THE EFFECTS OF A DIRECT-INSTRUCTION MATH INTERVENTION ON STANDARDIZED TEST SCORES OF AT-RISK MIDDLE SCHOOL STUDENTS

by

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Liberty University

A Dissertation Presented in Partial Fulfillment Of the Requirements for the Degree Doctor of Education

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Abstract

Educators are seeking ways to improve student academic achievement in math and to increase math standardized test scores because of the requirements of the reauthorization of the Elementary and Secondary Education Act, known as the No Child Left Behind Act (NCLB), Individuals with Disabilities Education Act (IDEA), and Race to the Top initiative (RTTT). One such intervention in middle school is a direct-instruction math program. This causal-comparative study examined the relationship between a direct-instruction math intervention and math achievement on standardized test scores of at-risk middle school students. This study compared the differences in the mean scale scores for at-risk middle-school students who received a direct-instruction math intervention and at-risk middle school students who did not receive a direct-instruction math intervention on the math subtest of the 2012 Georgia Criterion Referenced Competency Test, while using the 2011 scores as a control variable to control for previous math ability using a one-way between-groups analysis of covariate (ANCOVA) statistical test. Further, this study compared the relationship, by gender, between a direct-instruction math intervention and math achievement on standardized test scores. The data from the study suggests that the direct-instruction mathematic intervention did result in the intervention group having a significantly higher mean scale score on the 2012 mathematic subtest of the Georgia CRCT than the control group for both genders.

Keywords: math intervention, theory of instruction, direct-instruction, extended learning time, standardized test scores, mathematic gender gap, middle school
This dissertation is dedicated to my family and the people in my life who believed in me, stood by my side, and enabled me to earn this doctoral degree.

First, I thank my Heavenly Father for being by my side during the entire journey and carrying me when necessary. His guidance during my darkest moments brought light to my life and enabled me to carry on.

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CHAPTER ONE: INTRODUCTION

The reauthorization of the Elementary and Secondary Education Act, known as the No Child Left Behind Act (NCLB) of 2001, and the renewal of the Individuals with Disabilities Education Act (IDEA) in 2004, resulted in the requirement that schools must demonstrate annual yearly progress (AYP) in student achievement by assessing students using standardized tests (No Child Left Behind Act of 2001, 2008). AYP is an annual measurement of student achievement on statewide assessments. The goal of these laws is to ensure all students, including all subgroups, are meeting the state’s content standards. NCLB provides a foundation for the Race to the Top initiative. The Race to the Top (RTTT) initiative is voluntary. RTTT provides incentives in the way of additional federal funding to states that reform their educational system in four areas: (1) enhancing standards and assessments, (2) improving collection and use of data, (3) increasing teacher effectiveness and achieving equity in teacher distribution, and (4) turning around low-achieving schools (Lohman, 2010). RTTT still requires states to rely on standardized testing to measure academic achievement to ensure students are progressing. Additionally, RTTT requires states to focus on teacher effectiveness (Lohman, 2010). In Georgia, individual schools are placed in achievement categories based on their students’ standardized test scores. Additionally, 50% of teachers’ annual evaluations are based directly on their students’ standardized test scores (House Bill 244, 2013).

Low standardized test scores are one of the characteristics of at-risk students, and are a good predictor of whether a student will graduate high school. A study of a California school district found that fewer than half of the students who scored below the 50th percentile in either math or language arts in the sixth, seventh, or eighth grade
graduated high school (Silver, Saunders, & Zarate, 2008). Monrad (2007) found that dropouts are less likely to obtain stable jobs than in the past. Dynarski et al. (2008) found that each year more than half a million students drop out of high school, and earn an average of $9,000 a year less than students who graduate. Additionally, according to Niederle and Vesterlund (2010), “math test scores serve as a good predictor of future income. Although the magnitude of the effect of math performance on future income varies by study, the significant and positive effect is consistently documented” (p. 130). As a result, the importance of understanding how to close the math achievement gap and increase math standardized test scores continues to play an important role in educational reform.

In the examination of mathematic interventions, gender differences are an important factor to consider. A review of the literature suggests that students differ, by gender, in mathematic achievement and learning (Fryer & Levitt, 2010; Rosselli, Ardila, Matute, & Inozemtseva, 2009). In order to ensure a direct-instruction mathematic intervention is effective for both genders, it is important to understand the relationship that a direct-instruction mathematic intervention may have on male and female mathematic achievement on standardized test scores.

The purpose of this study is to examine the relationship between a direct-instruction mathematic intervention and student achievement on mathematic standardized test scores for at-risk middle school students. Because research suggests students differ by gender in mathematic achievement and learning (Geist & King, 2008; Halpern, 2004; Kommer, 2006; Leanne, David, & Fien, 2008), this study will also examine, by gender, the relationship between a direct-instruction mathematic intervention
and math achievement on standardized test scores to determine if the intervention helps improve test scores for both males and females.

**Background**

On January 8, 2002, President Bush signed the No Child Left Behind Act (NCLB) of 2001 that reauthorized the Elementary and Secondary Education Act (ESEA). NCLB significantly raised the expectations for state and local school districts, requiring that within twelve years all students meet or exceed state standards in reading and mathematics. NCLB has placed an emphasis on student achievement for all students. The goal of this law is to improve academic achievement for all students by closing the achievement gap and making sure all students, including those at risk, and all subgroups, including race/ethnicity, disability, limited English proficiency (LEP), and socioeconomic status (SES), are academically successful (No Child Left Behind Act of 2001, 2008).

In addition to NCLB, IDEA was renewed in 2004 with modifications to align with NCLB. The most significant modification to IDEA is that performance goals and indicators be consistent with those of students without disabilities; therefore, all students must meet the same standards set by the state (U. S. Department of Education, 2007).

NCLB and IDEA have implemented required standardized testing to provide evidence that students are meeting the state’s content standards (U. S. Department of Education, 2007). Both laws also require schools to provide research-based interventions for students who are not meeting the required standards (U. S. Department of Education, 2007). IDEA resulted in the introduction of Response to Intervention (RTI). RTI assists schools in providing and documenting research-driven support as required by NCLB and
IDEA for students at risk of failure. RTI is a multi-tiered approach that provides students with the assistance necessary to meet their academic needs (Barnes & Harlacher, 2008). With information garnered from the RTI process and research available on interventions, educators can provide better-informed decisions regarding interventions for at-risk students (Gersten et al., 2009). Because of this legislation, many states have begun to move quickly toward the implementation of some form of RTI (Berkley, Bender, Peaster, & Saunders, 2009).

No Child Left Behind provides the foundation for the Race to the Top (RTTT) initiative. RTTT is voluntary and provides incentives in the way of additional federal funding to states that reform their educational system in four areas: (1) enhancing standards and assessments, (2) improving collection and use of data, (3) increasing teacher effectiveness and achieving equity in teacher distribution, and (4) turning around low-achieving schools (Lohman, 2010). RTTT still requires states to rely on standardized testing to measure academic achievement to ensure students are progressing. Additionally, RTTT requires states to focus on teacher effectiveness (Lohman, 2010).

Research suggests math interventions have been shown to improve standardized test scores (Bahr, 2008; Bryant et al., 2008; Bryant, Bryant, Gerstein, Scammacca, & Chavez, 2008; Ketterlin-Geller, Chard, & Fien, 2008; Kroesbergen & Van Luit, 2003; Leanne, David, & Fien, 2008; Mong & Mong, 2010). Most research has been conducted at the primary grades level. However, a review of the literature indicates the mathematic achievement gap continues through the middle and upper grade levels (National Assessment of Educational Progress (NAEP), 2011; Trends in International Mathematics and Science Study (TIMMS), 2011). Because of the requirements of NCLB, IDEA, and
RTTT, it is important to understand if a math intervention helps to improve student achievement on mathematic standardized test scores for at-risk middle school students.

Additionally, a review of the literature suggests gender plays a role in mathematic achievement and learning. This difference in achievement may begin in the lower grades, and increases throughout the grades. “The bulk of the evidence in the past 50 years suggests that the gender gap in mathematics does not exist before children enter school, but is significant in the middle school years and beyond” (Fryer & Levitt, 2010, p. 211). “The gap between boys and girls seems to increase in high-school, where by the 12th grade males show very significant advantages over females of the same age in mathematical achievement tests” (Rosselli, Ardila, Matute, & Inozemtseva, 2009, p. 217). A review of the literature suggests one possible reason for the gap is males and females learn differently (Geist & King, 2008; Halpern, 2004; Kommer, 2006; Kulturel-Konak, D’Allegro, & Dickinson, 2011). In order to ensure a mathematic intervention is effective for both males and females, it is important to consider gender in understanding the relationship a direct-instruction mathematic intervention may have on mathematic achievement on standardized test scores.

This study will investigate if Engelmann and Carnine’s (1991) theory of instruction can help improve mathematic achievement on standardized test scores for at-risk students in middle school. Theory of instruction is the basis for the direct-instruction method of teaching. This study will contribute to the literature an understanding of how a direct-instruction mathematic intervention can influence mathematic standardized test scores for at-risk middle school students. Because research suggests that genders differ in mathematic achievement and learning, this study will also
contribute to the literature an understanding of how a direct-instruction mathematic intervention can influence mathematic standardized test scores for male and female at-risk middle school students.

**Problem/Purpose Statement**

According to a 2011 National Assessment of Educational Programs (NAEP) report, Georgia math standardized test scores are lower than those of math standardized test scores in 38 states and only higher than math standardized test scores in 8 states. A 2011 study conducted by Trends in International Mathematics and Science Study (TIMMS) reported that the average mathematics score of U.S. 4\textsuperscript{th} graders was among the top 15 education systems, with eight systems scoring higher and six systems with no measurable differences. A comparison of the average mathematics score of U.S. 8\textsuperscript{th} graders was among the top 24 education systems, with 11 systems scoring higher and 12 systems with no measurable difference. Georgia Title I schools making AYP has decreased from 82.7\% in 2007 to 69.5\% in 2011 (Georgia Department of Education, 2011). Therefore, the problem is low math scores on mathematic standardized tests for at-risk students, both in Georgia and nationally.

The purpose of this quantitative causal-comparative study is to test the theory of instruction, which suggests that a direct-instruction teaching method will improve student achievement. The study will compare the independent variable of a direct-instruction mathematic intervention program consisting of two levels (a control group receiving no intervention and a treatment group receiving a direct-instruction mathematic intervention), to the dependent variable, the mean scores of the mathematic subtest of the 2012 Georgia CRCT. The previous year’s 2011 Georgia mathematic scores will be used
as a covariate to control for previous mathematic ability. The participants will consist of at-risk middle school students attending Title I schools in a rural school district in Georgia.

**Significance of the Study**

The significance of the study is to contribute to the literature an understanding of the relationship between a direct-instruction math intervention provided to at-risk middle school students and improvement of mathematic achievement on standardized test scores.

Przychodzin, Marchand-Martella, and Azim (2004) stated the need for more research on the effects of direct-instruction based on learner characteristics, such as at-risk. Flores and Kaylor (2007) stated the need for future research to study how the components of direct-instruction could be used to enhance an existing curriculum and the effects of those methods on student achievement.

A review of the literature revealed most studies on mathematic interventions, including direct-instruction, have been conducted at the primary grades level (Bryant et al., 2008; Bryant, Bryant, Gerstein, Scammacca, & Chavez, 2008; Leanne et al., 2008; Mong & Mong, 2010). However, research suggests that the math achievement gap continues at the middle grades and beyond (National Assessment of Educational Progress, 2011; Trends in International Mathematics and Science Study, 2011). Therefore, more research is needed at the middle grades level to address the needs of at-risk middle school students.

Additionally, since research suggests that male and female students differ in mathematic achievement and learning (Geist & King, 2008; Halpern, 2004; Kommer, 2006; Kulturel-Konak, D’Allegro, & Dickinson, 2011), this study will contribute to the
literature an understanding if a direct-instruction math intervention can improve student math achievement on standardized tests for both males and females.

This study also specifically addresses the concerns of the school district in which the study is taking place. Because of the need to improve test scores for at-risk math students, the school administrator has implemented a math intervention at one of the two middle schools in the study. This intervention is *SRA Math Skillbuilder* by McGraw Hill. *SRA Math Skillbuilder* is a direct-instruction mathematic intervention program designed for McGraw Hill by Siegfried Engelmann (McGraw Hill Education, 2013). This study will help to assess the math intervention program’s effectiveness on mathematic standardized test scores. This study will also help to assess the math intervention program’s effectiveness for males and females. This study can offer suggestions to aid the school administrators in making informed curriculum decisions based on the effectiveness of the mathematic intervention program.

**Research Questions, Hypotheses, and Null Hypotheses**

The first guiding research question is: Does a direct-instruction math intervention improve student mathematic achievement on standardized test scores for at-risk middle school students?

RQ1: Do at-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention have statistically significant different mean scale scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention, while using their 2011 Georgia mathematic CRCT test scores as a covariate to control for previous math achievement?
H1: At-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention will have statistically significant different mean scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention, while using their 2011 Georgia mathematic CRCT test scores as a covariate to control for previous math achievement.

Ho₁: At-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention will not have statistically significant different mean scale scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention, while using their 2011 Georgia mathematic CRCT test scores as a covariate to control for previous math achievement.

The second guiding research question is: Is the direct-instruction mathematic intervention effective for both genders?

