematical knowledge to problem-solving situations (NCES, 2009). In 2009, more than 168,000 fourth graders and 161,000 eighth graders from around the country participated in the mathematics NAEP (NCES, 2009). The content of the test was divided into five mathematical domains: number properties and operations; measurement; geometry; data analysis, statistics, and probability; and algebra. Students in both grades answered questions that measured their knowledge in all five domains. According to the NCES (2009), the overall national average score for fourth graders was unchanged from the 2007 administration, while the eighth grade average score increased by two points. This increase in only eighth grade was also seen in the state of Georgia (NCES, 2009).

NAEP has used three achievement levels to report performance: basic, proficient, and advanced. In 2009, just as in 2007, 82% of fourth graders scored basic or above, 39% scored proficient or above, and 6% scored at the advanced level (NCES, 2009). In the same report, with regard to ethnicity, there was no change in the scores for White, Black, or Hispanic students. While Asian/Pacific Islander students increased by two points, and American Indian/Alaskan Native students decreased by three points, these changes were not found to be statistically significant (NCES, 2009). The report also stated that these results indicated that there was no change in the gap in mathematics scores between White and Black students (26 points) as well as between White and Hispanic students (21 points). Additionally, students who were not eligible for free or reduced price lunch scored an average of 250, while students who were eligible for reduced price lunch scored an average of 235, and students who were eligible for free lunch scored an average of 226. These scores were not significantly different from 2007 (NCES, 2009).

Data from the 2009 NCES report indicated that Georgia's fourth grade students scored an average of 236, which was three points below the national average. Additionally, with regard to achievement level, Georgia had more students score below basic than the national average, 22% and 19% respectively, and fewer students scored proficient or above than the national average, 34% and 39% respectively.

The eighth grade 2009 NAEP mathematics assessment indicated that performance continued to improve with a two point increase from 2007 to 2009 (NCES, 2009). The report also showed that the percent of students scoring basic, proficient, and advanced increased from 2007. Additionally, each of the five racial/ethnic groups demonstrated an increase, although the change in American Indian/Alaskan Native was not statistically significant (NCES, 2009). The same report indicated that the gap between White students and Black students, as well as White students and Hispanic students, continued to remain the same, 32 and 26 points respectively. The increase in scores for all three income levels was statistically significant, with an almost 30 point difference between students not eligible for free and reduced price lunch and those students eligible for free lunch (NCES, 2009).

Georgia's eighth grade students scored an average of 278, which was an increase from the 2007 scores, but was still below the national average of 282 (NCES, 2009). With regard to achievement level, Georgia had more students score below basic than the national average, 33% and 29% respectively, and fewer students score proficient or above than the national average, 26% and 32% respectively (NCES, 2009).

2008 National Assessment of Educational Progress Long-term Trend

During the 2007–2008 school year, the NAEP long-term trend assessment was given in reading and mathematics to a nationally representative sample of over 26,000 students aged 9, 13, and 17 (Rampey, Dion, & Donahue, 2009). These tests charted academic progress from the 1970s. Rampey et al. (2009) reported that the last administration of this test was in 2004, and mathematics scores increased for students aged 9 and 13, but did not change significantly for 17-year-olds. For 9-year-old students, the average score was 24 points higher in 1973 than in 2004 and for 13-year-old students the average score was 15 points higher (Rampey et al., 2009). This report indicated that although there were no significant differences from 2004 to 2008, from 1973 to 2008, at all three age groups, Blacks and Hispanics made greater gains than White students, with Black students making the greatest gain. There was an increase in the number of 17-year-old students who reported taking pre-calculus or calculus as well as second-year algebra or trigonometry from 1973 to 2008, yet the scores did not show a statistically significant improvement during this same time (Rampey et al., 2009).

2007 Trends in International Mathematics and Science Study

The 2007 administration of the Trends in International Mathematics and Science Study (TIMSS) was the fourth administration since 1995 (Gonzales et al., 2008). The report indicated that the test was administered to fourth and eighth grade students and the content aligned broadly with the countries participating. This allowed the United States to compare the performance of its students with its international peers. The mathematics test consisted of two parts: content that students should know, and cognitive skills that students should have (Gonzales et al., 2008). The results of the report indicated that the fourth grade content domains were number, geometric shapes and measures, and data display, and the eighth grade content domains were number, algebra, geometry, and data and chance. At both grade levels the cognitive domains were knowing, applying, and reasoning (Gonzales et al., 2008). TIMSS international benchmarks defined four levels of achievement: advanced, high, intermediate, and low. When compared to their international peers, both fourth- and eighth-grade students in the United States performed better in the knowing cognitive domain than in the applying and reasoning domains (Gonzales et al., 2008).

According to Gonzales et al. (2008), there were 36 countries participating in the fourth grade administration in 2007 and the average U.S. score of 529 was higher than the TIMSS scale average of 500; the U.S. also scored higher than 23 of the other 35 countries. Furthermore, the eight countries that scored higher than the U.S. were all in Asia and Europe, and there was no comparable difference with the other four countries. Additionally, at each of the four international benchmark levels, the percentage of U.S. students at or above that level was higher than the international median. For example, 10% of the fourth graders in the U.S. scored at or above the advanced international benchmark as compared to the international median of 5%. Only seven countries had more students scoring at or above the advanced benchmark (Gonzales et al., 2008). Compared to the U.S. average score of 529, Asian and White students scored higher, 582 and 550 respectively, while Hispanic and Black students scored lower, 504 and 482 respectively (Gonzales et al., 2008). Additionally, only Black students scored lower than the TIMSS scale average of 500.

Even though the gap between White and Black students was statistically significant, the gap decreased from 1995 to 2007 (84 points versus 67 points) while the gap between White and Asian students reversed and has grown during the same time period (Gonzales et al., 2008). The report indicated that in 1995, Whites scored higher than Asian students did by an average of 16 points, but in 2007 Asian students scored higher than White students did by an average of 32 points.

In 2007, there were 48 countries participating in the eighth grade administration and the average U.S. score of 508 was higher than the TIMSS scale average of 500 (Gonzales et al., 2008). The report also indicated that the U.S. scored higher than 37 of the other 47 countries, and the five countries that scored higher than the U.S. were all in Asia. There was no measurable difference with the remaining five countries (Gonzales et al., 2008). Just as with the fourth grade scores, the percentage of U.S. students in eighth grade at or above each of the four international benchmark levels was higher than the international median (Gonzales et al., 2008). Additionally, 6% of the U.S. eighth graders scored at or above the advanced international benchmark compared with the international median of 2%, and only seven countries had more students scoring at or above the advanced benchmark. Compared to the U.S. average score of 508, Asian and White students scored higher, 549 and 533 respectively, and Hispanic and Black students scored lower, 475 and 457 respectively (Gonzales et al., 2008). The scores of the Hispanic and Black students were also lower than the TIMSS scale average of 500 (Gonzales et al., 2008). While the difference in scores between White students and both Black students and Hispanic students was statistically significant, the gap decreased from 1995 to 2007 (Gonzales et al., 2008).

When U.S. scores were analyzed in terms of student eligibility for free or reduced-price lunch, there was an inverse relationship between the percent of students eligible and the scores at both the fourth and eighth grade levels (Gonzales et al., 2008). The report further indicated that in the fourth grade, schools with at least 75% eligibility for free or reduced-price lunch had an average score below all other categories of school poverty, as well as below the national average and the TIMSS scale average. Schools with 50% to 74.9% of fourth grade students eligible for free/reduced price lunch scored higher than the TIMSS scale average, but lower than the national average. In eighth grade, schools that had at least 50% of the students eligible scored below both the national average and the TIMSS scale average (Gonzales et al., 2008).

Extended Time Strategies

Many states have implemented end of course exams and graduation exams in order to ensure that all high school students graduate prepared for adult success (Balfanz, Letgers, & Jordan, 2004) and are college and career ready (Achieve, 2015). The increased demand for standardized testing has placed tremendous pressure on schools, teachers, and students to raise scores (Bowker & Irish, 2003; Camel & Chung, 2002;

Dangler, 1994). For high school students who struggle in mathematics, Georgia began to offer a mathematics support class for elective credit (GaDOE, 2012b). This course was to be taught concurrently with the student's regular mathematics class and used as an early intervention for student success. According to the Mathematics Graduation Requirement Guidance published by the GaDOE (2012b):

> The purpose of the mathematics support courses is to address the needs of students who have traditionally struggled in mathematics by providing the additional time and attention they need in order to successfully complete their core academic mathematics course without failing. (p. 28)

Along with the push for increasing academic rigor, there has been an increase in the number of students who need extra help (Balfanz et al., 2002). Traditionally high schools had different tiers, or tracks, of course offerings. Only students in the top tier were expected to receive, and master, challenging material. With the movement to have all students take rigorous courses, the tiered system has vanished; all students have been expected to master challenging material. The concept of extra help has been changed. Extra help has become more about supporting students in their learning and mastery of rigorous intellectual work rather than remediating students (Balfanz et al., 2002). Many schools and districts across the nation have implemented the practice of doubling the amount of time struggling students spend in reading and mathematics (Cavanagh, 2005; Nomi & Allensworth, 2009).

A generally held belief has been that increased time spent in a classroom resulted in increased student learning (Gould, 2010). This belief has been supported and encouraged with the current federal funding tied to federal educational priorities (Oxley

& Baete, 2012). Summer school programs and Saturday school programs have provided some students with the extra help they needed in order to master more rigorous material, but these programs were not enough (Balfanz et al., 2002). According to Gould (2010),

> Used appropriately, time is a precious resource that could be used to foster student learning rather than constrain student learning. Changing the current organizational structure to use time as a means to meet the individual learning needs of each individual student is a viable method of improving student academic achievement (p. 100).

Time needs to be found during the regular school day. Piper, Marchaned-Martella, and Martella (2010) reported that increased academic learning has been correlated with increased instructional time. Schools with federal School Improvement Grants are required to provide increased learning time for students through redesigning the school day (Oxley & Baete, 2012). One form of increased learning time has been double-dosing, which has allowed for additional instructional time during the school day and has been found to be an effective intervention (Cortes, Goodman, & Nomi, 2013; Nomi & Allensworth, 2013; Piper et al., 2010). Double-dosing is the most common form of support for struggling students in that nearly half of large urban districts report using this strategy (Council of the Great City Schools, 2009).