RQ2: Based on gender, do at-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention have statistically significant different mean scale scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention, while using their 2011 Georgia mathematic CRCT test scores as a covariate to control for previous math achievement?

H2: Based on gender, at-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention will have statistically significant different mean scores on the 2012 Georgia mathematic CRCT when compared to at-risk
sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention while, using their 2011 Georgia mathematic CRCT test scores as a covariate to control for previous math achievement.

**H02:** Based on gender, at-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention will not have statistically significant different mean scale scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention while, using their 2011 Georgia mathematic CRCT test scores as a covariate to control for previous math achievement.

In addressing the research questions, the study will accept or reject the null hypotheses.

**Identification of Variables**

For Research Questions 1 and 2, the independent variable is a direct-instruction math intervention consisting of two levels, students who received a math intervention (treatment group) and students who did not receive a math intervention (control group); the dependent variable is the 2012 mean scores of the math subtest of the Georgia Criterion Referenced Competency Test. The 2011 mean scores of the math subtest of the Georgia Criterion Referenced Competency Test will serve as the covariate.

In a study conducted by Vandervoot, Amrein-Beardsley, and Berliner (2004), the dependent variable was the yearly gains on the Stanford Achievement Test (SAT-9). The scaled scores associated with the SAT-9 were used as a pretest-posttest measure of yearly achievement growth for each student in the sample. The differences in each student’s scaled score from year to year were reported as gain scores. Because the students were not placed in classrooms in a random manner, the possibility existed that
the groups may have been different prior to the study. For this reason, a pretest-posttest
design was used where covariance adjusted gain scores were used to control for the
effects that non-random assignment might have had on student’s growth over time. The
use of the pretest as a covariate reduced the amount of difference or natural variation that
could obscure effects within groups, as well as between them. The covariance
adjustment makes the two compared more uniform, tending to eliminate bias in the
sample (Vandervoot et al., 2004, p. 22).

According to McMillan and Schumacher (2010), secondary data analysis is
becoming more popular as federal and state data sets are released because of NCLB.
“Researchers can take these data sets and conduct studies that compare achievement
among the groups or examine trends” (p. 23).

Definitions

**A Model of School Learning**- A theory put forth by John Carroll that states the degree
development of learning equals time spent learning divided by time needed to learn (Carroll, 1963).

**Academic Learning Time (ALT)** - The actual part of class time during which students
are actively engaged in successfully learning subject matter that is valued (Berliner,
1990).

**Adequate Yearly Progress (AYP)** - Adequate Yearly Progress is a requirement of the
federal No Child Left Behind Act. It is a measure of year-to-year student achievement on
statewide assessments (Georgia Department of Education, 2013).

**At-risk student**- “An at-risk student is a student with specific needs that may hinder
academic achievement, graduation, or ability to successfully transition to college or
career opportunities” (Georgia Department of Education, 2011, Glossary, para. 7).
**Behaviorism** - Behaviorism emphasizes that behavior is directed by stimuli. An individual selects one response instead of another because of prior conditioning and psychological drives. Behaviorism posits that all behavior is learned habits, and attempts to explain how these habits are formed (Miller, 2011).

**Criterion Referenced Competency Test (CRCT)** - “The CRCT is designed to measure how well students acquire the skills and knowledge described in the state-adopted curriculum, including the Common Core Georgia Performance Standards (CCGPS) in reading, English/language arts, and mathematics, and the Georgia Performance Standards (GPS) in science and social studies. The assessments yield information on academic achievement at the student, class, school, system, and state levels. This information is used to diagnose individual student strengths and weaknesses as related to the instruction of the state-adopted curriculum and to gauge the quality of education throughout Georgia” (Georgia Department of Education, 2013, para. 1).

**Individual Disabilities Education Act (IDEA)** - “The Individuals with Disabilities Education Act (IDEA) is a law ensuring services to children with disabilities throughout the nation. IDEA governs how states and public agencies provide early intervention, special education, and related services” (U. S. Department of Education, 2004, para. 1).

**Intervention** – “Targeted instruction that is based on student needs. Interventions supplement the general education curriculum. Interventions are a systematic compilation of well-researched or evidence-based specific instructional strategies and techniques” (Georgia Department of Education, 2011, p. 12).

**National Assessment of Educational Progress (NAEP)** - “The National Assessment of Educational Progress (NAEP) is the largest nationally representative and continuing
assessment of what America's students know and can do in various subject areas.

Assessments are conducted periodically in mathematics, reading, science, writing, the
arts, civics, economics, geography, and U.S. history” (National Assessment of
Educational Progress (NAEP), 2011, para. 1).

**National Center for Educational Statistics (NCES)**- “The National Center for
Educational Statistics is the primary federal entity for collecting and analyzing data
related to education” (National Center for Educational Statistics, 2013, para. 1).

**No Child Left Behind Act of 2001 (NCLB)** - The No Child Left Behind Act of 2001
reauthorized the Elementary and Secondary Education Act (ESEA). No Child Left
Behind significantly raises expectations for states, local school districts, and schools in
that all students will meet or exceed state standards in reading and mathematics in twelve
years (Georgia Department of Education, 2013, para. 1).

**Response to Intervention (RTI)**- “Response to Intervention (RTI) is a practice of
academic and/or behavioral interventions designed to provide early, effective assistance
to underperforming students” (Georgia Department of Education, 2011, para. 1).

**Trends in International Mathematics and Science Study (TIMMS)** - “For the past 20
years, TIMMS has measured trends in mathematics and science achievement at the fourth
and eighth grades. It has been conducted on a regular 4-year cycle” (Trends in
International Mathematics and Science Study (TIMMS), 2011, para. 1).

**Time on Task**- Engaged time on a particular learning task (Berliner, 1990).
CHAPTER TWO: REVIEW OF THE LITERATURE

Theory

The theoretical framework for this study is Engelmann and Carnine’s theory of instruction. Theory of instruction was developed by Engelmann and Carnine (1991) and used to study the most effective and efficient way to teach so that students can learn successfully. The theory indicates that by using faultless communication, students are able to effectively and efficiently learn through explicit instruction and examples, and generalize to new examples based on sameness of quality. As applied to this study, theory of instruction holds that the independent variable, a direct-instruction math intervention, should influence the dependent variable, mathematic achievement on the mathematic subtest of the Georgia CRCT. The theory suggests that by using a direct-instruction math intervention, students will learn more effectively and efficiently and their achievement will improve. Engelmann and Carnine’s theory of instruction is not a learning theory that describes how people learn. Learning theories suggest how people learn in the absence of instruction. Theory of instruction examines the components of instruction, and suggests the best method for providing effective and efficient instruction. Engelmann and Carnine’s theory evolved through application of logical analysis to years of existing empirical observations. According to Engelmann and Carnine (1991), “the strategy of making the communication faultless and then observing the performance of the learner is the basis for the theory of instruction” (p. 3).

Magliaro, Lockee, and Burton (2005) state that Engelmann and Carnine’s theory of instruction is “rooted in behavioral theory, particularly the radical or selectivist behaviorism of Skinner” (p. 41). According to Magliaro et al. (2005), theory of
instruction is “based on the basic notion that behavior evolves or is selected by the environment. Those behaviors that work are selected by the consequences that follow the behavior. Since there are different consequences for the same behavior in different environments, behaviors are situated in contexts” (Magliaro et al., 2005, p. 42).


Theory of instruction begins with the assumption that the environment is the primary variable in accounting for what the learner learns. Although the environment is assumed the primary cause of what is learned, it is not assumed the total cause. Within any group of people there are individual differences; therefore, the learner is also the variable. To show the relationship between the learner and the environment, one of the variables must be controlled. Since the learner cannot be controlled, Engelmann and Carnine’s solution is to control the environment (Engelmann & Carnine, 1991).

Designing instruction so it would communicate to the learner one single interpretation is known as faultless communication. Faultless communications are designed to convey only one interpretation. There would be no misunderstandings, therefore enabling the learner to understand any concept. These communications would be capable of teaching any learner who possesses the minimal attributes the intended concept or skill. Either the learner responds to the faultless communication by learning
the intended concept or the learner fails to learn the intended concept. In either case, the learner’s performance is framed as the dependent variable. The strategy of making the communication faultless and then observing the performance of the learner is the basis for the theory of instruction. This strategy is used for designing instructional sequences and in deriving principles for communicating with the learner (Engelmann & Carnine, 1991). The following is a summary of the steps used in the strategy: a) design communications that are faultless using logical analysis of the stimuli, not a behavioral analysis of the learner, b) predict that the learner will learn the concept conveyed by the faultless presentation, c) present the communication to the learner and observe whether the learner actually learns the intended concept or whether the learner has trouble, d) design instruction for the unsuccessful learner that will modify the learner’s capacity to respond to the faultless presentation (Engelmann & Carnine, 1991, p. 3).

According to Engelmann and Carnine (1991), “the learning mechanism has two attributes: a) the capacity to learn through examples any quality that is exemplified, and b) the capacity to generalize to new examples based on sameness of quality (and only based on sameness)” (p. 4). The capacity to learn any quality from examples indicates what the learner is capable of learning, not how they learn. A quality is any irreducible feature of the example. The simplest way to identify qualities is to begin with a concrete example. The assumption that the learner learns qualities simply means that if an example possesses a quality, no matter how subtle, the learner has the capacity to learn that quality. The capacity to generalize to new examples based on sameness suggests how learning occurs. According to this attribute, the learner somehow makes up a rule that indicates which qualities are common to the set of examples presented to teach a
concept. By using this rule, the learner classifies new examples as either positive examples of the concept or negative examples. A new example is positive if it has the same qualities possessed by all positive examples presented earlier; it is a negative example if it does not have the same qualities. According to the assumption about the generalization attribute, there is no sharp line between initial learning and generalization. The only possible basis for generalization is sameness of quality (Engelmann & Carnine, 1991).

The two-attribute learning mechanism suggests that the learner operates on qualities and sameness, and that both the qualities and sameness come from the concrete examples that have the same quality and provide information that these concrete examples are the same in a relevant way (Engelmann & Carnine, 1991).

There are five structural conditions a communication of basic concepts must meet to be capable of producing a particular generalization. First, the set of positive examples must possess only one distinguishing quality. For example, if every positive example of the color purple presented to the learner was a triangle, and every example presented as not purple was box-shaped, at least two generalizations are presented by the same communication. The learner may call any triangle purple regardless of color. Since a given learner is assumed to have no previous knowledge of the concept and must base generalization solely on the quality and sameness of demonstrated examples, a given learner may learn an inappropriate generalization from an example with more than one distinguishing quality. To avoid this problem, inappropriate qualities must be eliminated from the demonstration examples. The simplest way to achieve this is to modify the set
of examples so that some of the examples identified by the teacher as not purple are triangles (Engelmann & Carnine, 1991).

Second, the communication must also provide a signal that accompanies each example that has the quality to be generalized. This signal is the only means available for treating examples in the same way. In the example above, saying “purple” for all examples that are purple provides the learner with a basis for communicating with the teacher. The assumption about the signal accompanying the various examples is necessary because the goal is to induce a particular generalization. For the most basic type of communication, two signals are implied; one is used for examples that have the quality, and another is used for examples that do not have the quality (Engelmann & Carnine, 1991).

Third, the communication must present a range of examples that show the physical variation of the examples that exhibit a common quality. The communication must present positive examples that are physically different but that share the quality that is to be generalized. For example, examples for the quality purple would need to present different shades of purple for the learner. The requirement of showing a range of positive variations derives directly from the assumptions about the learning mechanism. It is assumed that the learner is capable of learning any quality exemplified through examples. For most concepts, the quality is something that is common to variations that are physically different. If the learner is not shown an appropriate range of variation, the learner may not be provided with enough information to formulate an appropriate “rule” (Engelmann & Carnine, 1991).
Fourth, a basic communication must present negative examples to show the limits of the variation in quality that is permissible for a given concept. To show the learner basic concepts, the communication must demonstrate the boundaries for the range of permissible generalizations. For example, all negatives presented to demonstrate the limits of permissible variation are the same in that they possess the quality of being “not purple.” To signal that these negative examples are the same, a common behavior is presented with each example. To assure that the learner does not classify these examples in the same way that the positive examples are classified, the communication presents a different signal for the negatives, for example, “not purple.” The basic communication therefore presents two sets of examples, one for positive and one for negative, and two distinct signals, one for positive and one for negative (Engelmann & Carnine, 1991).

Fifth, the communication must provide a test to assure that the learner has received the information provided by the communication. The test should provide positive and negative examples that had not been demonstrated earlier but that are implied through the range of variation of quality demonstrated for the positives and negatives (Engelmann & Carnine, 1991).

In summary, Engelmann and Carnine (1991) postulated a learning mechanism that has these attributes: the capacity to learn any stimulus quality shown through examples, and the capacity to generalize a sameness of quality to new examples. This assumed mechanism implies that the primary analysis of cognitive learning must focus on quality and sameness of the examples presented to the learner. Further implications suggest the structural criteria that must be met by a communication if the communication is to induce a generalization for a basic concept.
1. The positive examples of the concept must be distinguished by one, and only one quality.

2. An unambiguous signal must accompany each positive example, and a different signal must accompany each negative example.

3. The examples must demonstrate the range of variation to which the learner will be expected to generalize.

4. Negative examples must clearly show the boundaries of permissible positive variation.

5. Test examples, different from those presented to demonstrate the concept, assure that the generalization has occurred (p. 8).