Talent Development High Schools

Balfanz, Legters, and Jordan (2004) reported on the ninth grade instructional program of the Talent Development High Schools (TDHS) in Baltimore, Maryland. The program sought to accelerate the learning of poorly prepared students entering high school using a Ninth Grade Success Academy (Balfanz et al., 2004). The Academy operated on a 4 x 4 block schedule in a separate location on the high school campus with its own principal, and students were taught by a team of teachers with a common planning period. Additionally, these students received a double-dose in both reading and mathematics instruction through 90 minutes of mathematics and reading each day of the school year. First semester courses in reading and mathematics were research based courses specifically aimed at helping these students to overcome their poor prior preparation, so that during the second semester the students were able to take regular Algebra I and English I (Balfanz et al., 2004).

In the first semester reading intervention class, called TDHS Strategic Reading, the focus was on increasing students' reading fluency and comprehension strategies (Balfanz et al., 2004). According to the study, teachers modeled read-aloud/think-aloud strategies and supplemented this with specific mini-lessons on various comprehension strategies. Students worked on fluency in small cooperative learning teams through paired reading and vocabulary activities. Finally, each classroom had a library of high interest selections to provide for self-selected reading and writing activities. After a semester of these research-based instructional strategies, students took the regular district English I second semester, which was supplemented with the instructional strategies learned during the first semester.

The mathematics intervention class, Transition to Advanced Mathematics, covered topics traditionally taught in a pre-algebra class with an emphasis on using mathematical manipulatives and student discussion of mathematical concepts (Balfanz et al., 2004). The second semester regular Algebra I class used supplemental materials that emphasized reasoning and understanding of concepts.

Of the nine nonselective high schools in Baltimore, three were chosen to be experimental schools and were matched with three demographically similar schools in the 1999-2000 school year (Balfanz et al., 2004). Balfanz et al. (2004) reported that there were school level implementation issues even though the study had high levels of support from the district level. There were eight teachers who taught the reading intervention class across all three experimental schools with a total of 20 classes of 257 regular education students. Through the weekly implementation support classroom visits one teacher was characterized as having high implementation, five with medium implementation, and two with medium to low implementation. For the mathematics intervention class, Balfanz et al. reported that there were seven teachers across the three experimental schools with a total of 16 regular education classrooms and 140 regular education students. Four of these teachers were rated as having medium-high implementation, two with medium-low implementation, and one with low implementation.

In the control schools, Balfanz et al. (2004) reported that the students were also in an Academy setting and received 90 minutes of instruction in reading and mathematics all year just as the experimental schools; however, these schools designed their own first semester course, which had an emphasis on preparing students for the Maryland State Functional writing and mathematics test. There were a total of 200 students in the reading classes and 233 students in the mathematics classes (Balfanz et al., 2004).

Balfanz et al. (2004) found that prior achievement was based on eighth grade scores on the district administered CTBS test. For the main study, the students were given a shortened version of the CTBS-5 Terra Nova achievement test in reading and mathematics in February and May of their ninth grade year. Finally, scores on the Maryland State Functional test were collected and school records were used to calculate course pass rates (Balfanz et al., 2004). When the data were analyzed the eighth grade to May and the February to May comparisons indicated that students in the experimental schools significantly outperformed the students in the control schools in terms of overall achievement as well as achievement gains (Balfanz et al., 2004). With regard to the scores on the Maryland State Functional tests in reading, writing, and mathematics Balfanz et al. reported the experimental schools had approximately equivalent value-added gains when compared to the control schools. Balfanz et al. also reported the experimental schools had higher Algebra I pass rates. It is important to note that these significant gains were achieved in less than ideal implementation settings (Balfanz et al., 2004).

Balfanz et al. (2004) reported that there was a second field test conducted in Philadelphia the following school year. During the 2000-2001 school year, three nonselective high schools used the TDHS materials in mathematics and reading first semester and the school district's regular Algebra I and English I class materials second semester (Balfanz et al., 2004). These three high schools were matched with similar schools as controls. The control schools had similar demographics, prior achievement, and attendance rates; however, these students did not receive a double-dose of mathematics or reading (Balfanz et al., 2004). Balfanz et al. (2004) reported that the overall level of implementation in mathematics was rated as medium, and in reading one school was rated high, one medium, and one low in terms of implementation. All eighth grade students took the Stanford-9 achievement test in April, and the ninth grade students in the study took an abbreviated version of the test in reading and mathematics in May of their ninth grade year (Balfanz et al., 2004). The results of this supplemental study replicated the results of the Baltimore study in that the TDHS students significantly outperformed the control students in both mathematics and reading (Balfanz et al., 2004).

An additional supplemental study was conducted in 2000-2001 (Balfanz et al., 2004). The purpose of this study was to measure the effect of the first semester intervention classes in reading and mathematics (Balfanz et al., 2004). In mathematics, the study included eight high schools across three cities (Baltimore, Philadelphia, and Newark) and in reading; the study included nine high schools in four cities (Baltimore, Philadelphia, Newark, and New York City). Balfanz et al. (2004) reported that all students in these schools participating in the TDHS ninth grade programs were given pre-tests in September and post-tests in January–CTBS-5 in mathematics and Gates-McGinitie in reading. According to Balfanz et al. (2004), the results indicated that intervention classes did help close the achievement gap in reading and in mathematics. Balfanz et al. (2004) reported that in half of the mathematics schools the typical student learned at twice the normal rate, and in five of nine reading schools, more than a third of the students gained two and a half times as much than the average student in the nation. When viewed together, the studies on the Talent Development High Schools ninth grade instructional program indicated that extra help provided to students should include accelerating students' learning and not just the remediation of basic skills (Balfanz et al., 2004).

Chicago Public Schools

Nomi and Allensworth (2009) conducted a study to examine a Chicago Public Schools' policy implemented in 2003 that required all incoming ninth-graders with below average test scores on the mathematics portion of the Iowa Test of Basic Skills to take two periods of algebra a day. The policy was implemented in order to address high failure rates in ninth grade algebra (Nomi & Allensworth, 2009). The study examined five ninth-grade cohorts of ninth grade students entering high school between 2000 and 2004, which totaled 92,432 students in 64 schools. The researchers reported that approximately 85% of the students were eligible for free or reduced lunch, and that the ethnic make-up of the students was 54% Black, 34% Latino, 9% White, and 4% Asian. To evaluate the effectiveness of the policy, Nomi and Allensworth (2009) examined algebra course grades and standardized test scores on the preliminary ACT, the PLAN exam, given in the fall of tenth grade for all five cohorts.

The district provided teachers of the double-dose classes with professional development three times a year (Nomi & Allensworth, 2009). These professional development sessions were designed to provide teachers with suggestions on how to use the extra instructional time for algebra instruction. Additionally, the district provided guidelines for the structure of these double-dose classes: (a) students in the double-dose classes should have the same teacher for both classes, (b) the classes should be offered sequentially, and (c) the students in both classes should be the same. While these recommendations were strongly encouraged, they were not mandated, and in the first year of implementation in 2003, only 80% of the students had the same teacher, 72% of the students took the classes sequentially, and 92% of the students in the regular algebra class were also double-dosed students (Nomi & Allensworth, 2009). The researchers also reported that after the first year the adherence to these guidelines decreased even more.

Nomi and Allensworth (2009) reported that the double-dose policy did not decrease failure rates of the students in the double-dose algebra classes, and it actually increased failure rates of the students in the single algebra class. However, the students in the double-dose classes had significantly higher test scores, almost one-third of a standard deviation, on the standardized test given in the fall of the tenth grade year. This research demonstrated that while students may have learned more in the double-dose classes, the increase in learning was not always accompanied with an increase in grades. Additionally, the authors went on to discuss the fact that the double-dose policy was the least effective for the students with the weakest mathematics abilities. These students did not show an increase in grades or earn a higher score on the test.

Cortes, Goodman, and Nomi (2013) expanded on the work of Nomi and Allensworth (2009) by using data from the first two cohorts of students subjected to the double-dose policy and examined the impact of this policy on longer-term outcomes such as advanced mathematical coursework and performance in those courses, along with high school graduation rates, ACT scores, and college enrollment rates. Cortes et al. (2013) analyzed the results from students just above and just below the threshold for the double-dose requirement, thereby allowing them to compare the impact of this policy on students who were very similar in academic skills, but differed greatly in their exposure to algebra. Thus the scope of work from Nomi and Allensworth was reduced to 11,507 students with scores on the eighth grade mathematics portion of the Iowa Test of Basic Skills who were within 10 percentile points of the cutoff used to assign students to the double-dose class (Cortes et al., 2013). The researchers used longitudinal data from the Chicago Public Schools to track students through college enrollment, which was verified through the National Student Clearinghouse (Cortes et al., 2013).

Students in the Chicago Public Schools took the preliminary ACT, PLAN, in both tenth and eleventh grades (Cortes et al., 2013). The results on these achievement tests indicated that while the students in the double-dosed classes experienced few short-term achievement gains, they had experienced larger long-term achievement gains that persisted at least two years after the double-dose class. Additionally, the students in the double-dosed classes experienced a 17% improvement in high school graduation rates, and were 8.6 percentage points more likely to enroll in college after graduating high school. Cortes et al. (2013) reported other positive effects from the double-dosed cohorts included higher non-math grade point averages in courses taken after ninth grade, scoring 0.20 standard deviations higher on the verbal portion of the ACT, and more likely to pass Chemistry.

Double-dosing Studies

In 2004-2005 Ketterlin-Geller, Chard, and Fien (2008) conducted a study to examine the effects of two supplemental mathematics interventions in a fast-growing district in the Pacific Northwest. One of the interventions studied was a conceptually-based intervention aimed at reteaching fundamental mathematics concepts, and the other one was extended time. The district included both rural and suburban areas and had a large migrant population. All six of the schools participating in the study qualified for Title I funds, and the district did not meet AYP in 2004-2005. The study encompassed a 16 week period and included a total of 51 low-performing fifth grade students. Students participating in the interventions attended 30-45 minute sessions after school 4 days a week.

In the fall of 2004, a mathematics screening test was administered to all fifth grade students and those selected to participate scored in the lowest 40th percentile (Ketterlin-Geller, Chard, & Fien, 2008). These 51 students were randomly assigned to the treatment groups: 17 to the conceptually-based intervention (Knowing Math), 26 to the extended time core group, and 8 to the control group. The ethnic breakdown of the participants was 69% White, 15% Hispanic, 12% Black, and 4% Asian/Pacific Islander. Additionally, 13% of the students spoke a language other than English and 29% received special education services. Finally, 54% of the participants were females and 46% were males.

There were 13 teachers who participated in the project, seven of which administered the Knowing Math intervention and the other six administered the Extended Core intervention (Ketterlin-Geller et al., 2008). Prior to implementing the interventions, the teachers received two days of training on the intervention, and 6 weeks into the intervention a follow-up training was conducted (Ketterlin-Geller et al., 2008).

Ketterlin-Geller et al. (2008) reported that there were several measures used to evaluate the project: *DIBELS Oral Reading Fluency*, a locally created district math screener test, the *Knowing Math* test, and the statewide accountability test in mathematics. The *DIBELS Oral Reading Fluency* test is a standardized test that measures accuracy and fluency with connected text and was administered to determine reading levels, because differences in reading skills can contribute to poor mathematics performance (Ketterlin-Geller et al., 2008). Ketterlin-Geller et al. (2008) reported that the locally created district math screener test was checked for validity and reliability, was found be to be both valid and reliable, and was administered in the fall, winter, and spring. The *Knowing Math* test was created by the authors of *Knowing Math* and was designed to assess how well students learned the concepts and methods taught in that intervention (Kellerlin-Geller et al., 2008). The statewide accountability test in mathematics administered every year in grades three through eight measures student knowledge in five mathematical domains and has well documented validity and reliability (Ketterlin-Geller et al., 2008).

The *Knowing Math* intervention was specifically designed for students who were at least 2 years below grade level and included scripted daily lessons for the teacher (Ketterlin-Geller et al., 2008). The lessons were designed to encourage student discourse around common misconceptions and build student knowledge around these concepts (Ketterlin-Geller et al., 2008). The *Extended Core* intervention was designed to allow students extra time to master the concepts taught in the regular core curriculum (Ketterlin-Geller et al., 2008). In this intervention, the teachers demonstrated strategies, worked more examples, taught vocabulary strategies, and provided students with extra practice. Finally, students in the control group received no additional support outside of the regular mathematics class.

Ketterlin-Geller et al. (2008) reported no significant difference in the treatment groups on the district math screener test or the statewide accountability test in mathematics, and that the results indicate that both strategies help students gain proficiency. Therefore, interventions designed to reteach fundamental mathematics concepts and those designed to provide extra time for students can both increase student achievement in mathematics (Ketterlin-Geller et al., 2008).

Piper, Marchand-Martella, and Martella (2010) conducted an action research study to determine the effectiveness of explicit instruction and double-dosing to at-risk students in a middle school in the suburbs of a midsized city in the Pacific Northwest. The school had an enrollment of 817 students, all seventh and eighth graders, and approximately 18% of the students qualified for free and reduced lunch. The school was approximately 92% White and 8% from culturally diverse backgrounds. The participants for the study consisted of two groups of students, an at-risk group and a peer group. The at-risk group consisted of eight participants, six girls and two boys, all White. The participants for this group were selected based on three criteria. First, they did not meet the minimum academic requirements on the sixth-grade Washington Assessment of Student Learning. These students also scored below 40% on the district mandated mathematics diagnostic test, which was given to all students at the beginning of the school year. Finally, the participants scored below 70% on mathematics assessments that were administered during the fall quarter of their seventh-grade year. The peer group consisted of 49 participants, all performing at grade level in mathematics (Piper et al., 2010).

All of the students in the study were taught by the same mathematics teacher and were mixed within two periods of seventh-grade mathematics instruction (Piper et al., 2010). A pre-test was administered to the at-risk participants in order to evaluate the specific needs of the students. The pre-test consisted of two sections, a 22 question calculator section and a 26 question noncalculator section. The 44 question posttest was administered to all students. There were 18 questions on the noncalculator section.

There were 31 days in the instructional period of the research study (Piper et al., 2010). The unit of instruction during this time period was ratios, proportions, and percentages. The unit was an inquiry unit from *Connected Math Project*, called Comparing and Scaling. Of those instructional days, 24 were allocated for explicit instruction and seven were allocated for inquiry-based lessons. Students in the at-risk group attended a double-dose mathematics period one day each week for 25 minutes. During the double-dose period, skills were reviewed and practiced from previously taught lessons. On the post-test, the participants in the at-risk group performed near their peer group. Piper et al. (2010) reported that there were large increases for both the noncalculator and the calculator assessments across all the at-risk participants.

Gould (2010) conducted a study in a large suburban high school district in Illinois to determine the effectiveness of an extended time algebra class and associated teacher professional development, on improving student mathematics performance. The school had an enrollment of 3,944 students with approximately 6.3% of the students classified as economically disadvantaged. The student population was 78.6% White, 6.1% Black, 10.8% Hispanic, 2.3% Multiracial, and 2.2% other. The study was a mixed-methods design using a control group, the standard algebra class, and an intervention group, the extended algebra class. The ninth-graders were divided into two groups based on their scores on the EXPLORE test given at the end of their eighth grade year. The control group consisted of 341 students, and they received 46 minutes of algebra instruction every day. The intervention group consisted of 178 students, and they received the extended instructional time and met for 82 minutes every day. Each group was administered a pre- and a post-test and mean growth scores were used to determine the amount of academic achievement. The data indicated that students in the intervention group, the extended time algebra class, increased on average 1.46 points when compared to the students in the control group, the standard algebra class. Gould concluded that extra learning time was effective in not only meeting the individual learning needs of students, but also in increasing student mastery of content.

Kratofil (2013) conducted a case study to examine the effects of a double-dose intervention for high school students in Algebra I. There were 44 participants in the study; 21 were in the intervention during the 2011-2012 school year and 23 during the 2012-2013 school year (Kratofil, 2013). Of the participants, 95% were White and 15.7% were eligible for free and reduced lunch. Participants were selected for the intervention based on teacher recommendations, and the students who participated had to give up an elective class to enroll in the intervention class. Kratofil collected qualitative data through administrator and teacher interviews, parent and student surveys, physical artifacts via student journals, and class observations. Quantitative data included Algebra I grades and scores on the state Algebra I End-of-Course Exam.

The study took place in a school that operated on a block schedule in which students took four 90 minute classes on *A* day and four different 90 minute classes on *B* day (Kratofil, 2013). Students participating in the intervention class had a regular algebra class on one day and the intervention class the next day, thus allowing students to have mathematics every day. The intervention classes were taught by the same teacher who taught the regular algebra class and class size for the intervention class was limited to 15 students. The intervention class supplemented the regular instruction by providing targeted pre-teaching and re-teaching through varied instructional strategies.

To analyze the impact on student achievement, Kratofil (2013) established a comparison group. Scores on the state assessment, student Algebra I grades, and overall grade point averages were compared. Additionally, growth in achievement from eighth grade to ninth grade was compared for the two groups. In each of these analyses, the treatment group showed greater improvement than the comparison group. The qualitative data was used to measure impact on student affect. The interviews and survey results indicated an improvement in student affect. Thus, the intervention not only increased student achievement in Algebra I, but also had a positive effect on student affect (Kratofil, 2013).

Franco (2013) conducted a study on double-dosing and middle school mathematics student achievement in a small suburban community in Oregon. The double-dosing took place in a mathematics lab setting. There were a total of 109 students in grades six through eight who were below the math benchmark in the study. Of those students, 53 were double-dosed and 56 were not double-dosed. There was no demographic data on the participants, however the school consisted of 74% White, 17% Hispanic, 2% Black, 2% Asian/Pacific Islander, and 5% Other. In the school, 41% of the students were economically disadvantaged, 12% of the students had limited English proficiency, and 19% of the students were enrolled in special education (Franco, 2013). Students were selected for the mathematics lab class based on the following criteria: did not pass the Oregon Assessment of Knowledge and Skills (OAKS), teacher recommendation, good attendance, and on track for a regular diploma (Franco, 2013).

Students enrolled in the mathematics lab class have to give up an elective class. Franco (2013) used OAKS data and student grades from the 2012–2013 school year to evaluate the effectiveness of the mathematics lab class.

In Oregon, student achievement is measured by growth performance on the OAKS. Therefore, student growth percentiles have been used in Oregon very similarly to the SGP in Georgia. The OAKS compares students to similar academic peers (Franco, 2013). Franco (2013) used independent-samples *t* test to determine the effectiveness of the mathematics lab class by comparing the mathematics achievement of students who were double-dosed to those who were not. The data indicated that there was significant growth for the students who were double-dosed through the mathematics lab class (Franco, 2013). He also found a significant difference in the mathematics grades of the two groups of students, where the students who were double-dosed through the mathematics lab class received significantly higher grades in their regular mathematics class.

My study will add to the body of knowledge on double-dosing as a method of intervention to help struggling students. While there have been a few studies on the effectiveness of double-dosing, none have been conducted in Georgia, and only one study used growth percentiles as a measure. This study will add to the body of knowledge available on double-dosing and provide the leaders at the school and district level with knowledge that will help them make informed decisions.

Chapter III

RESEARCH DESIGN AND METHODOLOGY

In this study, I analyzed the EOCT scores, the SGP of ninth grade students enrolled in Coordinate Algebra, and those enrolled in Coordinate Algebra with Support during the school years 2012-2013 and 2013-2014. The data used for the study were archival data. In this chapter I have discussed the context of the study, participants, design, instrumentation, data collection, data analysis, and limitations of the study.

Research Question 1. Do students enrolled in a Mathematics Support class achieve at a significantly higher rate than students who are not enrolled in a Mathematics Support class as measured by the EOCT?

Research Question 2. Are scores on the mathematics EOCT significantly higher for the 2013-2014 school year as compared to the 2012-2013 school year?

Research Question 3. Do students enrolled in a Mathematics Support class demonstrate more growth than students who are not enrolled in a Mathematics Support class as measured by the SGP?

Research Question 4. Are the SGP in mathematics significantly higher for the 2013-2014 school year as compared to the 2012-2013 school year?