Faultless communication and generalization is the core of Engelmann and Carnine’s theory of instruction. It utilizes explicit instruction with both positive and negative examples. It is a teacher-led instructional strategy. What a learner learns is a function of the instruction received. If the students are capable of learning but do not learn, it is assumed to be the fault of the instruction (Engelmann & Carnine, 1991).

**Math Interventions**

A 2011 study conducted by Trends in International Mathematics and Science Study (TIMMS) reports that U.S. math scores are improving; however, the average mathematics score of U.S. 4th graders was among the top 15 education systems, with 8 systems scoring higher and 6 systems with no measurable differences. A comparison of the average mathematics score of U.S. 8th graders was among the top 24 education systems, with 11 systems scoring higher and 12 systems with no measurable difference (Trends in International Mathematics and Science Study, 2011).
One possible intervention that may be used to help students meet the requirements of No Child Left Behind (NCLB), response to intervention (RTI), and Race to the Top (RTTT) is a math intervention program. Georgia’s Department of Education defines intervention as “Targeted instruction that is based on student needs. Interventions supplement the general education curriculum. Interventions are a systematic compilation of well researched or evidence-based specific instructional strategies and techniques” (“Response to Intervention,” 2011, p. 12).

In Georgia the Remedial Education Program (REP) is a part of the Response to Intervention (RTI) framework and is “an instructional program designed for students in grades 6-12 who have deficiencies in reading, writing, and math. This program provides individualized basic skills instruction as mandated by Georgia Law in the areas of reading, writing, and mathematics. . . . The REP Program provides a structure for additional instruction to ensure students meet grade level expectations at the middle and high school level.” (Georgia Department of Education, 2013, p. 3). Eligible students include students in grades 6-12 if they meet two or more of the following criteria: a) a formal student support team process containing documented evidence that supports remedial placement, b) the student has been retained in the grade in which he or she is enrolled, c) the student is eligible to receive services under Part A of Chapter 1 of Title 1, d) the student has been recommended by a teacher who has documented low performance in reading or math; current standardized test information indicates the student has scored at or below the 25th percentile in reading, writing, or mathematics; or the student demonstrates an inability to verbally express ideas or write a meaningful sentence. For participation in a middle school intervention program, the most recent Criterion
Referenced Competency Test (CRCT) scores indicate the student has a score in the “Does Not Meet” category in reading, English/language arts, or mathematics (Georgia Department of Education, 2013, p. 4).

A math intervention can take the form of a supplemental program using direct-instruction. Instruction may consist of remediation of current standards students are struggling with and/or the teaching of current standards concurrently with the regular education mathematic classes. During the school year, Georgia allows middle schools to provide intervention math services in suggested models such as the pullout class, reduced class size, extension class, or during the connections block. Students are to receive direct-instruction from a state-certified teacher on their instructional level for a minimum of 50-60 minutes.

Several recent meta-analyses have been conducted on the features of mathematics instruction that most benefit at-risk students. A meta-analysis conducted by Gersten et al. (2009) examined 42 interventions by instructional strategies. The instructional strategies found to be statistically effective were: a) explicit instruction with a mean effect size of 1.22, b) use of heuristics with a mean effect size of 1.56, c) student verbalization of math reasoning with a mean effect size of 1.04, and d) sequence and range of examples with a mean effect size of 0.82. A meta-analysis by Kroesbergen & Van Luit (2003) of 58 studies of mathematic interventions for elementary students with special needs found the following teaching methods to be statistically effective: teaching basic facts had a mean effect size of 1.14, direct-instruction had a mean effect size of 0.91, and self-instruction had a mean effect size of 1.45.
In a meta-analysis of math interventions for students with emotional and behavioral problems, Templeton, Neel, and Blood (2008) used Percentage Nonoverlapping Data (PND) to measure effect size. According to Templeton et al. (2008), “PND is calculated by finding the percentage of intervention points that exceed the highest baseline point” (p.231). The highest baseline point was retrieved for each pair of baseline and treatment phases. A PND between 70% and 90% is considered effective. Interventions that focused on math performance as the primary interest had a mean intervention PND of 87.30. Interventions that focused on strategy instruction had a mean intervention PND of 86.41. Interventions that focused on instructional delivery had a mean intervention PND of 86.41.

Research conducted on math intervention at the elementary grade level suggests math intervention is effective. In a study by Mong and Mong (2010), two interventions designed to enhance math fluency were evaluated. Math to Mastery (MTM) and Cover, Copy, and Compare (CCC) were both shown to be effective at increasing mathematic fluency for elementary students.

A study by Bryant, Bryant, Gersten, Scammacca, and Chavez (2008) examined the effects of a mathematic intervention consisting of tutoring sessions in same-ability, small instructional groups consisting of three or four first and second-grade students. A regression-discontinuity analysis revealed that no significant effect was observed among first-grade students; however, a significant main effect ($\beta = .19$, $p = .018$) was observed between second grade students. Another study by Bryant, Bryant, Scammacca, Winter, and Shih (2008) examined the effects of a mathematic intervention consisting of booster lessons on specific number, operations, and quantitative reasoning performance of
students in first grade that were identified as having mathematics difficulties. A
regression-discontinuity analysis revealed a positive effect (β = .21, p = .014) for the
intervention for first grade students.

At the middle school level, studies also suggest a math intervention program can
increase mathematic performance. A study by Flores and Kaylor (2007) on
seventh-grade at-risk students examined a direct-instruction math intervention consisting
of 14 instructional lessons on fraction performance. The following results were reported:
a) 76% increase in translating whole numbers into fractions, b) 68% increase in
translating fractions into whole numbers, c) 63% increase in multiplication of like
fractions with like denominators, d) 70% increase in addition and subtraction of fractions
with like denominators, e) 54% increase in addition and subtraction of mixed numbers
with like denominators, and f) 66% increase in multiplication of whole numbers and
fractions.

Another study by Ketterlin-Geller, Chard, and Fien (2008) examined the effects
of two supplemental interventions on the mathematics achievement of low-performing
intermediate-grade students. An intervention designed to reteach fundamental
mathematics and an intervention designed to provide extended time in the core
curriculum were studied. After a 156-week intervention with 51 low-performing
students, the authors found the students in both interventions outperformed students in
the control group.

**Direct-Instruction**

A review of the literature indicates that direct-instruction may be an effective
mathematic intervention to help improve at-risk students’ standardized test scores. In
1968 the U. S. Office of Education initiated one of the largest comprehensive programs of its kind for economically disadvantaged children called Project Follow Through. The participants consisted of disadvantaged primary grade students in 180 communities. The project was designed to study the variations of different educational approaches over several years. In spite of its weaknesses in design, the Follow Through study produced new knowledge. Of the nine models whose data were reported in this study, the direct-instruction model outperformed all others in all categories (Kennedy, 1978).

Several meta-analyses have been conducted on the direct-instruction model. Adams and Engelmann (1996) conducted a meta-analysis of 34 selected studies, and found an average effect size of 0.97 per variable studied for direct-instruction. Borman, Hewes, Overman, and Brown (2003) examined studies pertaining to 29 comprehensive school reform models. Among the interventions listed as having the strongest evidence of effectiveness, direct-instruction was found to have the largest average effect size (0.21). An overview and research summary by Przychodzin, Marchand-Martella, Martella, and Azim (2004), examined 12 studies, and found significant results for direct-instruction programs in 11 of the 12 studies. More recently a synthesis by John Hattie (2009) of over 800 meta-analyses relating to achievement found direct-instruction to be one of the most effective teaching strategies, with an effect size of 0.59. Most of these studies consisted of students in the elementary grades. A study by Flores and Kaylor (2007) found positive results while examining the effects of a direct-instruction math program on student achievement at the primary grades level. In a study conducted by Ketterlin-Galler, Chard, and Fien (2008), two direct-instruction math interventions, Knowing Math and Extended Core, were evaluated using students in four elementary
schools and two K-8 schools Title I schools. The participants scored in the bottom 40\textsuperscript{th} percentile on state standardized tests, and were randomly assigned to groups. Students in both direct-instruction interventions outperformed students in the control group.

According to Magliaro, Lockee, and Burton (2005), direct-instruction is rooted in Skinner’s selectionist behaviorism. As a selectionist model, direct-instruction is based on the belief that behavior “evolves, or is selected by the environment” (p. 42). According to Rosenshine and Stevens (1984), direct-instruction, with lower case di, involves explicit explanations and examples, repetition, frequent review, and choral response. Direct-Instruction, with upper case DI, is generally recognized in education as referring to material and programs authored by Siegfried Engelmann and his colleagues. The instructional material is designed according to the principles presented in Engelmann and Carnine’s *Theory of Instruction: Principles and Applications* (1982). The direct-instruction model is guided by the basic principle that if children are not learning, the fault lays with the instruction, not the children.

“The DI model was created by Engelmann and his colleagues in the 1960’s at the University of Illinois at Champagne-Urbana under a Project Follow Through Grant. Science research published the first implementation of the model known as Direct-Instruction System for Teaching And Remediation (DISTAR) programs that addressed beginning reading, language, and math” (Magliaro et al., 2005, p. 4).

At the center of DI is curriculum. One of Engelmann’s most important strategies is to find a rule or idea that can be used to explain the largest component of content possible. According to Barbash (2012), there are five rules to direct-instruction: a) be clear, b) be efficient, c) teach to mastery, d) celebrate success, and e) beware intuition.
The rule should be clear and concise about the concept being taught. Equal emphasis is placed on not learning the wrong rule as is placed on learning the correct rule. The rule for whatever concept is being taught should present both positive and negative examples. The examples should lead to generalization of the concept (Barbash, 2012).

Instruction must be efficient. One way DI increases efficiency is by properly placing students in homogeneous groups based on identified instructional needs. Students are placed in groups where they perform correctly 70% of the time when introduced to new material. Another way is through using algorithms. “DI programs take advantage of the mind’s instinct to generalize by teaching it algorithms (series of steps) that enable it to solve many problems, and conceptualize frameworks that enable it to learn, organize, and remember many facts” (Barbash, 2012, p. 22).

DI programs are designed to teach to mastery. This is accomplished in two steps. First, identify all the skills that go into performing a task, and arrange them into a logical sequence for teaching them; then provide enough repetition to enable mastery of the skills. DI curriculum is designed like a staircase, with each step a lesson. Each step comprises at most 15% new material and 85% reinforcement of material already taught. Everything learned is applied repeatedly in a different context (Barbash, 2012).

According to Barbash (2012), much of what Engelmann has learned from years of observations may not be obvious:

1. Children with low IQs learn at rates comparable to children with higher IQs when both groups are taught things that are equally unfamiliar to them.
2. Children differ in what they know and like to do, but they do not learn in
different ways: the same scientific techniques of instruction induce learning in
everyone.

3. Learning rates change quickly and spectacularly, particularly on tasks that
require analogous reasoning.

4. Children from middle-class and affluent homes perform no better at many logic
and reasoning tasks than do children from poor homes.

5. Low performers have more trouble learning patterns of numbers than random
sequences. Anything that is patterned will interfere with their learning (p. 33).

A more specific understanding of designing direct-instruction for mathematics is
articulated by Stein, Kinder, Silbert, and Carnine in Designing Effective Math
students’ acquisition of mathematics, these variables are certainly central: a) instructional
design, b) instructional delivery, and c) classroom organization and management” (Stein
et al., 2006, p. 3). Five basic instructional design components are emphasized to assist
teachers in designing direct-instruction. These five basic design components are: “a)
sequence of skills and concepts, b) explicit instructional strategies, c) pre-skills, d)
example selection, and e) practice and review” (Stein et al., 2006, p. 3).

The sequence of skills and concepts involves determining the most effective and
efficient order for introducing new information and strategies. Stein et al. (2006) state
there are three general guidelines for sequencing the introduction of new skills:
“a) pre-skills of a strategy are taught before the strategy, b) easy skills are taught before
more difficult skills, and c) strategies and information that are likely to be confused are
not introduced consecutively” (p. 4).
Direct-instructional strategies are described as “clear, accurate, and unambiguous instruction” (Stein et al., 2006, p. 4). Instructional strategies must be explicit and must be able to be applied to a range of different problems. Instruction should be sequenced so that pre-skills are taught before the strategy itself is introduced. To ensure that the students have mastered the pre-skills, teachers should test students on those pre-skills (Stein et al., 2006).

Several guidelines assist teachers in selecting examples so that students experience success. First, select only examples that require students to use strategies that have been explicitly taught. Second, examples should not only require currently introduced strategies but should also require previously taught strategies to reinforce retention of strategies previously taught (Stein et al., 2006).

Providing sufficient practice for initial mastery and adequate review for retention is an essential part of instructional design. First, repetition must provide massed practice on an individual skill until mastery is reached. Second, previously taught skills must be continuously reviewed over time to ensure retention of the previously taught skills (Stein et al., 2006).

A major aspect of direct-instruction involves attention to how instruction is presented. Explanations should be clear and concise. Since teachers cannot call on every individual student, choral response should be incorporated into the teacher-directed lessons. Giving individual turns is also an essential part of any instructional activity in which students are asked to respond in unison, and helps teachers verify that all students are participating in the activity (Stein et al., 2006, p. 7).
At-risk Students

This study examines the relationship between a math intervention for at-risk students and their standardized test scores. The generally accepted definition for at-risk students is students who are in danger of failing and dropping out of school before graduation. Georgia’s Department of Education defines an at-risk student as “a student with specific needs that may hinder academic achievement, graduation, or ability to successfully transition to college or career opportunities” (Georgia Department of Education, 2011, Glossary, para. 7). Higher standards in the public schools have affected millions of minority and disadvantaged students who are at risk of failure.

Research on low-achieving students provides an understanding of students likely to fail in elementary or secondary schools. The National Education Longitudinal Study of 1988 (NELS:88) (National Center for Educational Statistics, 1992), is a large-scale national longitudinal study designed and sponsored by the National Center for Education Statistics (NCES), with support from government agencies. The study examined 25,000 eighth-grade students attending public and private schools during the 1988 school year. These students were re-surveyed in 1990. This study examined the characteristics of eighth-grade students who were at risk of school failure (i.e., low achievement test scores and dropping out of school).

Three measures of school failure were used: 1) scores on achievement tests in mathematics, 2) scores on achievement tests in reading, and 3) dropout status as of spring 1990. Three basic demographic variables were examined: the student’s sex, race/ethnicity, and socioeconomic status.
Based on demographic variables, the study (National Center for Educational Statistics, 1992) found that African American, Hispanic, and Native American students and students from low socioeconomic backgrounds were more likely than other students to be deficient in basic math and reading skills and were more likely to drop out between the 8th and 10th grades. Male eighth-graders were more likely than their female peers to have low basic skills, but were no more likely to drop out. After controlling for the student’s sex and socioeconomic status, black and Hispanic dropout rates were no longer statistically different from white dropout rates. Even after controlling for the students’ sex and socioeconomic status, African American and Hispanic students were more likely than white students to perform below basic proficiency levels in mathematics and reading (para. 3).

After controlling for basic demographic information, researchers (National Center for Educational Statistics, 1992) found many other factors to predict at-risk status that were independent of the students’ sex, race/ethnicity, and socioeconomic background. Students from single-parent families, students who were overage for their peer groups, or students who had frequently changed schools were at increased risk of failure and dropout. Eighth-grade students whose parents were not actively involved in the students’ education were at increased risk. Students who repeated an earlier grade, students who had histories of low grades in mathematics and English, or students who did little homework were at increased risk (para. 3).

Not only do educators have a legislative responsibility to improve test scores for at-risk students, they also have a moral responsibility. In today’s workforce, dropouts are less likely to obtain stable jobs than in past generations (Monrad, 2007). According to
Dynarski et al. (2008), “each year more than half a million young people drop out of high school. Dropouts typically earn less than graduates do--an average of $9,000 less a year, and $260,000 over the course of a lifetime. Dropouts contribute only half as much in taxes as do graduates, and draw larger government subsidies in the form of food stamps, housing assistance, and welfare payments” (p. 4). In a study on education levels and incarceration, Harlow (2003) found “41% of inmates in the Nation’s State and Federal prisons and local jails in 1997 had not completed high school” (para. 1).

**Extended Learning Time**

Due to the differentiation of instruction and use of homogeneous ability grouping, many mathematic interventions are taught during extended learning time. In Georgia a math intervention is required to supplement the regular education class (Georgia Department of Education, 2012). Extended learning time may be additional learning time at the end of a regular class, additional learning time during an additional class, or additional learning time after the regular school hours, such as after-school programs or Saturday school.

**Model of School Learning**

In 1963 John Carroll developed his model of school learning. Carroll’s model of school learning states, “The learner will succeed in learning a given task to the extent that he spends the amount of time that he needs to learn the task” (Carroll, 1963, Overview of the Model, para. 1). The model is not about the theory of the learning process, but, rather, a theory of the economics of the learning process. The model expresses the learning process with a mathematical formula: Learning is a function of time engaged relative to time needed for learning (Degree of learning = Time spent learning/Time
needed to learn). However, it is not only the amount of time spent that determines students’ degree of learning but also how engaged they are during that time and the extent to which they are engaged on task relevant to the curriculum. Time is not merely elapsed time but the time during which the student is actively engaged in learning (Carrol, 1963).

Benjamin Bloom extended Carroll’s model by making a distinction between allocated time and utilized time. Bloom explained that if aptitude was an indicator of the time a student would require to learn, but not necessarily the capacity to learn, it should be possible to set the degree of learning expected of each child at some mastery level. If the instruction could be structured to provide more opportunities to learn and a more appropriate quality of instruction for each student, then a majority of students could be expected to learn (Bloom, 1974).

The earliest and most extensive research program to examine the relationship between learning time and achievement was the Beginning Teacher Evaluation Study (BETS). The purpose of the BETS was to identify teaching activities and classroom conditions that promote increased student learning. Based on observations in classrooms over a six-year period, BETS researchers arrived at the concept of academic learning time (ALT) (Denham & Lieberman, 1980).

**Academic Learning Time**

David Berliner expanded upon David Carroll’s model of school learning to develop the academic learning time (ALT) model. David Berliner (1990) determined that four variables make up ALT-- “allocated time, engaged time, success rate, and the degree of alignment of the curriculum with the outcome measures” (para. 23). Therefore, time
must be spent on the right task. The ALT model of learning is distinguished from Carroll’s model in two ways: First, the ALT model is more explicit about content. Students must be engaged in the correct task, which should align with the curriculum. Second is the inclusion of success rate in the ALT model. High success rates appear to predict high levels on outcome measures. Berliner (1990) states, “These special features of ALT, explicit concerns with the curriculum and the use of success rate as an indicator of a teacher’s skill in matching curriculum to a student’s ability, as well as having the success rate provide a measure of the quality of instruction being offered, give ALT capabilities for understanding instruction” (para. 27).

According to Berliner (1990), “any proposal to change instructional materials or teaching practices in the classroom that does not affect allocated time, engaged time, the rate of success, or the alignment of curriculum with the outcome measure that is used to assess learning is not likely to affect student achievement” (para. 31). In other words, unless you affect ALT in some way, there will be no change in student achievement.

A review of the literature by The Core Academic Learning Time Group (2002) found a positive relationship between time on task and student achievement and a strong positive relationship between ALT and student achievement. The more positive results from ALT may be a result of the difference between time on task and ALT. Berliner (1990) defines time on task as “engaged time on a particular learning task” and ALT as “successful engagement in tasks that are relevant to outcomes or measures” (Concepts of Instructional Time, para. 5).
Gender

Research related to gender differences suggests that male and female students differ in mathematic achievement and learning. The difference in mathematic ability based on gender appears to begin at the grade-school level and increase throughout the years as students advance in grade level; although, results are mixed. “The bulk of the evidence in the past 50 years suggests that the gender gap in mathematics does not exist before children enter school but is significant in the middle school years and beyond” (Fryer & Levitt, 2010, p. 211). “The gap between boys and girls seems to increase in high school, where by the 12th grade males show very significant advantages over females of the same age in mathematical achievement tests” (Rosselli, Ardila, Matute, & Inozemtseva, 2009, p. 217).

Several studies have found boys outperform girls in the upper grades (Fryer & Levitt, 2010; Lee, Grigg, & Dion, 2007; Liu & Wilson, 2009; Rosselli et al., 2009). Lee et al. found that data from NAEP showed that boys consistently outperformed girls in fourth and eighth grade over the last two decades (2007).

Guiso, Monte, Sapienza, and Zingales (2008) found small to moderate gaps. Ellison and Swanson (2010) have found that as the course-taking gap has narrowed, the gap in standardized test scores has also narrowed.

Other studies have found the gender gap to be small to nonexistent (Georgiou, Stavrinides, & Kalavana, 2007; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Lindberg, Hyde, Peterson, & Linn, 2010). Hyde and colleagues (2008) examined gender differences between boys and girls in mathematics from grades 2 through 11, drawing on samples of over seven million students from ten states using NAEP data. Hyde et al.
(2008) reported an effect size for gender differences in each grade that approached zero. Hyde et al. acknowledged that the NAEP does not include complex test items (2008). Lindberg and colleagues (2010) conducted a meta-analysis of 242 studies published between 1990 and 2007, representing the testing of over one million students. Overall, $d = 0.05$ indicates no gender difference. A variance ratio of 1.08 indicates nearly equal male and female variance.

Studies have also found the gender gap among high-achieving students is consistently larger, with males outperforming females on the SAT and on the Program for International Student Assessment (PISA) (Guiso et al., 2008). A study by Ellison and Swanson found “the gender gap to widen substantially at percentiles beyond the 99th: at the very high end of our data, the male-female ratio exceeds 10 to 1” (2010, p. 110).

A review of the literature suggests one possible explanation for the mathematic gender gap is gender-learning preferences. Research suggests that males and females have different learning preferences and learn differently. According to Kulturel-Konak et al. (2011), the experimental learning theory (ELT) suggests that learning may not necessarily depend only on the transfer of knowledge from the teacher to the student, but may also be created by the learner. According to ELT, learning style depends on the individuals’ preference for receiving and transforming knowledge. According to Kulturel-Konak et al. (2011), males tend to match the assimilator style, and prefer inductive reasoning, theory and concepts, logic, and research. Males think logically and rationally, and enjoy working with symbols and like structure. Females are least comfortable with the assimilator learning style. They excel at identifying problems, brainstorming, and imagining. Geist and King (2008) state females prefer to work in
cooperative learning groups while males prefer competitive ones. Females tend to focus on the needs of the group, and want the whole group to succeed. Males like to work independently, even in groups, and then report to a group leader. Males like to be rewarded individually for what they achieve. Geist and King (2008) found that males seem better at deductive reasoning and abstract thinking, making it easier for males to do better on multiple-choice tests. Girls are better at inductive reasoning and concrete thinking, and benefit from the use of real experiences in problem solving. Males tend to learn better from part to whole and females from whole to part.

Research also suggests there are cognitive learning differences between males and females. Halpern examined differences in gender learning using the cognitive process approach. According to Halpern (2004), females have more rapid access to long-term memory. As a result, females have the advantage in early elementary grades when math involves learning math facts and calculations. In the later grades, they perform better on algebra problems when the cognitive components are similar to those of language processing. By contrast, Halpern (2004) states males have a large advantage on tasks that require visual-spatial working memory, creating an advantage to using spatially based strategies. A male advantage was found with math problems that had multiple solutions, but not multiple steps, which taxed working memory. Geist and King (2008) state, “boys are better at quantitative problem-solving and tasks that involve maintaining or manipulating a visual image in working memory” (p. 47). Geist and King (2008) found females “are better at tasks that require rapid retrieval of information such as learning mathematics skills such as the multiplication table” (p. 47). Geist and King (2008) found females to be more read/write and auditory learners while males tend to be more visual
and kinesthetic learners. Read/write learners prefer reading problems and using books as a reference. They understand mathematics better when it is written. Auditory learners like to have things explained verbally and working with partners. Visual learners may respond best to drawing things out or seeing a problem on a chalkboard. Kinesthetic learners learn best with manipulatives (Geist & King, 2008). According to Geist and King (2008), repetitive activities are more difficult for males.

There is some evidence for sex-related biological influences. Kommer (2006) suggests males and females have slightly different brain chemistry, and may think differently. According to Kommer (2006), females mature more quickly than males. As individuals mature, there is an increase in myelin, which transmits electrical impulses throughout the nervous system. Another difference Kommer (2006) notes is the corpus callosum, which is a system of nerves connecting the right and left hemisphere of the brain is, on average, 20% larger in females. Males tend to be right hemisphere-dominant, and are better at spatial tasks. Females use both hemispheres, and tend to be better at literacy. Halpern (2004) states the prenatal hormones that shape a fetus’s developing genitals also influence the development of the fetus’s brain. According to Halpern (2004), “research has shown that cognitive abilities vary systematically over the menstrual cycle for women and over the daily and annual testosterone cycle for men” (p. 138). Geist and King (2008) state that developmentally, at birth, males are a few weeks behind girls, and remain behind until late adolescence. This difference affects their early learning experience, and remains throughout their education. According to Geist and King (2008), males’ fine motor skills mature about six years later than females’, and may result in difficulty writing and aligning numbers correctly.
Since research suggests students may achieve in math differently and learn differently based on gender, it is important to understand the relationship between a direct-instruction mathematic intervention and mathematic achievement on standardized scores by gender in order to ensure the mathematic intervention increases mathematic achievement on standardized test scores for both genders.

**Standardized Test Scores**

According to Zucker (2003), rather than compare a student’s test results with the results of a reference group (norm-referenced tests), “criterion-referenced tests are intended to measure a level of mastery according to a specific set of performance standards” (p. 6). A review of the literature indicates that in educational studies the use of two consecutive years’ criterion-referenced standardized test scores are an acceptable means of measuring student achievement (Adams, 2011; Cryder, 2011; Horton, 2010; Manning, 2004; Ogden, 2008; Scheidler, 2012; Vandervoot, Amrein-Beardsley, & Berliner, 2004).

In a study conducted by Vandervoot et al. (2004), the dependent variable was the yearly gains on the Stanford Achievement Test (SAT-9):

The scaled scores associated with the SAT-9 were used as a pretest-posttest measure of yearly achievement growth for each student in the sample. The differences in each student’s scaled score from year to year were reported as gain scores. … Because the students were not placed in classrooms in a random manner, the possibility existed that the groups may have been different prior to the study. For this reason, we used a pretest-posttest design where covariance adjusted gain scores were used to control for the effects that non-random
assignment might have had on students’ growth over time. The use of the pretest as a covariate reduced the amount of difference or natural variation that could obscure effects within groups, as well as between them. The covariance adjustment makes the two compared more uniform, tending to eliminate bias in the sample (Vandervoot et al., 2004, p. 22).