Context

This study was conducted in a large urban middle Georgia school district. The district had 25 elementary schools, seven middle schools, seven high schools, three alternative school programs, and two program schools. Based on the October 2013 Full-

Time Equivalent report to the state, the total enrollment of the School District was approximately 24,000 students (GaDOE, n.d. e), and approximately 81.9% qualify for free or reduced lunch (GaDOE, n.d. c). The ethnic make-up was 73.6% Black, 18.7% White, 3.9% Hispanic, and 3.8% other (GaDOE, n.d. d). Of the total enrollment, approximately 2,100 were freshmen. According to the 2013 CCRPI report, the 4-year graduation cohort rate was 61.1% (GaDOE, n.d. b).

The participants in this study were selected based on their freshman mathematics course enrollment during school years 2012-2013 and 2013-2014. Students enrolled in the Coordinate Algebra class were selected based on prior mathematics enrollment. From this group only students with an EOCT score, an SGP score, and an eighth grade mathematics CRCT were included. Students were then categorized as *with Support* or *without Support* depending on whether or not they were concurrently enrolled in a Mathematics Support class.

Ethical Considerations

This quantitative research study was conducted through the collection of archival data from the school district, thus the risk to participants was nominal. I obtained approval from the Superintendent of the school district and Valdosta State University's Institutional Review Board (see Appendix A) prior to the collection and analysis of any data. Strict confidentiality and security measures were taken to protect the identity of all students and identifying information was deleted from the data files. Participants were assigned to one of two groups based on their freshman mathematics course enrollment.

Instrumentation

The Georgia Coordinate Algebra EOCT was used as one measure of student achievement (GaDOE, n.d. h). This test comprised 20% of the students' final course grade and aligned with the content standards for the course (GaDOE, n.d. h). The assessment measures specific content knowledge and skills and was also used to evaluate the effectiveness of classroom instruction. Beginning with the 2011-2012 school year the EOCT became part of Georgia's high school accountability measures (GaDOE, 2014c). Scores are reported in the form of scale score, grade conversion score, performance level (does not meet, meets, exceeds), and domain level information. For this study, student scale scores were used.

The second measure of student achievement was quantified using Student Growth Percentiles (SGPs), which described a student's growth relative to other students in the state, who had a similar academic history (GaDOE, n.d. f). These scores range from 1 to 99 with lower values indicating lower growth and higher values indicating higher growth (GaDOE, n.d. f). The SGPs provided an additional means of analyzing student performance by providing data about the student's growth in mathematical knowledge when compared to their academic peers.

Students' prior mathematics achievement were measured using their eighth grade mathematics CRCT scores (GaDOE, n.d. i). According to the GaDOE, the CRCT is specifically intended to test Georgia's performance/content standards outlined in the CCGPS/GPS curriculum (GaDOE, n.d. i). The eighth grade mathematics CRCT has been administered every spring since 2000. Like the EOCT, the CRCT measures specific content knowledge and skills. It is also used to evaluate the effectiveness of classroom instruction and has been a part of Georgia's accountability system since the implementation of NCLB. Scores are reported in the form of scale score, performance level (does not meet, meets, exceeds), and domain level information. For this study, student scale scores were used.

Validity and Reliability

Every year the GaDOE publishes *An Assessment and Accountability Brief* for the EOCT and a separate brief for the CRCT. Each brief addresses both validity and reliability (GaDOE, 2013a; GaDOE, 2013b). The validity of each test is discussed in three sections: content/curricular validity, construct validity, and criterion-related validity. Reliability for each test is reported using Cronbach's alpha reliability coefficient and the Standard Error of Measurement (SEM). The GaDOE oversees the development of both tests and adheres to the 1999 *Standards for Educational and Psychological Testing* (GaDOE, 2013a; GaDOE, 2013b).

EOCT. The purposes of the EOCT are two-fold: to assess how well students have mastered the state curriculum, and to improve student achievement by providing diagnostic data (GaDOE, 2013b). Therefore content/curricular validity is based upon how well the EOCT matches the curriculum standards for the course, as well, as how the scores from the assessment inform the various stakeholders regarding the performance of students. The content standards, then, are the beginning of the test development process. The GaDOE's Accountability Brief states that the test development process relies heavily on the inclusion of educators from around the state because they are responsible for interpreting and delivering the instruction of the mandated curriculum. Committees of educators from around the state, under the guidance of GaDOE and the assessment contractor, conduct a curriculum review and decide upon a *test blueprint* and *test specifications*. These documents indicate which standards will be assessed and how they will be assessed. These documents are then used to create *content domain specifications* that indicate how the standards will be grouped into domains. From this, an additional document is produced; *test item specifications*, that provides details about the items that are to be written, such as the cognitive complexity and the item format. (GaDOE, 2013b).

All of these documents, with the exception of the *test item specifications*, are then combined into one document, the *EOCT Content Descriptions*, and published on the GaDOE website (GaDOE, n.d. h). The GaDOE website also features a Content Weight document, which shows the distribution of items by domain that are included on each content area test.

The specifications detailed above are provided to the assessment contractor for the item writing portion of the process (GaDOE, 2013b). Thus, the items are written by professional assessment specialists. Once written, these items are then reviewed by committees of Georgia educators with respect to alignment with the curriculum, as well as potential bias and sensitivity issues (GaDOE, 2013b). Items can be accepted as written, revised, or rejected. Acceptable items are then embedded in operational tests as field test items. The GaDOE Accountability Brief (2013b) describes the process as follows:

> After the items have been field tested, another committee of Georgia educators examines the items again, along with the data from the field test. The committee reviews how items performed in terms of how many

students selected the correct answers and how many students selected each incorrect answer. The review also includes an analysis of how different groups of students performed to detect potential bias (i.e., did the item appear to favor one group of students over another?). Once again, the review committees have the authority to accept items as is, revise items for re-field testing, or reject items. Accepted items are then banked for future inclusion on an operational test form. Only after items have been field tested and approved by Georgia educators do they appear on an operational test form…Items are carefully selected for a test form based on the blueprint developed by Georgia educators…Each form of a test must assess the same range of content as well as carry the same statistical attributes…Tests must be equated…Equating refers to the use of a statistical procedure to make sure that tests are of equal difficulty. This process is critical because it ensures that students are always held to the same standard…When a test is administered for the first time, performance level standards must be established for the test…The final stage in test development is to produce scores and distribute results. Scores are typically reported as scale scores and performance levels" (p. 3).

The contractors for the EOCT provide documentation for each phase of the test development process (GaDOE, 2013b). This documentation and the input from Georgia educators at each phase of the test development provide validity of the assessment. Further evidence of validity comes from separate independent alignment studies ensuring that the assessment measures the state's curriculum. The GaDOE also conducts analyses of external validity by comparing the EOCT with other assessments with similar content (GaDOE, 2013b).

The two measures of construct validity are item point-biserial correlations and Rasch fit statistics (GaDOE, 2013b). An item with a high point-biserial correlation means that item required knowledge of the construct in order for it to be answered correctly; i.e., the item discriminates between high-ability and low-ability students. The statistics produced by the Rasch model demonstrate that the items fit the measurement model and are monitored closely during the test development process to ensure construct validity.

Criterion-related validity refers to how accurately test scores describe the criterion performance (GaDOE, 2013b). The criterion should be relevant and reliable, and the results should be in agreement with other measures of mathematics achievement.

The state reports two reliability indices, Cronbach's alpha reliability coefficient and the Standard Error of Measurement (SEM). Cronbach's alpha measures internal consistency and ranges from 0 to 1. The values for the Spring 2013 Coordinate Algebra EOCT are 0.87 and 0.86 for the two forms given and are 0.91 and 0.89 for Spring 2014. These values are in the range of industry standards and suggest reliability of the test scores. The SEM quantifies the precision of the test scores. The SEM values range from 3.29 for both forms of the test in Spring 2013 and are 3.22 and 3.21 for Spring 2014. These values indicate generally high reliability and support the tests' claim for validity (GaDOE, 2013b).

CRCT. The two main purposes of the CRCT are to measure how well students have mastered the state curriculum and to inform various stakeholders about students' performance (GaDOE, 2013a). Therefore content/curricular validity is based upon how well the CRCT matches the curriculum standards for the course, as well, as how the scores from the assessment inform the various stakeholders regarding the performance of students. The test development process of the CRCT mirrors that of the development of the EOCT as described above. The GaDOE Accountability Brief (2013a) describes the development process as follows,

> Foremost, the CRCTs have a high degree of validity because they serve the purpose for which they are intended–to measure student mastery of the state's curriculum. Validity is established via the process of test development. The careful development from inception of the CRCT testing program and all steps in-between such as alignment with curriculum, creation of test and item specifications, multiple reviews by educators, and careful form construction by content experts and psychometricians provide evidence that the CRCT are valid instruments for the uses for which the department has developed the test. (p. 6)

The state reports two reliability indices, Cronbach's alpha reliability coefficient and the Standard Error of Measurement (SEM). Cronbach's alpha measures internal consistency and ranges from 0 to 1. For both Spring 2013 and Spring 2014, Cronbach's alpha for eighth grade mathematics CRCT is 0.92. These values are in the range of industry standards and suggest reliability of the test scores. The SEM quantifies the precision of the test scores. The SEM value for Spring 2013 is 3.15 and Spring 2014 is

3.16 indicating generally high reliability and support the test claims for validity (GaDOE, 2013a; GaDOE, 2014a).

Data Collection Procedures

Data for this study were archival data from school years 2012-2013 and 2013-2014. Data files included data for first time ninth graders only during these school years. Data files were grouped into two categories: students enrolled in a support class and students not enrolled in a support class. For each category student SGP, EOCT, and eighth grade mathematics scores were analyzed.

Participants

According to the GaDOE March 2013 FTE data there were 2,164 freshmen enrolled in the high schools included in this study for the 2012–2013 school year (GaDOE, n.d. e). Of those students, there were 1,294 students who met all criteria: first time freshman, enrolled in Coordinate Algebra, had an eighth grade mathematics CRCT score, a Coordinate Algebra EOCT score, and an SGP. Approximately 36% of the students were concurrently enrolled in the Mathematics Support class. The sample consisted of 49% males and 51% females. The racial breakdown was 16% White, 79% Black, and 5% other. There were not enough English Learners to use as a reporting group; however 82% were economically disadvantaged and 8% of the students were students with disabilities. See Table 1 for a breakdown of the demographics.