The purpose of the Georgia Criterion Referenced Competency Test is to measure how well students acquire the skills and knowledge described in the state-adopted curriculum. The assessments provide information on academic achievement. Scores are typically reported as scale scores and performance scores. A scale score is based on the raw score (number of items correct) for each of the five mathematics domains on the test. The five specific domains are: (a) Numbers and Operations, (b) Measurement, (c) Geometry, (d) Algebra, and (e) Data Analysis and Probability. These five domains are the same for sixth, seventh, and eighth grades.

This information is used to diagnose individual student strengths and weaknesses as related to the instruction of state-adopted curriculum, and to measure the quality of education throughout Georgia. The changing of raw scores to scale scores is analogous to converting from the centigrade scale to the Fahrenheit scale to report temperature. Scale scores are commonly used in large assessment programs. Georgia law, as amended by the A+ Education Reform Act of 2000, requires that all students in grades one through eight take the CRCT in the content areas of reading, English/language arts, and mathematics. Students in grades three through eight are also assessed in science and social studies. The CRCT assesses the state-adopted curriculum as defined in the CCGPS and the GPS (Georgia Department of Education, 2013).
The Georgia Department of Education (GaDOE) oversees the development of the Georgia Criterion-Referenced Competency Test. The Georgia CRCT uses a scale score that consists of three categories: “Does Not Meet”, “Meets Expectations”, and “Exceeds Expectations”. A student’s scale score can range between 650 and 900. Students that score in the “Does Not Meet” category have a score below 800. Students in the “Meets Expectations” category score between 800 and 849. Students in the “Exceeds Expectations” have a score of 850 or above.

“Validity refers to the degree to which evidence and theory support the interpretation of test scores entailed by proposed use of tests” (Georgia Department of Education, 2012, p. 1). One of the first pieces of evidence for establishing validity is a clear identification of the purpose of the test. For the Georgia CRCT, the state legislation identified the purpose to be a measure of how well students have mastered the state’s curriculum. The CRCT is mandated by state law, and is designed to measure how well students acquire the skills and knowledge described in the Georgia Performance Standards. In addition to measuring how well students acquire knowledge, the CRCT has the additional goal of identifying the areas where students need improvement. Qualified professional assessment specialists write items specifically for the Georgia tests. Committees of Georgia educators review the items for alignment with the curriculum, suitability, and potential bias or sensitivity issues. After review, items are field-tested. This is accomplished by embedding the field test items in the operational tests. After field-testing, another committee of Georgia educators examines the items again, along with the data from the field tests. After acceptance, items are then banked for future inclusion. When multiple test forms are used in the same administration, or when a test is
given in subsequent years, they must be equated. Equating refers to a statistical procedure to ensure the tests are of equal difficulty. Equating is critical because it ensures that students are always held to the same standards. The Georgia Department of Education has determined the Georgia CRCT to be valid (Georgia Department of Education, 2012).

“Reliability is the degree to which test scores for a group of test takers are consistent over repeated applications of measurement procedures, and are inferred to be dependable and repeatable for an individual test taker; the degree to which scores are free of errors of measurement for a given group” (Georgia Department of Education, 2012, p. 4). For the Georgia CRCT program, several reliability indices are reported. The first index is Cronbach’s (1951) alpha reliability coefficient. The second statistical index used to describe test score reliability for the Georgia CRCT is the standard error of measurement (SEM). The reliability coefficient is a unitless index, which can be compared from test to test and ranges from zero to one (Georgia Department of Education, 2012). These reliabilities are consistent with the reliabilities of past Georgia CRCT tests, suggesting the assessment is reliable. According to DeVellis (2003), ideally the Cronbach alpha coefficient of a scale should be above .7. The Cronbach alpha coefficients for the 2012 mathematic subtest of the Georgia CRCT meet this recommendation.

Table 2.1 shows the reliability indices in terms of Cronbach’s alpha along with the raw score SEM for sixth, seventh, and eighth-grade mathematics.
<table>
<thead>
<tr>
<th>Grade</th>
<th>2012 Mathematics</th>
<th>2011 Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alpha</td>
<td>SEM</td>
</tr>
<tr>
<td>6th</td>
<td>0.92</td>
<td>3.26</td>
</tr>
<tr>
<td>7th</td>
<td>0.92</td>
<td>3.08</td>
</tr>
<tr>
<td>8th</td>
<td>0.92</td>
<td>3.22</td>
</tr>
</tbody>
</table>
CHAPTER THREE: METHODOLOGY

Introduction

The purpose of this quantitative causal-comparative study is to understand the relationship between a direct-instruction mathemati c intervention program in a rural school district in Georgia and math achievement on the mathematic subtest of the 2012 Georgia CRCT of at-risk middle school students. Further, the purpose of this study is to contribute to the understanding the relationship, by gender, between a direct-instruction mathematic intervention program in a rural school district in Georgia and math achievement on the mathematic subtest of the 2012 Georgia CRCT of at-risk middle school students to determine if the intervention is effective for both males and females.

This study will help enable school administrators to make informed, research-based decisions regarding whether a direct-instruction math intervention helps improve math achievement on standardized test scores for at-risk middle school students.

Chapter 3 provides the study design, research questions, hypotheses and null hypotheses, participants, setting, instrumentation, procedures, and data analysis.

Design

A causal-comparative research study utilizing a quasi-experimental pretest-posttest non-equivalent groups design will be conducted to compare the mean math scores of the math subtest of the 2012 Georgia Criterion Referenced Competency Test of at-risk sixth, seventh, and eighth-grade students, using intervention as the independent variable. This causal-comparative research design was chosen because it attempts to explore possible cause-and-effect relationships by forming groups of individuals in whom the independent variable is present or absent and then determining
whether the groups differ on the dependent variable. Because the groups and assignment of the independent variables are naturally occurring, randomization is not possible in a causal-comparative study. The control procedure of comparing homogeneous groups based on collected demographic data will be adopted to help achieve equality of groups (Gall et al., 2007). Students in both the control group and the intervention group will consist of students scoring 815 or below on the 2011 mathematic subtest of the CRCT.

The assignment of participants for both the experimental and control groups are based upon non-random selection for the experimental group attending school A and random selection for the control group attending school B. The groups will be matched based on grade level and gender.

This study utilizes planned comparisons known as *a priori*. According to Pallant (2010), an *a priori* design is used when you are testing a specific hypothesis, usually drawn from theory or past research. This study is testing the theory of instruction developed by Engelmann and Carnine that states direct-instruction will improve student learning.

This quantitative causal-comparative study follows a similar design used by Adams (2011), and Ogden (2008) to study how using a mathematic intervention affects at-risk students’ CRCT math scores. The study also follows a similar design used by Adams (2011), Ogden (2008), Rakestraw (2013), and Vandervoot et al. (2004) in using the current year’s standardized test scores as the dependent variable or posttest, the prior year’s standardized test scores as a covariate or pretest, and using an ANCOVA to perform the statistical analyses.
Research Questions, Hypotheses, and Null Hypotheses

The first guiding research question is: Does a direct-instruction math intervention improve student mathematic achievement on standardized test scores for at-risk middle school students?

RQ1: Do at-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention have statistically significant different mean scale scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention, while using their 2011 Georgia mathematic CRCT test scores as a covariate to control for previous math achievement?

H1: At-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention will have statistically significant different mean scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention, while using their 2011 Georgia mathematic CRCT test scores as a covariate to control for previous math achievement.

H01: At-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention will not have statistically significant different mean scale scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention, while using their 2011 Georgia mathematic CRCT test scores as a control covariate to control for previous math achievement.
The second guiding research question is: Is the direct-instruction mathematic intervention effective for both genders?

RQ2: Do at-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention have statistically significant different mean scale scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention, based on gender; while using their 2011 Georgia mathematic CRCT test scores as a covariate to control for previous math achievement?

H2: Based on gender, at-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention will have statistically significant different mean scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention, while using their 2011 Georgia mathematic CRCT test scores as a covariate to control for previous math achievement.

Ho2: Based on gender, at-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention will not have statistically significant different mean scale scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention, while using their 2011 Georgia mathematic CRCT test scores as a covariate to control for previous math achievement.

In addressing the research questions, the study will accept or reject the null hypotheses.
Participants

This study used a convenience sample, since the naturally occurring groups could not be manipulated. According to Gall et al. (2007), in convenience sampling a researcher selects a sample that suits the purpose of the study and that is convenient. The researcher should (a) specify the population to which the sample would likely generalize, (b) describe pertinent characteristics of the sample, and (c) provide the rationale for why the sample was suited for the purpose of the study. Convenience samples “are used in more than 95 percent of research studies in the social sciences” (Gall et al., 2007, p. 174).

The participants in this study consisted of students identified as being at-risk by their 2011 scale scores on the mathematics subtest of the Georgia CRCT and enrolled in the sixth, seventh, and eighth grades in 2012 at two Title I middle schools in a rural Northwest Georgia school district. A score of 815 or below on the mathematics subtest of the 2011 Georgia CRCT was used to determine at-risk status. Since this study is comparing the relationship between a mathematic intervention for at-risk students and their standardized test scores, at-risk students were purposefully selected. According to Gall et al. (2007), “in purposeful sampling the goal is to select cases that are likely to be information-rich with respect to the purpose of the study” (p. 178).

The assignment of participants for the experimental group was based upon non-random selection. The experimental group consists of participants from middle school A (the middle school with a mathematic intervention program) scoring 815 or below on the mathematic subtest of the 2011 Georgia CRCT and enrolled in a mathematic intervention class in place of one of the electives during the connections block in 2012. Students participate in two different elective classes during the
connections block each semester. The connections block consists of instruction beyond the academic classes, such as art, computer, technology, music, PE, and health (Georgia Department of Education, 2013). Based on students’ 2011 mathematic CRCT scores and space available in the math intervention class, administrators place these participants in the mathematic intervention as one of their connections block classes. The same highly qualified mathematics teacher taught all mathematic intervention classes at the school with the mathematic intervention program.

The assignment of participants in the control group was based upon random selection. The control group consists of participants from middle school B (the middle school without a mathematic intervention program) who scored 815 or below on the mathematic subtest of the 2011 Georgia CRCT. The participants were not enrolled in a mathematic intervention course.

Both groups were matched by grade level and gender. Only students enrolled in a mathematic intervention class for the three quarters prior to CRCT testing were included in the study. Students who moved during the year were not included in this study.

The two schools are both Title I middle schools located in the same rural school district in northwest Georgia. Both schools met AYP during the 2011-2012 school year. Based upon interviews with the academic coaches and principals of the participating schools (P. Intervention School, personal communication, March 13, 2014; A. C. Intervention School, personal communication, March 17, 2014; A. C. Control School, personal communication, March 17, 2014; and P. Control School, personal communication, March 17, 2014), the intervention school provides a direct-instruction mathematic intervention to at-risk students and the control school does not provide an
intervention to at-risk students. The two schools are demographically similar. Table 3.1 shows the demographics of the two schools.

Table 3.1

Demographics of Participating Schools

<table>
<thead>
<tr>
<th></th>
<th>Black</th>
<th>Hispanic</th>
<th>White</th>
<th>Multi-Racial</th>
<th>SES</th>
<th>SWD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention School A</td>
<td>3.5%</td>
<td>3.3%</td>
<td>89.5%</td>
<td>3.7%</td>
<td>67.3%</td>
<td>16.5%</td>
</tr>
<tr>
<td>Non-intervention School B</td>
<td>5.2%</td>
<td>1.7%</td>
<td>90.0%</td>
<td>2.4%</td>
<td>68.8%</td>
<td>13.2%</td>
</tr>
</tbody>
</table>

This study consists of a treatment group and a control group. Table 3.2 shows the breakdown of participants by intervention and grade level.

Table 3.2

Participant Treatment Sample Breakdown by Grade Level

<table>
<thead>
<tr>
<th>Grade level</th>
<th>Entire Sample</th>
<th>Control Group</th>
<th>Treatment Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>6th</td>
<td>52</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>7th</td>
<td>60</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>8th</td>
<td>34</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Totals</td>
<td>146</td>
<td>73</td>
<td>73</td>
</tr>
</tbody>
</table>

This study also examines the direct-instruction intervention to determine if a direct-instruction mathematic intervention is effective for both males and females. Table 3.3 shows the gender breakdown by grade level.
### Table 3.3

**Participant Gender Sample Breakdown for each Intervention by Grade Level**

<table>
<thead>
<tr>
<th>Grade level</th>
<th>Entire Sample</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>6th</td>
<td>26</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>7th</td>
<td>30</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>8th</td>
<td>17</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>73</strong></td>
<td><strong>34</strong></td>
<td><strong>39</strong></td>
</tr>
</tbody>
</table>

**Setting**

This study took place at two public Title I middle schools located in the same rural Northwest Georgia school district. Both schools met AYP during the 2012 school year. As required by the state, all students were taught the same math standards and completed the Georgia CRCT. Georgia Professional Standards Commission certified highly qualified mathematics teachers teach all math classes.

Based on interviews with the principals and academic coaches of the participating schools (Academic Coach Control School, personal communication, March 17, 2014; Academic Coach Intervention School, personal communication, March 17, 2014; Principal Control School, personal communication, March 13, 2014; and Principal Intervention School, personal communication, March 17, 2014) in both schools all students attend regular mathematic classes consisting of grade-level heterogeneous ability groups. The prescribed curriculum, as mandated by the Georgia Department of Education, is taught using the pacing guide provided by the Georgia Department of
Education. The curriculum is taught using the workshop model. The workshop model consists of an opening, work time, and closing. During the opening, the teacher gives instruction. During work time, students work in pairs or small groups on the assigned task with the teacher acting as a facilitator. During the closing, selected students share their work with the class, and the class participates in a reflective discussion. Math books are not used. The method is student-centered and utilizes the active learning style of discovery learning, problem-based learning, and project-based learning. The state provides specific performance tasks for the curriculum. All math teachers are highly qualified, as required by the state. All math teachers in the county attend the same professional development together.

The mathematic intervention consists of a direct-instruction math intervention (SRA Mathematic Skillbuilder) taken during the connections period in place of an elective class. The classes consist of same-grade-level homogeneous mathematic ability groups. The participants are taught basic skills needed to succeed on the current grade-level standards using a specific direct-instruction mathematic intervention program, SRA Mathematic Skillbuilder by McGraw Hill. The program is based on the state standards for each grade level. Siegfried Engelmann, coauthor of theory of instruction, designed the program. The SRA Direct-Instruction programs consist of basic skills divided into small units. Any prerequisite skills are built in. The workbooks teach skills that consistently give students trouble on standardized tests (McGraw Hill Education, 2013). Students receive instant feedback and reward through tracking and praise. The direct-instruction method is used to teach the lessons. Instructions are explicit, using concrete positive and negative examples. The teacher models the
examples. The design is teacher-centered. Through repetition, participants practice the concept being taught until they are proficient. The lessons may remediate a concept students struggled with in the regular mathematics class or may parallel the concept currently being taught in the regular mathematics class. The purpose of the intervention is to help students who did not meet grade-level standards, as assessed by the 2011 Georgia mathematics subtest of the CRCT, reach grade-level expectations for the 2012 Georgia mathematics subtest of the CRCT. The intervention classes are approximately 80 minutes in length each. Every two weeks students in the remedial math class receive 400 minutes of math remediation. Students are placed in the class on an A or B day. The intervention classes rotate according to Table 3.4 and continue throughout the school year.

Table 3.4

*Rotating Connections Class Schedule*

<table>
<thead>
<tr>
<th>Week 1</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>Tuesday</td>
<td>Wednesday</td>
<td>Thursday</td>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 2</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>Tuesday</td>
<td>Wednesday</td>
<td>Thursday</td>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
</tbody>
</table>
**Instrumentation**

According to Zucker (2003), rather than compare a student’s test results with the results of a reference group (norm-referenced tests), “criterion-referenced tests are intended to measure a level of mastery according to a specific set of performance standards” (p. 6).

The Georgia CRCT is a criterion-referenced test. The 2012 math subtest of the Georgia Criterion Referenced Competency Test will be used as a dependent variable. The 2011 math subtest of the Georgia Criterion Reference Competency test will be used as a control variable. The purpose of the Georgia Criterion Referenced Competency Test is to measure how well students acquire the skills and knowledge based on the performance standards described in the state-adopted curriculum. The assessments provide information on academic achievement. Scores are typically reported as scale scores and performance scores. A scale score is based on the raw score (number of items correct) for each of the five mathematics domains on the test. The five specific domains are: (a) Numbers and Operations, (b) Measurement, (c) Geometry, (d) Algebra, and (e) Data Analysis and Probability. These five domains are the same for sixth, seventh, and eighth-grades (Georgia Department of Education, 2013).

Scale scores are commonly used in large assessment programs. Georgia law, as amended by the A+ Education Reform Act of 2000, requires that all students in grades one through eight take the CRCT in the content areas of reading, English/language arts, and mathematics. Students in grades three through eight are also assessed in science and social studies. The CRCT assesses the state-adopted curriculum as defined in the CCGPS and the GPS (Georgia Department of Education, 2013).
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Equating refers to a statistical procedure to ensure the tests are of equal difficulty.

Equating is critical because it ensures that students are always held to the same standards. The Georgia Department of Education has determined the Georgia CRCT to be valid (Georgia Department of Education, 2012).

“Reliability is the degree to which test scores for a group of test takers are consistent over repeated applications of a measurement procedure and are inferred to be dependable and repeatable for an individual test taker; the degree to which scores are free of errors of measurement for a given group” (Georgia Department of Education, 2012, p. 4). For the Georgia CRCT program, several reliability indices are reported. The first index is Cronbach’s alpha reliability coefficient. The second statistical index used to describe test score reliability for the Georgia CRCT is the standard error of measurement (SEM) (Georgia Department of Education, 2013). Table 3.5 shows the reliability indices in terms of Cronbach’s alpha along with the raw score SEM for sixth, seventh, and eighth-grade mathematics.

Table 3.5

<table>
<thead>
<tr>
<th>Grade</th>
<th>2012 Mathematics</th>
<th>2011 Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alpha</td>
<td>SEM</td>
</tr>
<tr>
<td>6th</td>
<td>0.92</td>
<td>3.26</td>
</tr>
<tr>
<td>7th</td>
<td>0.92</td>
<td>3.08</td>
</tr>
<tr>
<td>8th</td>
<td>0.92</td>
<td>3.22</td>
</tr>
</tbody>
</table>

The reliability coefficient is a unitless index, which can be compared from test to test and ranges from zero to one (Georgia Department of Education, 2012). These
reliabilities are consistent with the reliabilities of past Georgia CRCT tests, suggesting the assessment is reliable. According to DeVellis (2003), ideally the Cronbach alpha coefficient of a scale should be above .7. The Cronbach alpha coefficients of the above scales of the 2011 and 2012 Georgia CRCT meet this recommendation.

**Procedures**

Preliminary approval will be sought from the Walker County School Superintendent to conduct the study in the two selected middle schools. If approval is received, the consent form from the Superintendent will be forwarded, along with the necessary IRB packet, to Liberty University to obtain IRB approval from Liberty’s Internal Review Board. Liberty’s IRB approval form will then be forwarded to the Walker County School Superintendent for permission to conduct the study.

After submitting an IRB packet and gaining approval, I will begin the study by gathering specific demographic information from the school administrators of the two selected schools. Information will be gathered from the administrator, academic coach, and mathematic intervention teacher about specific information on the math intervention program, such as how the participants are chosen and how the programs are implemented. I will work with the intervention school’s academic coach to collect mathematic subtest scores from the 2011 and 2012 CRCT for the students participating in the 2012 mathematic intervention. The academic coach will provide an Excel spreadsheet with the student data. To ensure privacy and confidentiality, the spreadsheet will not contain any student names. The non-intervention school’s academic coach will provide the mathematic subtest scores from the 2011 and 2012 CRCT for at-risk students scoring below 815 on the mathematic subtest of the 2011 CRCT. The academic coach
will provide an Excel spreadsheet with the student data. To ensure privacy and confidentiality, the spreadsheet will not contain any student names. To control for statistical regression, students in both the intervention group and the control group will consist of at-risk students scoring 815 or below on their 2011 mathematic CRCT scores. According to Rovai et al., to control for statistical regression a researcher may “assign participants to both the experimental and control groups from the same extreme pool” (Rovai et al., 2013, p. 109). Students will participate in the math intervention, or will not. For the treatment group, all students labeled to be at risk based on a score of 815 or below on their 2011 Georgia CRCT were considered for placement in a mathematic intervention course. Administrators and the academic coach placed students in the program based on their 2011 CRCT scores and quarterly math grades. There were not enough slots available for every student to participate. Students were not able to choose whether they were in the mathematic intervention course or not. Students remained in the mathematic intervention class for one full school year (180 days). Only students enrolled in the mathematic intervention class for the three quarters prior to the CRCT will be included in this study. Students in the treatment group will consist of students participating in the mathematic intervention, and will not be randomly selected.

For the control group, all students labeled to be at-risk based a score of 815 or below on their 2011 Georgia CRCT will be considered. Students in the control group will be randomly selected. Groups will be matched by grade level and gender so the groups will be as equivalent as possible.
Data Analysis

The statistical program used to perform all statistical analysis will be SPSS version 20. Gall et al. (2007) recommends a sample size of at least 15 participants in each subgroup, and Rovai et al. (2013) recommends at least 30 participants in each subgroup. According to Olejnik (1984), based on a large effect size with a power of .7 and alpha at the .05 level, an analysis of covariance must include at least 27 participants (N = 27) with at least 13 (n = 13) in each subgroup. This convenience sample meets these requirements.

A one-way between-groups analysis of covariance (ANCOVA) test utilizing a quasi-experimental pretest-posttest non-equivalent groups design will be used to examine the null hypothesis for Research Questions 1 and 2. According to Pallant (2010), an ANCOVA can be used when you have a two-group pretest-posttest design, such as comparing the impact of two different interventions, taking before and after measures for each group (p. 298).

A one-way between-groups analysis of covariance (ANCOVA) test will be used to examine the null hypotheses for Research Question 1. Two separate one-way between-groups analyses of covariance (ANCOVA) tests will be used to examine the null hypotheses for Research Question 2, one for male, and one for female. According to Gall et al. (2007), an ANCOVA is used to make two groups equal with respect to one or more control variables (potentially confounding variables). According to Rovai et al. (2013), “a covariate is a continuous variable that is included in the analysis to adjust for relevant differences in study participants that exist at the start of the study. Covariates must not be selected arbitrarily, but, rather, selected based on theoretical considerations.
Moreover, covariates should correlate significantly with the DV” (p. 317).

The independent variable, direct-instruction math intervention, will exist at two levels, the treatment group receiving the intervention and the control group not receiving the intervention. The dependent variable will consist of the mean scores of the mathematic subtest of the 2012 Georgia CRCT. The covariate will consist of the mean scale scores of the mathematic subtest of the 2011 Georgia CRCT.

According to Rovai et al. (2013), assumptions and requirements include one continuous dependent variable utilizing an interval/ratio scale and one or more categorical independent variables. The covariates should be measured with high reliability. The dependent variable is normally distributed in subgroup. Observations should be independent. There should be linear relationships between each covariate and dependent variable as well as all covariates. There should be homogeneity of regression of slopes (for each level of the independent variable, the slope of the prediction of the dependent variable from the covariate is equal). Groups should have homogeneity of variance.
CHAPTER FOUR: RESULTS

The purpose of this study was to examine the differences in mean scale scores of the mathematic subtest of the 2012 Georgia CRCT for a group of at-risk middle school students who participated in a direct-instruction mathematic intervention and a group of at-risk middle school students who did not participate in a direct-instruction mathematic intervention during the 2012 school year, using each group’s pretest-posttest mean scale scores. In addition, comparisons between the experimental and control groups within this study will be analyzed based upon student gender.

Two analyses were conducted using the data. The first analysis compared the mean scale scores of the control group to the mean scale scores of the intervention group. The second analysis segregated both groups by gender and compared the mean scale scores of males who participated in a direct-instruction mathematic intervention to the mean scale scores of males who did not participate in a direct-instruction mathematic intervention and the mean scale scores of females who participated in a direct-instruction mathematic intervention to the mean scale scores of females who did not participate in a direct-instruction mathematic intervention.

This study utilized a one-way between-groups ANCOVA statistical analysis using each group’s 2011 scores as pretest scores and each group’s 2012 scores as posttest scores for all analyses. The control group did not come from the same group as the experimental group, which means the control and experimental groups’ pretest mean scale scores are different. The scores on the pretest are treated as a covariate to control for any existing differences. The ANCOVA adjusts the posttest means for the difference in the pretest means using regression. This procedure ensures that posttest differences
result from the treatment and are not a leftover effect of pre-test differences between the groups. The ANCOVA then conducted a within-groups and between-groups analysis to compare the two means to determine if there was a statistically significant difference in the means.

This chapter is divided into three sections: (1) the results of the ANCOVA comparing the intervention group to the non-intervention group for hypothesis one, (2) the results of the ANCOVA comparing the intervention group to the non-intervention group by gender, and (3) the summary.

This study is a planned comparison (also known as *a priori*), which is used when testing for a specific hypothesis. When using a planned comparison, post hoc comparisons are not necessary (Pallant, 2010). IBM SPSS version 21 was used for all statistical analyses.

**Hypothesis One**

The first guiding research question is: Does a direct-instruction math intervention improve mathematic academic achievement and increase standardized test scores for at-risk middle school students? A one-way between-groups analysis of covariance (ANCOVA) was conducted to determine if there was a statistically significant difference between the mean scale scores of the mathematic subtest of the Georgia CRCT for at-risk middle school students who participated in a direct-instruction mathematic intervention and at-risk middle school students who did not participate in a mathematic intervention. Intervention served as the independent variable, and consisted of two levels- students who received a direct-instruction mathematic intervention and students who did not receive a direct-instruction mathematic intervention. The dependent variable was the
2012 mathematics CRCT mean scale scores for each student, and served as the posttest. The 2011 mathematic CRCT mean scale scores for each student was the covariate, and served as the pretest.