For the 2013–2014 school year, the Georgia Department of Education March FTE reported 2,011 freshmen students enrolled in the high schools included in this study (GaDOE, n.d. e). Of those students, there were 1,109 students who met all criteria as stated above. Approximately 33% of the students were concurrently enrolled in the

Mathematics Support class. There were 57% males and 43% females. The racial breakdown was 13% White, 78% Black, and 9% other. There were not enough English Learners to use as a reporting group; however, 95% of the students were economically disadvantaged, and 5% of the students were students with disabilities. See Table 1 for a breakdown of the demographics.

Table 1

Demographic Distribution of Ninth Grade Algebra Students (N = 2403)

	2012–2013 (*n* = 1294)		2013–2014 (*n* = 1109)	
	With Support	Without Support	With Support	Without Support
Ethnicity				
White	40	167	56	88
Black	407	611	285	584
Other	15	54	29	67
Gender				
Male	224	406	203	427
Female	238	426	167	312
Economically Disadvantaged				
Yes	402	660	313	739
No	60	172	57	122
Students with Disabilities				
Yes	66	35	20	40
No	396	797	350	699

Data Analysis

This study was designed to assess the effectiveness of the Mathematics Support class as measured by EOCT and SGP data. I had no control over the assignment of students to the two groups, with or without the Support class; the inclusion of a covariate was helpful in reducing possible error variance (Mertler & Vannatta, 2005). According to Mertler and Vannatta (2005), an analysis of covariance allows group differences to be determined while controlling for the effect of a concomitant variable, in this case prior mathematics achievement. The use of an ANCOVA improved the efficiency of the research design by adjusting for the effect of a variable that was related to the dependent variable (Mertler & Vannatta, 2005). Because the dependent variables in this study, EOCT and SGP scores, could have been partially influenced by prior mathematics achievement, the use of an ANCOVA was selected to analyze the data. Therefore, in order to answer Research Questions 1 and 2, a 2 x 2 ANCOVA was utilized and a separate 2 x 2 ANCOVA was used to answer Questions 3 and 4.

One of the assumptions of an ANCOVA is homogeneity of regression (Mertler & Vannatta, 2005). The assumption is that the regression slopes for each group in the analysis are equal (Mertler & Vannatta, 2005). If this assumption had not been fulfilled, then the data would have been analyzed using a 2 x 2 ANOVA, which does not have this assumption (Mertler & Vannatta, 2005). The assumption was fulfilled.

Limitations

This study is limited to first time freshmen taking the Coordinate Algebra class in an urban middle Georgia district. The results from this study may not be applicable to other districts in the state of Georgia.

Summary

This chapter provided an overview for the context of the research, participants, design, instrumentation, data collection, data analysis, and limitations of the study. The purpose of this study was to evaluate the effectiveness of the Mathematics Support class as measured by EOCT and SGP data.

Chapter IV

RESULTS

The purpose of this study was to investigate the effectiveness of the Mathematics Support class by analyzing student performance on the End of Course Test (EOCT), and Student Growth Percentiles (SGP) for school years 2012–2013 and 2013–2014 while controlling for CRCT mathematics scores. Archival data from the 2012–2013 and 2013–2014 school years were used in the analysis. The data set for both years included first-time freshmen students enrolled in the Coordinate Algebra class. Students who did not have all three data points (eighth grade mathematics CRCT score, ninth grade EOCT score, SGP) were eliminated from the data set. The following hypotheses were tested using a 2 x 2 ANCOVA.

Main Effect Hypothesis for Support variable for EOCT Mathematics Scores. When controlling for CRCT mathematics scores, students who are not enrolled in a Mathematics Support class will achieve significantly higher EOCT mathematics scores than students who are enrolled in a Mathematics Support class.

Main Effect Hypothesis for School Year Variable for EOCT Mathematics Scores. When controlling for CRCT mathematics scores, students for school year 2013–2014 will achieve significantly higher EOCT mathematics scores than students for school year 2012–2013.

Interaction Effect Hypothesis for Support and School Year Variables for EOCT Mathematics Scores. When controlling for CRCT mathematics scores, there will be no difference in EOCT mathematics scores for non-support students for the 2012–2013 and

2013–2014 school years; however, support students for school year 2013–2014 will score higher on EOCT mathematics scores than support students for school year 2012–2013.

Main Effect Hypothesis for Support variable for SGPs. When controlling for CRCT mathematics scores, students who are enrolled in a Mathematics Support class will achieve significantly higher SGPs than students who are not enrolled in a Mathematics Support class.

Main Effect Hypothesis for School Year Variable for SGPs. When controlling for CRCT mathematics scores, students for school year 2013–2014 will achieve significantly higher SGPs than students for school year 2012–2013.

Interaction Effect Hypothesis for Support and School Year Variables for SGPs. When controlling for CRCT mathematics scores, there will be no difference in SGPs for non-support students for the 2012–2013 and 2013–2014 school years; however, support students for school year 2013–2014 will have higher SGPs than support students for school year 2012–2013.

Data Analysis

A 2 x 2 between-subjects analysis of covariance (ANCOVA) was conducted on EOCT scores to determine the effect of a Mathematics Support class and school year on EOCT mathematics scores while using CRCT mathematics scores as a covariate. The test for homogeneity of regression revealed no significant differences in the regression slope ($F(1, 2396) = 2.162$, $p = .142$), thus CRCT scores were partialed out for the following analyses. There was a significant main effect for school year, $F(1, 2398) = 84.68$, $p < .001$. Students for school year 2013–2014 ($M = 370.87$, *Adjusted* $M = 371.61$, SD = 19.85) scored significantly higher on EOCT mathematics scores than students for school year 2012-2013 (*M* = 365.57, *Adjusted M* = 365.02, SD = 20.80) (see Figure 1). However, the effect size, $\eta p^2 = .034$, is quite small in that the school year accounts for only 3.4% of the variance in EOCT scores.

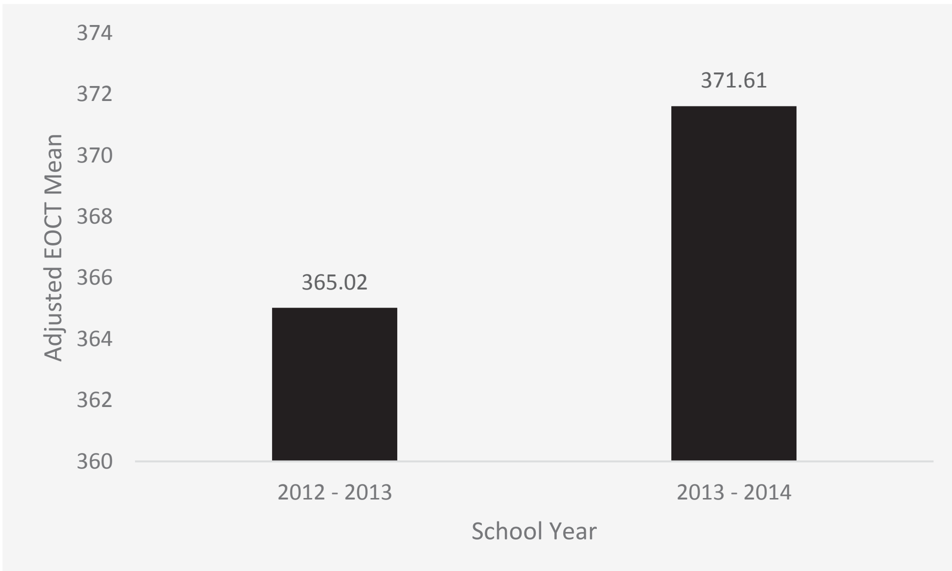

Figure 1. Adjusted mean EOCT scores as a function of school year. Covariate was evaluated at the following value: CRCT = 805.98.

There was no significant main effect for support class, $F(1, 2398) = .139$, $p = .709$. Students in support classes (*M* = 363.02, *Adjusted M* = 368.46, *SD* = 18.89) scored similarly on EOCT mathematics scores as students in non-support classes (*M* = 370.66, *Adjusted M* = 368.17, *SD* = 20.88) (see Figure 2).

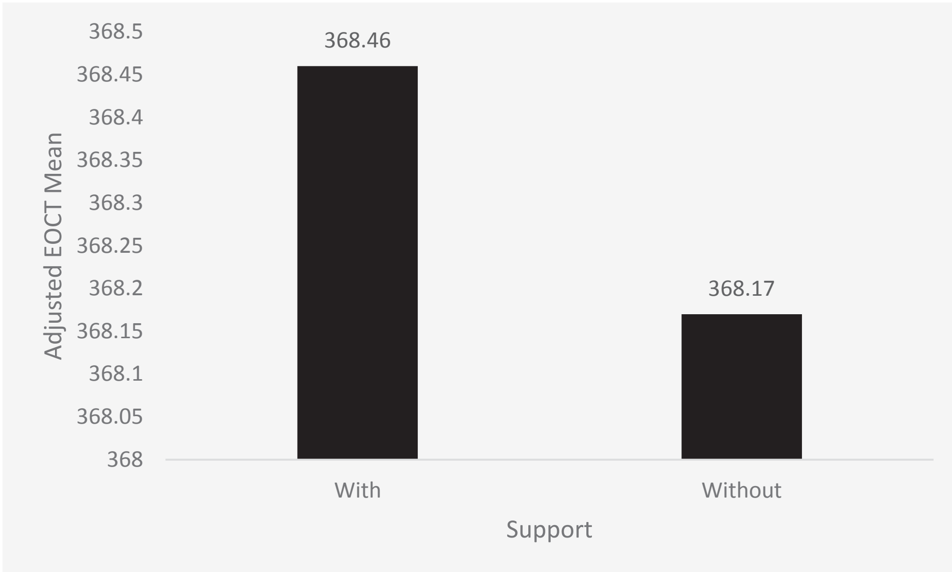

Figure 2. Adjusted EOCT mean scores as a function of support classes. Covariate was evaluated at the following value: CRCT = 805.98.

There was not a significant interaction for school year and support class, $F(1, 2398) = 3.65$, $p = .056$; however, the p value was trending very close to the .05 criterion. Given this trend toward significance, the null hypothesis is rejected and the interaction effect is described. The adjusted means for students in the support classes for 2012–2013 ($M = 360.42$, *Adjusted* $M = 364.47$, $SD = 18.22$) were similar to the students in non-support classes for 2012–2013 ($M = 368.43$, *Adjusted* $M = 365.56$, $SD = 21.59$); however, the adjusted mean scores for students in the support classes for 2013–2014 ($M = 366.27$, *Adjusted* $M = 372.44$, $SD = 19.24$) were slightly higher than students in non-support classes for 2012–2013 ($M = 373.18$, *Adjusted* $M = 370.79$, $SD = 19.76$) (see Figure 3).

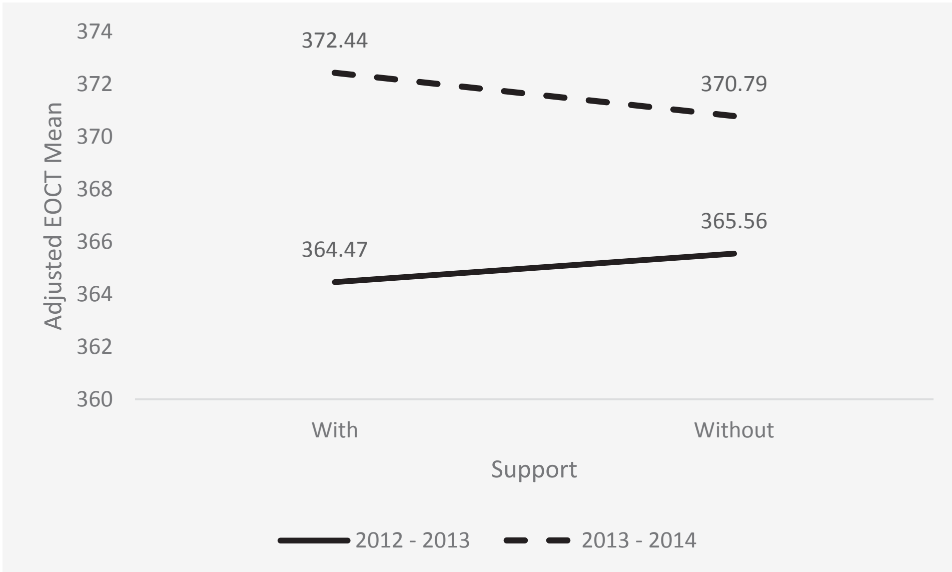

Figure 3. Adjusted EOCT mean scores as a function of school year and support classes. Covariate was evaluated at the following value: CRCT = 805.98.

A 2 x 2 between-subjects analysis of covariance (ANCOVA) was conducted on SGPs to determine the effect of a Mathematics Support class and school year on SGPs while using CRCT mathematics scores as a covariate. The test for homogeneity of regression revealed no significant differences in the regression slope ($F(1, 2396) = 3.673$, $p = .055$), thus CRCT scores were partialed out for the following analyses. There was a significant main effect for school year, $F(1, 2398) = 93.67$, $p < .001$. Students for school year 2013–2014 ($M = 44.36$, *Adjusted* $M = 45.13$, SD = 28.98) scored significantly higher SGPs than students for school year 2012-2013 ($M = 33.35$, *Adjusted* $M = 33.47$, SD = 27.13) (see Figure 4). However, the effect size, $\eta p^2 = .038$, is quite small in that the school year accounts for only 3.8% of the variance in SGPs.

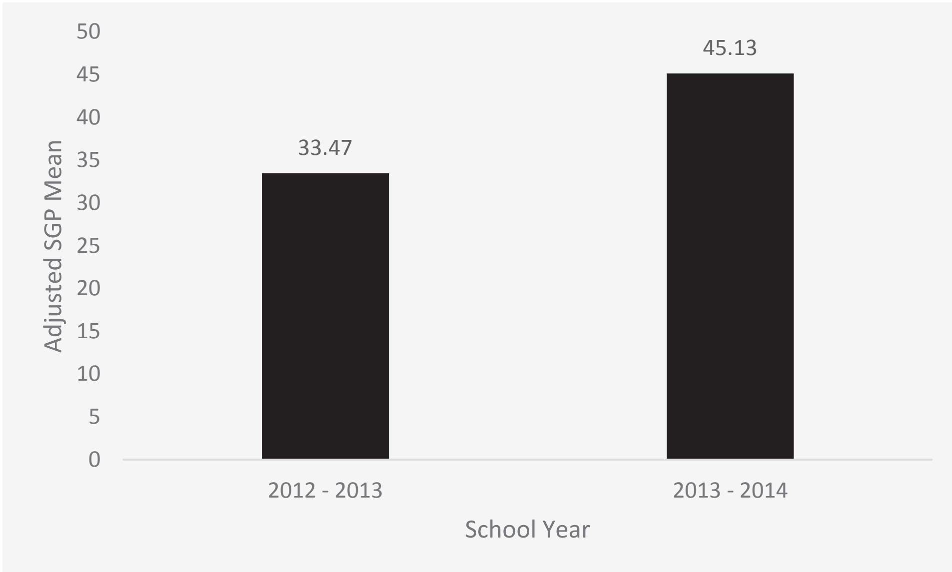

Figure 4. Adjusted SGP means as a function of school year. Covariate was evaluated at the following value: CRCT = 805.98.

There was a significant main effect for support class, $F(1, 2398) = 4.806$, $p = .028$. Students in support classes ($M = 40.46$, *Adjusted M* = 40.69, $SD = 28.89$) had significantly higher SGPs as students in non-support classes ($M = 37.35$, *Adjusted M* = 37.92, $SD = 28.28$). However, the effect size $\eta p^2 = .002$, is very small in that the support class accounts for only .2% of the variance in SGPs (see Figure 5).

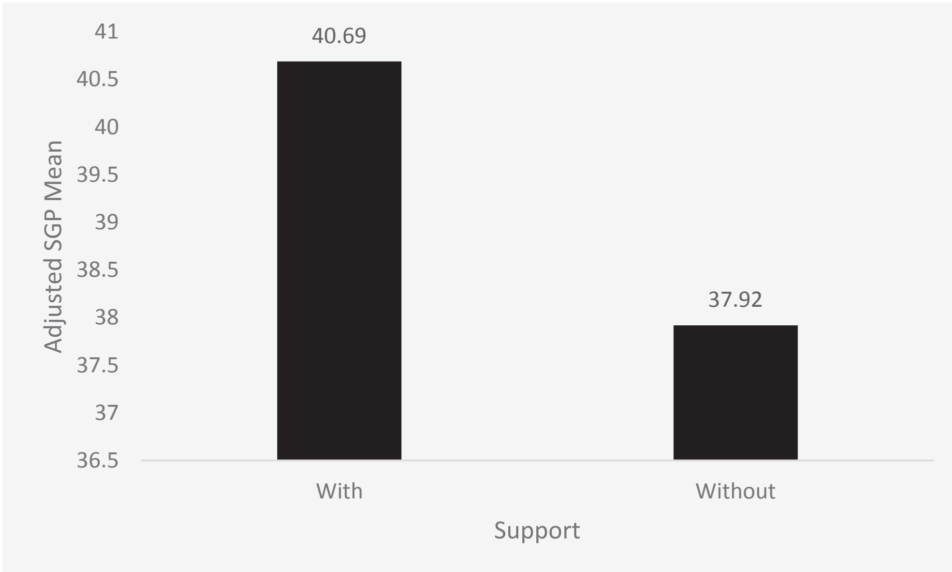

Figure 5. Adjusted SGP means as a function of support classes. Covariate was evaluated at the following value: CRCT–805.98.

There was not a significant interaction for school year and support class, $F(1, 2398) = 3.34$, $p = .068$; however, the p value was trending close to the .05 criterion. Given this trend toward significance, the null hypothesis is rejected and the interaction effect is described. The adjusted mean SGPs for students in the support classes for 2012–2013 ($M = 34.2$, *Adjusted* $M = 33.76$, $SD = 27.01$) were similar the students in non-support classes for 2012–2013 ($M = 32.88$, *Adjusted* $M = 33.19$, $SD = 27.19$); however, the adjusted mean SGPs for students in the support classes for 2013–2014 ($M = 48.28$, *Adjusted* $M = 47.62$, $SD = 29.29$) were slightly higher than students in non-support classes for 2012–2013 ($M = 42.39$, *Adjusted* $M = 42.65$, $SD = 28.64$) (see Figure 6).

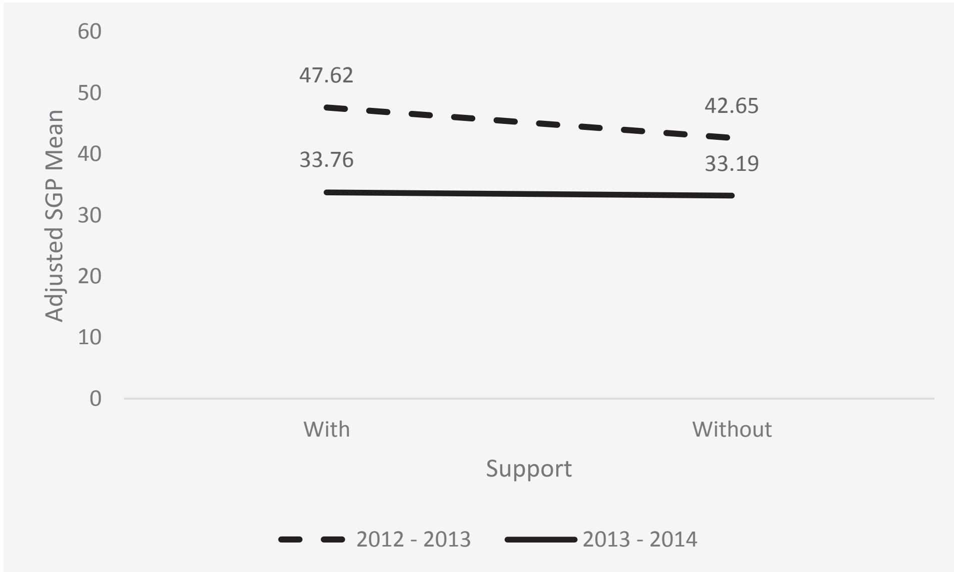

Figure 6. Adjusted SGP means as a function of school year and support classes. Covariate was evaluated at the following value: CRCT = 805.98.