Normality was examined using the statistics for the CRCT score data listed in Table 4.1 and 4.2. The descriptive statistics for the 2011 scores by intervention are presented in Table 4.1

Table 4.1

Descriptive Statistics for 2011 CRCT Scores by Intervention

<table>
<thead>
<tr>
<th>Intervention</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
</tr>
<tr>
<td>Direct Instruction</td>
<td>73</td>
<td>774</td>
<td>815</td>
<td>795.38</td>
<td>11.881</td>
<td>-.048</td>
<td>.281</td>
</tr>
<tr>
<td>Control</td>
<td>73</td>
<td>774</td>
<td>815</td>
<td>796.42</td>
<td>10.612</td>
<td>-.149</td>
<td>.281</td>
</tr>
</tbody>
</table>

The descriptive statistics for the 2012 scores by intervention are presented in Table 4.2.

Table 4.2

Descriptive Statistics for 2012 CRCT Scores by Intervention

<table>
<thead>
<tr>
<th>Intervention</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
</tr>
<tr>
<td>Direct Instruction</td>
<td>73</td>
<td>770</td>
<td>851</td>
<td>816.16</td>
<td>16.746</td>
<td>-.305</td>
<td>.281</td>
</tr>
<tr>
<td>Control</td>
<td>73</td>
<td>755</td>
<td>830</td>
<td>802.44</td>
<td>16.832</td>
<td>-.432</td>
<td>.281</td>
</tr>
</tbody>
</table>

The data from Table 4.1 and 4.2 indicate normality with skewness values close to zero.

Figure 4.1 presents a histogram for the 2011 CRCT scores by intervention, and Figure 4.2 presents a histogram for the 2012 CRCT scores by intervention.
Figure 4.1. Histogram of 2011 CRCT Scores by Intervention

Figure 4.2. Histogram of 2012 CRCT Scores by Intervention
Figures 4.1 and 4.2 indicate that CRCT scores for 2011 and 2012 appear approximately bell-shaped and symmetric. Normality was also checked using the Kolmogorov-Smirnov test (n > 50). Table 4.3 presents the results for normality for the CRCT scores by intervention.

Table 4.3

<table>
<thead>
<tr>
<th>Test of Normality for CRCT Scores by Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2012 Scores</td>
</tr>
<tr>
<td>Direct Instruction</td>
</tr>
<tr>
<td>Control</td>
</tr>
<tr>
<td>2011 Scores</td>
</tr>
<tr>
<td>Direct Instruction</td>
</tr>
<tr>
<td>Control</td>
</tr>
</tbody>
</table>

Table 4.3 indicates p > .05 for all groups, indicating the assumption of normality is valid.

Several assumptions specific to an ANCOVA were examined. The first assumption is, the covariate is measured prior to the intervention. The covariate was the 2011 CRCT mathematic mean scale scores measured prior to the intervention. The second assumption is, the covariate is measured without error. The reliability of the covariate was assumed based on the information provided by the Georgia Department of Education (Table 3.5). According to DeVellis (2003), ideally the Cronbach alpha coefficient of a scale should be above .7. The Cronbach alpha coefficients of the above scales of the 2011 Georgia CRCT meet this recommendation. A third assumption is a linear relationship (linearity) between the dependent variable and the covariate for all groups. Linearity was tested by examining a scatterplot (Figure 4.3). Fit lines were
added by subgroup, which appear to be straight. Therefore, the general distribution of scores indicates a linear relationship for each group.

Figure 4.3. Scatterplot of 2011 and 2012 CRCT Scores by Intervention

A final assumption is, the relationship between the covariate and dependent variable is the same for each of the groups (homogeneity of regression of slopes). The assumption of homogeneity of slopes was also tested. The scatterplot (Figure 4.3) indicated no violation of homogeneity (similar lines between dependent variable and covariate). An analysis of between-subjects test (Table 4.4) was chosen to verify the homogeneity of regression of slopes. \( F(1,137) = 1.770, \text{MSE} = 493.474, p = .185, \) indicating the assumption was not violated.
Table 4.4

Test of Homogeneity of Slopes for Intervention Groups

Tests of Between-Subjects Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>7882.966^a</td>
<td>3</td>
<td>2627.655</td>
<td>9.427</td>
<td>.000</td>
</tr>
<tr>
<td>Intercept</td>
<td>13587.799</td>
<td>1</td>
<td>13587.799</td>
<td>48.746</td>
<td>.000</td>
</tr>
<tr>
<td>Groups</td>
<td>442.658</td>
<td>1</td>
<td>442.658</td>
<td>1.588</td>
<td>.210</td>
</tr>
<tr>
<td>CRCT_2011</td>
<td>400.051</td>
<td>1</td>
<td>400.051</td>
<td>1.435</td>
<td>.233</td>
</tr>
<tr>
<td>Groups * CRCT_2011</td>
<td>493.474</td>
<td>1</td>
<td>493.474</td>
<td>1.770</td>
<td>.185</td>
</tr>
<tr>
<td>Error</td>
<td>39581.773</td>
<td>142</td>
<td>278.745</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>95672896.000</td>
<td>146</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>47464.740</td>
<td>145</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

^a. R Squared = .166 (Adjusted R Squared = .148)

Levene’s test for homogeneity of variances (Table 4.5) produced a significance level of ρ = .800, indicating that the homogeneity of variance was not violated.

Table 4.5

Levene’s Test of Equality of Variances for 2012 Scores

<table>
<thead>
<tr>
<th></th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>.065</td>
<td>1</td>
<td>144</td>
<td>.800</td>
</tr>
</tbody>
</table>

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.^a

^a. Design: Intercept + CRCT_2011 + Groups

Since it was determined that no assumptions were violated, a between-subjects ANCOVA (Table 4.10) was conducted to test null hypothesis one; Ho1: At-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention will not have statistically significant different mean scale scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students
who do not receive a direct-instruction math intervention, while using their 2011 Georgia mathematic CRCT test scores as a control variable for previous math achievement.

Descriptive statistics for the 2011 scores are presented in Table 4.6. Descriptive statistics for the 2012 CRCT scores before adjusting for the 2011 CRCT scores are presented in Table 4.7.

Table 4.6

Descriptive Statistics for 2011 CRCT Scores by Intervention

<table>
<thead>
<tr>
<th>Intervention</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Instruction</td>
<td>73</td>
<td>774</td>
<td>815</td>
<td>795.38</td>
<td>11.881</td>
</tr>
<tr>
<td>2011 Scores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>73</td>
<td>774</td>
<td>815</td>
<td>796.42</td>
<td>10.612</td>
</tr>
<tr>
<td>Valid N (listwise)</td>
<td>73</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.7

Descriptive Statistics for 2012 CRCT Scores by Intervention

<table>
<thead>
<tr>
<th>Intervention</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Instruction</td>
<td>73</td>
<td>770</td>
<td>851</td>
<td>816.16</td>
<td>16.746</td>
</tr>
<tr>
<td>2012 Scores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>73</td>
<td>755</td>
<td>830</td>
<td>802.44</td>
<td>16.832</td>
</tr>
<tr>
<td>Valid N (listwise)</td>
<td>73</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.8 provides the adjusted means (the effect of the covariate has been statistically removed) for the 2012 scores on the dependent variable for each of the groups.

Table 4.8

Adjusted Means by Intervention

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Mean</th>
<th>Std. Error</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Instruction</td>
<td>816.252$^*$</td>
<td>1.960</td>
<td>812.376 - 820.127</td>
</tr>
<tr>
<td>Control</td>
<td>802.351$^*$</td>
<td>1.960</td>
<td>798.476 - 806.226</td>
</tr>
</tbody>
</table>

80
Table 4.9 shows the descriptive statistics for growth by intervention.

Table 4.9

*Descriptive Statistics for Growth by Intervention*

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011 Pretest scores</td>
<td>73</td>
<td>795.380</td>
<td>11.881</td>
</tr>
<tr>
<td>2012 Adjusted Posttest scores</td>
<td>73</td>
<td>816.252</td>
<td>1.960</td>
</tr>
<tr>
<td>Gain</td>
<td></td>
<td>20.872</td>
<td></td>
</tr>
<tr>
<td>Control group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011 Pretest scores</td>
<td>73</td>
<td>796.420</td>
<td>10.612</td>
</tr>
<tr>
<td>2012 Adjusted Posttest scores</td>
<td>73</td>
<td>802.350</td>
<td>1.960</td>
</tr>
<tr>
<td>Gain</td>
<td></td>
<td>5.931</td>
<td></td>
</tr>
<tr>
<td>Difference between gains</td>
<td></td>
<td>14.941</td>
<td></td>
</tr>
</tbody>
</table>

Based on table 4.9, the intervention group had a mean pretest score of 795.38 (SD = 11.881). The intervention group’s adjusted mean posttest score was 816.252 (SE = 1.960). Based upon the intervention group’s mean pretest and adjusted mean posttest scores, there was a 20.872 average increase in the students’ mean scale test scores. The control group within this study had a mean pretest score of 796.420 (SD = 10.612). The control group’s adjusted mean posttest score was 802.351 (SE = 1.960). Based upon the control group’s mean pretest and adjusted mean posttest scores, there was a 5.931 average increase in the students’ mean scale test scores. Both the intervention group and the control group showed an increase in their test scores for the year. However, when comparing the growth rates between both the intervention group and the control group, the intervention group received an overall 14.941-point gain over the control group. The results of the ANCOVA for hypothesis one is presented in table 4.10.
Table 4.10 provides the data from the ANCOVA for hypothesis one.

**Table 4.10**

**ANCOVA for Hypothesis One**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>7389.492a</td>
<td>2</td>
<td>3694.746</td>
<td>13.184</td>
<td>.000</td>
<td>.156</td>
<td>.997a</td>
</tr>
<tr>
<td>Intercept</td>
<td>13176.868</td>
<td>1</td>
<td>13176.868</td>
<td>47.019</td>
<td>.000</td>
<td>.247</td>
<td>1.000</td>
</tr>
<tr>
<td>CRCT_2011</td>
<td>512.752</td>
<td>1</td>
<td>512.752</td>
<td>1.830</td>
<td>.178</td>
<td>.013</td>
<td>.269</td>
</tr>
<tr>
<td>Groups</td>
<td>7037.367</td>
<td>1</td>
<td>7037.367</td>
<td>25.111</td>
<td>.000</td>
<td>.149</td>
<td>.999</td>
</tr>
<tr>
<td>Error</td>
<td>40075.248</td>
<td>143</td>
<td>280.246</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>95672896.000</td>
<td>146</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>47464.740</td>
<td>145</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. R Squared = .156 (Adjusted R Squared = .144)
b. Computed using alpha = .05

After adjusting for pretest scores (covariate), there was a statistically significant difference between groups at $\alpha = .05$, $F(1,143) = 25.11$, $p = .00$, partial $\eta^2 = .15$, indicating the group taking a direct-instruction math intervention had a significantly higher mean score. As interpreted by Cohen, the effect size of .15 is large, indicating that 15% of the variance in the 2012 scores can be explained by the intervention.

**Hypothesis Two**

The second guiding research question is: Is the direct-instruction mathematic intervention effective for both genders? A one-way between-groups analysis of covariance (ANCOVA) was conducted for each gender to determine if there was a statistically significant difference between the mean scale scores of the mathematic subtest of the 2012 Georgia CRCT for at-risk middle students who participated in a direct-instruction mathematic intervention and at-risk middle school students who did not participate in a direct-instruction mathematic intervention. The dependent variable was the 2012 mathematic mean scale scores of the Georgia CRCT for each student. The 2011
mathematic mean scale scores of the Georgia CRCT for each student served as the covariate. The analysis was conducted using a split data file based on gender. This resulted in separate analysis for males and females based on intervention.

Preliminary analyses were conducted to ensure there were no violations of the assumption of normality, linearity, homogeneity of variances, homogeneity of regression of slopes, and reliable measure of covariate.

Normality was examined using the statistics for the CRCT score data listed in Tables 4.11 and 4.12. Based on the statistics in the tables, normality may be assumed based on the kurtosis and skew values close to zero.

Table 4.11

*Descriptive Statistics for 2011 CRCT Scores by Intervention for each Gender*

<table>
<thead>
<tr>
<th>Gender</th>
<th>Intervention</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Std. Error</td>
</tr>
<tr>
<td>Male</td>
<td>Direct_Instruction 2011 Scores</td>
<td>34</td>
<td>774</td>
<td>815</td>
<td>795.06</td>
<td>11.987</td>
<td>.076</td>
<td>.403</td>
</tr>
<tr>
<td></td>
<td>Control 2011 Scores</td>
<td>34</td>
<td>776</td>
<td>815</td>
<td>797.50</td>
<td>11.548</td>
<td>-.274</td>
<td>.403</td>
</tr>
<tr>
<td>Female</td>
<td>Direct_Instruction 2011 Scores</td>
<td>39</td>
<td>774</td>
<td>815</td>
<td>795.67</td>
<td>11.937</td>
<td>-.158</td>
<td>.378</td>
</tr>
<tr>
<td></td>
<td>Control 2011 Scores</td>
<td>39</td>
<td>774</td>
<td>815</td>
<td>795.49</td>
<td>9.779</td>
<td>-.098</td>
<td>.378</td>
</tr>
</tbody>
</table>

Table 4.12

*Descriptive Statistics for 2012 CRCT Scores by Intervention for each Gender*

<table>
<thead>
<tr>
<th>Gender</th>
<th>Intervention</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Std. Error</td>
</tr>
<tr>
<td>Male</td>
<td>Direct_Instruction 2012 Scores</td>
<td>34</td>
<td>770</td>
<td>850</td>
<td>813.44</td>
<td>17.921</td>
<td>-.406</td>
<td>.403</td>
</tr>
<tr>
<td></td>
<td>Control 2012 Scores</td>
<td>34</td>
<td>776</td>
<td>827</td>
<td>801.97</td>
<td>14.018</td>
<td>.031</td>
<td>.403</td>
</tr>
<tr>
<td>Female</td>
<td>Direct_Instruction 2012 Scores</td>
<td>39</td>
<td>786</td>
<td>851</td>
<td>818.54</td>
<td>15.492</td>
<td>-.045</td>
<td>.378</td>
</tr>
<tr>
<td></td>
<td>Control 2012 Scores</td>
<td>39</td>
<td>755</td>
<td>830</td>
<td>802.85</td>
<td>19.125</td>
<td>-.614</td>
<td>.378</td>
</tr>
<tr>
<td></td>
<td>Valid N (listwise)</td>
<td>39</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figures 4.4 and 4.5 present histograms for the 2011 CRCT scores for each gender by intervention, and Figures 4.6 and 4.7 present histograms for the 2012 CRCT scores for each gender by intervention.