Summary

The purpose of this study was to analyze the effectiveness of a mathematics support class on student EOCT scores and SGPs over two school years. This chapter presented the data analysis and the findings of the study. Descriptive statistics, effect size and ANCOVA results were used to determine the statistical significance of each of the hypotheses for the four research questions.

After a thorough analysis of the findings, it appears that students enrolled in a mathematics support class do not necessarily achieve at a significantly higher rate than students not enrolled in a support class. When analyzing EOCT scores, there was no significant difference between the two groups; however, when analyzing growth scores students enrolled in the mathematics support class did demonstrate significantly higher growth. With respect to EOCT scores and SGPs, both groups in school year 2013–2014 scored significantly higher than in school year 2012–2013. School year 2012–2013 was the first year this curriculum was implemented; therefore, it is not surprising the students in the second year of implementation scored significantly higher in both areas.

Chapter V

SUMMARY, DISCUSSION, AND CONCLUSIONS

Summary

During the 2012–2013 school year, Georgia implemented a new curriculum, CCGPS. The CCGPS increased the rigor of the mathematics curriculum (GaDOE, 2011). In order to support students in this implementation of a more rigorous mathematics curriculum, the GaDOE created a Mathematics Support class to provide students with an extra period of mathematics during the school day (GaDOE, 2012b). This study was designed to determine the effectiveness of this supplemental mathematics class on students' mathematics achievement over the course of 2 years, 2012–2013 and 2013–2014. The effectiveness was measured in two ways. One measure was student achievement scores on the End of Course Test for both years of the study. The second measure was student growth as measured by the Student Growth Percentiles for both years of the study. Participants were divided into two groups: those enrolled in the supplemental mathematics support class and those not enrolled in the supplemental mathematics support class. A 2 x 2 ANCOVA was utilized to analyze the data with prior mathematics achievement as measured by the CRCT as the covariate.

The study was conducted in a large urban middle Georgia school district. District enrollment in October 2013 was approximately 24,000 students with about 2,100 being classified as freshmen (GaDOE, n.d. e). The ethnic make-up of the district was 73.6% Black, 18.7% White, 3.9% Hispanic, and 3.8% Other (GaDOE, Student Enrollment by

Ethnicity). The district 4-year cohort graduation rate for 2013 was 61.1% (GaDOE, n.d. b).

Over the 2 year period of the study, there were a total of 2,403 participants who met all criteria: first time freshmen, enrolled in Coordinate Algebra, had an eighth grade mathematics CRCT score, a Coordinate Algebra EOCT score, and an SGP. Approximately 35% of the participants were concurrently enrolled in the Mathematics Support class. The participants consisted of 52% males and 48% females, and 88% of the participants were economically disadvantaged. The ethnic breakdown was 79% Black, 14% White, and 7% other. Approximately 7% of the participants were students with disabilities. See Table 1 on page 45 for full demographic distribution.

Research Questions

For the purpose of this study, the following research questions were tested. These questions were used to evaluate the relationship between mathematics support courses and student achievement as measured by the EOCT and SGP.

1. Do students enrolled in a Mathematics Support class achieve at a significantly higher rate than students who are not enrolled in a Mathematics Support class as measured by the EOCT?
2. Are scores on the mathematics EOCT significantly higher for the 2013–2014 school year as compared to the 2012–2013 school year?
3. Do students enrolled in a Mathematics Support class demonstrate more growth than students who are not enrolled in a Mathematics Support class as measured by the SGP?

4. Are the SGP in mathematics significantly higher for the 2013–2014 school year as compared to the 2012–2013 school year?

Results

The results of the study indicate the following findings:

1. Students scored significantly higher on both the EOCT and SGP in the second year of implementation.
2. In school year 2012-2013, students had similar scores on the EOCT for both the support class and the non-support class.
3. In school year 2013-2014, students with support scored slightly higher on the EOCT than students without support.
4. Students enrolled in support classes had significantly higher SGPs than students not enrolled in support classes.
5. There was a significant interaction for school year and support classes on both the EOCT scores and the SGPs.

The results of this study provide a basis for further discussion. There was a statistically significant growth in both measures for the second year of implementation. While students in the support class only showed slight improvements on the EOCT scores, they showed significant growth as measured by SGP.

Discussion

Research Question 1

Do students enrolled in a Mathematics Support class achieve at a significantly higher rate than students who are not enrolled in a Mathematics Support class as measured by the EOCT?

There was no significant main effect for support class with students concurrently enrolled in support classes scoring slightly higher on the EOCT as students who were not concurrently enrolled in support classes; however, there was a significant interaction for school year and support class on EOCT scores. Gould (2010) reported similar results in his study of an extended time algebra class. The data in his study indicated that students in the extended time algebra class increased an average of 1.46 points when compared to the control group. However, Nomi and Allensworth (2009) had different results in their study of the double-dose policy implemented in Chicago Public Schools in 2003. They reported that students in the double-dosed classes had significantly higher test scores, approximately one-third of a standard deviation. It is interesting to note that the district implemented other instructional supports concurrently with the double-dosing policy (Nomi & Allensworth, 2009). The teachers who were teaching the double-dose classes received professional development three times a year that focused on what to teach and how to teach in the double-dose class, and also received new curricular materials. Additionally, the district had guidelines that placed the double-dose classes sequentially for students, the same teacher for both classes, and all students in the class were double-dose students. These guidelines had a high implementation rate across the district (Nomi & Allensworth, 2009).

In this study, there was not any professional development with the teachers on strategies for the double-dose support class, nor were there guidelines for implementation. The teachers who were teaching the support class did not get any additional professional development; they received the same professional development that all of the other mathematics teachers received. Additionally, in any one support class, there were students from multiple teachers in the same support class where the teachers might have been in different places in the curriculum.

In the study of the *Talent Development High School* in Baltimore, Maryland by Balfanz, Legters, and Jordan (2004), the intervention class, called Transition to Advanced Mathematics, emphasized conceptual understanding of pre-algebra mathematical topics through the use of mathematics manipulatives and student discussion. This class was followed the next semester with a regular Algebra I class which used supplemental materials, which also emphasized reasoning and conceptual understanding. When compared to the control schools, which implemented an intervention class based on preparing students for the state test, the students in the experimental schools significantly outperformed the students in the control schools both in terms of achievement levels and achievement gains (Balfanz et al., 2004).

According to the guidance from the GaDOE, the Mathematics Support course is to be taught concurrently with the regular math class (GaDOE, 2012b). This is different from the intervention class used in the *Talent Development High School* model, where the intervention class comes first and prepares students for the regular Algebra I class. Additionally, the Transition to Advanced Mathematics course covered pre-algebra topics, whereas the Mathematics Support class is supposed to "focus on mastery of the standards being taught in the associated core academic mathematics course, and not on general content from elementary or middle school" (GaDOE, 2012b, p. 29). Therefore, the content of the Mathematics Support class is to support, or align with, the content in the regular class. This does not allow the teacher to go back to pre-requisite material and fill any gaps in previous knowledge like the Transition to Advanced Mathematics course does.

Research Question 2

Are scores on the mathematics EOCT significantly higher for the 2013-2014 school year as compared to the 2012-2013 school year?

Data analysis revealed a significant main effect for school year with students in 2013–2014 scoring significantly higher on the EOCT than students in school year 2012–2013. As school year 2012–2013 was the first year of implementation for the Common Core Georgia Performance Standards Coordinate Algebra class this result was not surprising. This effect can be thought of as a practice effect, referred to by Shulman (1987) as the wisdom of practice, where the teachers improved the second year because of the experience and knowledge gained in the first year of implementation.

The interaction for support class and school year on EOCT scores was significant. For school year 2013–2014, the adjusted mean scores for students in the support classes were slightly higher than students in the non-support classes. The more experience a teacher has teaching a course, the better his/her students perform (Jacob & Rockoff, 2011). This is due in part to the familiarity of the teacher with the material that the students are expected to master and can be referred to as specialized expertise (Jacob & Rockoff, 2011). This can also be thought of as mathematical knowledge for teaching, described by Hill, Rowan and Ball (2005) as the knowledge that teachers need in order to effectively teach mathematics, such as “explaining terms and concepts to students, interpreting students’ statements and solutions, judging and correcting textbook treatments of particular topics, using representations accurately in the classroom, and providing students with examples of mathematical concepts, algorithms, or proofs" (pp. 4-5). This knowledge comes through experience in teaching the course. Thus, it is not only about what teachers know about the subject matter, but also how they use that knowledge in their classrooms (Hill, Rowan, & Ball, 2005). Teachers therefore need to be able to discern a good assignment from one that is not so good at achieving the purpose of the lesson. Additionally, teachers have to learn how to manage the classroom discussions on the mathematical concepts to maximize student learning. This takes experience and practice. At the end of an instructional unit, effective teachers reflect on the learning that took place and use their own learning experiences to refine practices for the next unit, or for the next school year should they teach the course again (Shulman, 1987). Therefore, in order to maximize student achievement teacher assignments from one school year to the next need to be carefully and critically considered.

Research Question 3

Do students enrolled in a Mathematics Support class demonstrate more growth than students who are not enrolled in a Mathematics Support class as measured by the SGP?

There was a significant main effect for support class on SGP. This finding is in agreement with the results of Franco (2013) and Kratofil (2013). Franco's study was the only other study that I could find where one of the measures of the study used a growth model similar to the one Georgia uses. The Oregon model uses student data from the previous 2 years, as does the Georgia growth model. Therefore, both of these studies used a growth measure to determine effectiveness and both studies found that the double-dosing significantly increased students' growth in mathematics even though many of the characteristics of the study were different. For example, this study was set in a large urban community, and Franco's study was set in a small suburban community. The demographics of this study were majority Black, and the majority of Franco's study was White. The majority of the students in this study were economically disadvantaged, and less than half were economically disadvantaged in Franco's study.

Franco's study (2013) on double-dosing in middle school mathematics indicated that students who were double-dosed had a significant increase in growth when compared to those students who were not double-dosed as well as a significant increase in grades in the regular mathematics class when compared to those students who did not receive a double-dose mathematics lab class. The students in Franco's study were students who had been identified as below grade level mathematics students, and the study took place in a small suburban community in Oregon. While the demographic data of the students in this study are very different from the students in Franco's study, the results are consistent. Whether students are in a large urban setting with a predominantly Black population, or a small suburban setting with a predominantly White population, students' growth in mathematics can be significantly improved through a mathematics intervention class that supports the learning in the regular mathematics class.

Kratofil (2013), in his study on double-dosing students in Algebra I, found that not only did the students in the double-dosed classes significantly outperform students who were not double-dosed on the end of course exam, but they also achieved significant growth as compared to the students who were not double-dosed. Strategies used in the intervention class included pre-teaching upcoming concepts, re-teaching concepts as needed, and repairing foundational skill deficits. One of the key findings of the study was that "extended time by itself is not an effective intervention" (Kratofil, 2013, p. 105).

Kratofil (2013) indicated that five key components were critical to an effective mathematics intervention class: not only extending but also focusing the extended learning time, using a variety of instructional strategies, designing the lessons to address the individual needs of the students, building relationships with the students, and selection of intervention participants who would most benefit from the intervention.

In Kratofil's study (2013), students were on a block schedule where they received regular mathematics instruction on *A* day and the intervention double-dose class on *B* day, thus receiving mathematics instruction every day. Additionally, students were heterogeneously grouped in the regular mathematics class and homogeneously grouped in the double-dose class. This is similar to this study. Students in the regular Coordinate Algebra class were heterogeneously grouped with both support and non-support students in these classes, while only those students who need extra help in the support class. Kratofil reported benefits for students in two ways: students benefited from the heterogeneous classes through interactions with more advanced peers, exposure to a more rigorous curriculum, and the development of more critical thinking skills; and from the homogeneous classes through re-teaching of difficult concepts, pre-teaching of upcoming concepts, and focused tutorials on identified mathematics deficiencies. This is similar to the Georgia Mathematics Support class, which emphasizes re-teaching along with pre-teaching.

Research Question 4

Are the SGP in mathematics significantly higher for the 2013-2014 school year as compared to the 2012-2013 school year?

Data also indicated a significant main effect for school year with SGP. Just as with the EOCT results, the effect reflects practice and experience with the support class, similar to a learning curve. In year one, the teachers had not sufficiently grasped the techniques to be used in neither the support class nor the fine points of the curriculum. With experience, the teachers improved in the use of support techniques and increased in curriculum knowledge in the second year. Thus, in the second year of implementation the teachers are more prepared and can plan teaching strategies more effectively.

There was also a significant interaction of school year and support class on SGP. As stated in the previous paragraph, this can be thought of as a practice effect. With more experience teaching a new curriculum, the better a teacher gets with teaching strategies for that class. Teacher effectiveness is not only about the content knowledge that the teacher possesses, but also more importantly about how that knowledge is used (Hill, Rowan, & Ball, 2005). Experience includes knowing which assignments will yield the best results, how to foster in-depth student discussions, and when to include appropriate skill work. There are three ways in which content needs to be known in order to teach that content effectively: content knowledge, pedagogical content knowledge, and curriculum knowledge (Shulman, 1986). Teacher content knowledge is increased through more content classes; however, pedagogical content knowledge and curriculum knowledge come through experience. There is a positive correlation between the number of mathematics courses pre-service teachers take while still in college and the learning gains of students (Baumert et al., 2010). Pedagogical content knowledge takes the content knowledge of the teacher to another level through understanding of what makes concepts easier or more difficult for students (Baumert et al., 2010; Shulman, 1986).

Teachers have to have a knowledge of a variety of teaching strategies to make concepts more easily understood (Baumert et al., 2010; Shulman, 1986). Thirdly, curriculum knowledge involves an awareness of how concepts should best be arranged in the curriculum and how best to maximize the available resources to increase student achievement (Shulman, 1986). Of these, pedagogical content knowledge affects student achievement the most (Baumert et al., 2010).

Baumert et al. (2010) conducted a 1-year study to assess teacher content knowledge and pedagogical knowledge and the impact on student outcomes. The study was conducted in Germany in 2003–2004 and included a nationally representative sample of grade ten students and their teachers. There was a total of 181 teachers with 194 classes and 4,353 students. Teacher content knowledge was assessed through a paper-and-pencil test with 13 open-ended items that required mathematical argumentation or proof. Pedagogical content knowledge was assessed along three dimensions: tasks, students, and instruction. The test for pedagogical content knowledge consisted of 10 vignettes depicting typical classroom situations, and teachers had to describe as many ways as possible to support meaningful student learning in each situation. Programme for International Student Assessment (PISA) literacy tests were given to students at the end of grade nine, and student content knowledge was assessed at the end of grade ten. Data indicated that pedagogical content knowledge of teachers "has greater predictive power for student progress and is decisive for the quality of instruction" (p. 164). The effect size of teacher pedagogical knowledge was substantial and accounted for 39% of the variance in student achievement. Thus, pedagogical content knowledge greatly affects student learning opportunities in the classroom. Teachers increase their pedagogical content knowledge through training and reflective teaching practice. Having teachers teach the same course for two or more years in a row will greatly increase teacher pedagogical content knowledge thereby increasing student achievement.

Conclusions

This study supports and aligns with previous studies on the effectiveness of double-dose mathematics classes. While students in this study did not demonstrate the significant achievement gains found in other studies, there were key differences in the design. This study did not include any additional professional learning for teachers nor did this study include any additional implementation guidelines for the support class. Even so, students did demonstrate slightly significant achievement gains. However, when looking at student growth in mathematics, this study did have significant findings. The additional mathematics class did provide more instructional time for students to master concepts taught in the regular mathematics class. Students in the Mathematics Support class did demonstrate significant growth when compared to students who were not enrolled in the Mathematics Support class. The most successful double-dose approaches are those that are accompanied by instructional supports, including professional development for teachers and effective curricular materials (Nomi & Allensworth, 2013), the use of a variety of instructional materials (Kratofil, 2013), as well as remediation coupled with access to grade level material (NCTM, 2008).

Both measures, the EOCT scores and the SGP data, were significantly higher the second year of the study when compared to the first year. The first year of this study was the very first year of the new curriculum. This means that teachers did not have the benefit of asking teachers who had taught this class before for advice or suggestions.

These teachers were the first ones to teach this class. The second year the teachers benefitted from what can be called a practice effect. After having taught the course for one year, teachers were familiar with the mathematical concepts as well as strategies that can be used to teach the concepts. Therefore, teacher assignments from one year to the next should be carefully considered as that can have an impact on student achievement.

Limitations

The purpose of this study was to determine the effectiveness of the Mathematics Support class on student achievement as measured by scores on the EOCT and SGP data. The interaction effects for both the EOCT scores and the SGP data were marginally significant as both were slightly over the benchmark of $p = .05$. Based on the studies in the literature review, studies that demonstrated significant effects included teacher professional development, whereas this district did not include professional development for the teachers teaching the Mathematics Support class.

Suggestions for Future Study

Using student growth percentiles to evaluate students is new to Georgia and the only other study I could find using growth percentiles was in Oregon, where it was new as well (Franco, 2013). More studies are needed with the use of growth percentiles as a measure of effectiveness. Additionally, future studies should include study of special populations. While this study and the ones identified in the literature review were mostly general education students with small special education and English Learner subgroups, additional study is needed on the impact of double-dosing intervention classes on these subgroup populations.

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APPENDIX A:

Institutional Review Board Oversight Screening Form for Graduate Student Research

Valdosta State University Graduate School

Institutional Review Board Oversight Screening Form for Graduate Student Research

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Project Title:	Algegra Support for Ninth Grade Students		
Name:	Martha Lynn Janes	**Faculty Advisor:** Ellen W. Wiley	
Department:	Curriculum, Leadership, and Technology	**Please indicate the academic purpose of the proposed research:**	
E-mail:	mljanes@valdosta.edu	☒ Doctoral Dissertation ☐ Master's Thesis ☐ Other:	
Telephone:	229-894-3220		

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1. ☐ YES ☒ NO **Will you utilize *existing identifiable private* information about living individuals?** "Existing" information is data that were previously collected for some other purpose, either by the researcher or, more commonly, by another party. "Identifiable" means that the identities of the individuals can be ascertained by the researcher by name, code number, pattern of answers, or in some other way, regardless of whether or not the researcher needs to know the identities of the individuals for the proposed research project. "Private" information includes information about behavior that occurs in a context in which an individual can reasonably expect that no observation or recording is taking place or information provided for specific purposes that the individual can reasonably expect will not be made public (e.g., a medical record or student record).

   Note: If you are using data that: (1) are publicly available; (2) were collected from individuals anonymously (i.e., no identifying information was included when the data were first collected); (3) will be de-identified before being given to the researcher, (i.e., the owner of the data will strip identifying information so that the researcher cannot ascertain the identities of individuals); or (4) do not include any private information about the individuals, regardless of whether or not the identities of the individuals can be ascertained, your response to Question 1 should be NO.

2. ☐ YES ☒ NO **Will you *interact* with individuals to obtain data?** "Interaction" includes communication or interpersonal contact between the researcher and the research participant, such as testing, surveying, interviewing, or conducting a focus group. It does not include observation of public behavior when the researcher does not participate in the activities being observed.

3. ☐ YES ☒ NO **Will you *intervene* with individuals to obtain data?** "Intervention" includes manipulation of the individual or his/her environment for research purposes, as well as using physical procedures (e.g., measuring body composition, using a medical device, collecting a specimen) to gather data for research purposes.

If you answered YES to ANY of the above questions, your research is subject to Institutional Review Board oversight. Please discard this form and complete and submit an IRB application. Do not begin your research until your application has been reviewed by the IRB and you are informed of the outcome of the review.

◆◆◆◆◆◆◆◆◆◆◆◆

If you answered NO to ALL of the above questions, your research is not subject to Institutional Review Board oversight. Stop here, sign below, secure your faculty advisor's signature, and submit this form to the Graduate School. Please remember that, even though your project is not subject to IRB oversight, you should still observe ethical principles in the conduct of your research.

STUDENT CERTIFICATION: I certify that my responses to the above questions accurately describe my proposed research.

Student's Signature: Martha L. Janes **Date:** 12-2-14

FACULTY ADVISOR CERTIFICATION: I have reviewed the student's proposed research and concur that it is not subject to Institutional Review Board oversight.

Faculty Advisor's Signature: Ellen W. Wiley **Date:** 12-2-14