**Figure 4.4.** Histogram of 2011 Scores by Intervention for Females

**Figure 4.5.** Histogram of 2011 Scores by Intervention for Males
Figure 4.6. Histogram of 2012 Scores by Intervention for Females

Figure 4.7. Histogram of 2012 Scores by Intervention for Males
Figures 4.4, 4.5, 4.6, and 4.7 indicate that CRCT scores for 2011 and 2012 appear approximately bell-shaped and symmetric. Normality is assumed based on the figures. Normality was also checked using the Shapiro-Wilk test (n < 50). Table 4.13 presents the results for the 2011 CRCT scores by intervention, and Table 4.14 presents the results for the 2012 CRCT scores by intervention.

Table 4.13

*Test of Normality for 2011 Scores by Gender*

<table>
<thead>
<tr>
<th>Gender</th>
<th>Intervention</th>
<th>Shapiro-Wilk</th>
<th>Statistic</th>
<th>df</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>2011 Scores</td>
<td>Direct Instruction</td>
<td>.978</td>
<td>34</td>
<td>.701</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>.954</td>
<td>34</td>
<td>.159</td>
</tr>
<tr>
<td>Female</td>
<td>2011 Scores</td>
<td>Direct Instruction</td>
<td>.957</td>
<td>39</td>
<td>.141</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>.953</td>
<td>39</td>
<td>.806</td>
</tr>
</tbody>
</table>

Table 4.14

*Test of Normality for 2012 Scores by Gender*

<table>
<thead>
<tr>
<th>Gender</th>
<th>Intervention</th>
<th>Shapiro-Wilk</th>
<th>Statistic</th>
<th>df</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>2012 Scores</td>
<td>Direct Instruction</td>
<td>.979</td>
<td>34</td>
<td>.734</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>.959</td>
<td>34</td>
<td>.227</td>
</tr>
<tr>
<td>Female</td>
<td>2012 Scores</td>
<td>Direct Instruction</td>
<td>.980</td>
<td>39</td>
<td>.696</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>.950</td>
<td>39</td>
<td>.084</td>
</tr>
</tbody>
</table>

Tables 4.13 and 4.14 show p > .05 for all groups, indicating the assumption of normality is valid.

Several assumptions specific to an ANCOVA were examined. The first assumption is that the covariate is measured prior to the intervention. The covariate is the 2011 CRCT mathematic scale scores, and was measured prior to the intervention. The
second assumption is that the covariate is measured without error. The reliability of the covariate was assumed based on the information provided by the Georgia Department of Education (Table 3.5). These reliabilities are consistent with the reliabilities of past Georgia CRCT tests, suggesting the assessment is reliable. According to DeVellis (2003), ideally the Cronbach alpha coefficient of a scale should be above .7. The Cronbach alpha coefficients of the above scales of the 2011 and 2012 Georgia CRCT meet this recommendation. A third assumption is a linear relationship (linearity) between the dependent variable and the covariate for all groups. Linearity was tested by examining a scatterplot for females (Figure 4.8) and males (Figure 4.9). Fit lines were added by subgroup, which appear to be straight. Therefore, the general distribution of scores indicates a linear relationship for each group.

Figure 4.8. Scatterplot of 2011 and 2012 CRCT Scores by Intervention for Females
A final assumption is that the relationship between the covariate and dependent variable is the same for each of the groups (homogeneity of regression of slopes). The assumption of homogeneity of slopes was also tested. The scatterplots (Figures 4.8 and 4.9) indicated no violation of homogeneity (similar lines between dependent variable and covariate). An analysis of between-subjects test (Table 4.15) was chosen to verify the homogeneity of regression of slopes. For males, $F(1, 64) = .09$, $MSE = 22.502$, $p = .77$; and for females, $F(1, 74) = 2.24$, $MSE = 666.747$, $p = .14$; indicating there is no violation of the assumption.
Table 4.15

Test of Homogeneity of Slopes by Gender

Dependent Variable: 2012 Scores

<table>
<thead>
<tr>
<th>Gender</th>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corrected Model</td>
<td>2466.251*</td>
<td>3</td>
<td>822.084</td>
<td>3.122</td>
<td>.032</td>
</tr>
<tr>
<td></td>
<td>Intercept</td>
<td>6841.632</td>
<td>1</td>
<td>6841.632</td>
<td>25.980</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Groups</td>
<td>16.265</td>
<td>1</td>
<td>16.265</td>
<td>.062</td>
<td>.805</td>
</tr>
<tr>
<td>Male</td>
<td>CRCT_2011</td>
<td>201.633</td>
<td>1</td>
<td>201.633</td>
<td>.766</td>
<td>.385</td>
</tr>
<tr>
<td></td>
<td>Groups * CRCT_2011</td>
<td>22.502</td>
<td>1</td>
<td>22.502</td>
<td>.085</td>
<td>.771</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>16853.867</td>
<td>64</td>
<td>263.342</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>44381758.000</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corrected Total</td>
<td>19320.118</td>
<td>67</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>Corrected Model</td>
<td>5773.472*</td>
<td>3</td>
<td>1924.491</td>
<td>6.459</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>Intercept</td>
<td>6887.173</td>
<td>1</td>
<td>6887.173</td>
<td>23.116</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Groups</td>
<td>620.079</td>
<td>1</td>
<td>620.079</td>
<td>2.081</td>
<td>.153</td>
</tr>
<tr>
<td></td>
<td>CRCT_2011</td>
<td>144.890</td>
<td>1</td>
<td>144.890</td>
<td>.486</td>
<td>.488</td>
</tr>
<tr>
<td></td>
<td>Groups * CRCT_2011</td>
<td>666.747</td>
<td>1</td>
<td>666.747</td>
<td>2.238</td>
<td>.139</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>22047.144</td>
<td>74</td>
<td>297.934</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>51291138.000</td>
<td>78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corrected Total</td>
<td>27820.615</td>
<td>77</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Levene’s test for homogeneity of variances produced a significant level of

\( \rho = .451 \) for males and \( \rho = .205 \) for females (Table 4.16), indicating that the homogeneity

of variance was not violated.

Table 4.16

Levene’s Test for Homogeneity of Variance by Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>.575</td>
<td>1</td>
<td>66</td>
<td>.451</td>
</tr>
<tr>
<td>Female</td>
<td>1.631</td>
<td>1</td>
<td>76</td>
<td>.205</td>
</tr>
</tbody>
</table>

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.*

a. Design: Intercept + CRCT_2011 + Groups
Since it was determined that no assumptions were violated, a between-subjects ANCOVA (Table 4.21) was conducted to test null hypothesis two. Based on gender, at-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention will not have statistically significant different mean scale scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention, while using their 2011 Georgia mathematic CRCT test scores as a covariate to control for previous math achievement.

Descriptive statistics for the 2012 CRCT scores by gender before adjusting for the 2011 CRCT scores are presented in Table 4.17. Descriptive statistics by gender for the 2011 CRCT scores are presented in Table 4.18.

Table 4.17

*Descriptive Statistics for 2011 Scores by Intervention*

<table>
<thead>
<tr>
<th>Gender</th>
<th>Intervention</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
<td></td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
</tr>
<tr>
<td>Male</td>
<td>Direct Instruction 2011 Scores</td>
<td>34</td>
<td>774</td>
<td>815</td>
<td>795.06</td>
<td>11.987</td>
</tr>
<tr>
<td></td>
<td>Control 2011 Scores</td>
<td>34</td>
<td>776</td>
<td>815</td>
<td>797.50</td>
<td>11.548</td>
</tr>
<tr>
<td>Female</td>
<td>Direct Instruction 2011 Scores</td>
<td>39</td>
<td>774</td>
<td>815</td>
<td>795.67</td>
<td>11.937</td>
</tr>
<tr>
<td></td>
<td>Control 2011 Scores</td>
<td>39</td>
<td>774</td>
<td>815</td>
<td>795.49</td>
<td>9.779</td>
</tr>
</tbody>
</table>
Table 4.18

**Descriptive Statistics for 2012 Scores by Intervention**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Intervention</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
</tr>
<tr>
<td>Male</td>
<td>Direct Instruction</td>
<td>34</td>
<td>770</td>
<td>850</td>
<td>813.44</td>
<td>17.921</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>34</td>
<td>776</td>
<td>827</td>
<td>801.97</td>
<td>14.018</td>
</tr>
<tr>
<td>Female</td>
<td>Direct Instruction</td>
<td>39</td>
<td>786</td>
<td>851</td>
<td>818.54</td>
<td>15.492</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>39</td>
<td>755</td>
<td>830</td>
<td>802.85</td>
<td>19.125</td>
</tr>
</tbody>
</table>

Table 4.19 provides the adjusted means (the effect of the covariate has been statistically removed) for the 2012 scores, by gender, on the dependent variable for each of the groups.

Table 4.19

**Adjusted Means by Intervention for each Gender**

<table>
<thead>
<tr>
<th>Dependent Variable: 2012 Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

- Covariates appearing in the model are evaluated at the following values: 2011 Scores = 796.28.
- Covariates appearing in the model are evaluated at the following values: 2011 Scores = 795.58.

Table 4.20 shows the descriptive statistics for growth, by gender, for each intervention.
Table 4.20

Descriptive Statistics for Growth, by Gender, for each Intervention

<table>
<thead>
<tr>
<th>Variables</th>
<th>Growth</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Male Intervention Group</td>
<td>2011 Pretest scores</td>
<td>34</td>
<td>795.060</td>
<td>11.987</td>
</tr>
<tr>
<td></td>
<td>2012 Adjusted Posttest scores</td>
<td>34</td>
<td>813.625</td>
<td>2.771</td>
</tr>
<tr>
<td></td>
<td>Gain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>18.565</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Control group</td>
<td>2011 Pretest scores</td>
<td>34</td>
<td>797.500</td>
<td>11.548</td>
</tr>
<tr>
<td></td>
<td>2012 Adjusted Posttest scores</td>
<td>34</td>
<td>801.787</td>
<td>2.771</td>
</tr>
<tr>
<td></td>
<td>Gain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.278</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference between gains</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14.287</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female Intervention group</td>
<td>2011 Pretest scores</td>
<td>39</td>
<td>795.670</td>
<td>11.937</td>
</tr>
<tr>
<td></td>
<td>2012 Adjusted Posttest scores</td>
<td>39</td>
<td>818.522</td>
<td>2.787</td>
</tr>
<tr>
<td></td>
<td>Gain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22.852</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female Control group</td>
<td>2011 Pretest scores</td>
<td>39</td>
<td>795.490</td>
<td>9.779</td>
</tr>
<tr>
<td></td>
<td>2012 Adjusted Posttest scores</td>
<td>39</td>
<td>802.863</td>
<td>2.787</td>
</tr>
<tr>
<td></td>
<td>Gain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.373</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference between gains</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15.479</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on Table 4.20, the intervention group’s males had a mean pretest score of 795.06 (SD = 11.987). The intervention group’s adjusted mean posttest score was 813.625 (SE = 2.771). Based upon the intervention group’s mean pretest and adjusted mean posttest scores, there was an 18.565 average increase in the students’ mean scale scores. The control group’s males within this study had a mean pretest score of 797.50 (SD = 11.548). The control group’s males’ adjusted mean posttest score was 801.787 (SE = 2.771). Based upon the control group’s mean pretest and adjusted mean posttest scores, there was a 4.278 average increase in the students’ mean scale scores. Both the male intervention and control groups showed an increase in their test scores. However, when comparing the growth rates between both the intervention group and the control group, the intervention group received an overall 14.287-point gain over the control group.
The intervention group’s females had a mean pretest score of 795.67 (SD = 11.937). The intervention group’s females’ adjusted mean posttest score was 818.522 (SE = 2.787). Based upon the intervention group’s females’ mean pretest and adjusted mean posttest scores, there was a 22.852 average increase. The control group’s females within this study had a mean pretest score of 795.49 (SD = 9.779). The control group’s females’ adjusted mean posttest score was 802.863 (SE = 2.787). Based upon the control group’s females’ mean pretest and adjusted mean posttest scores, there was a 7.373 average increase. Both the female intervention and control groups showed an increase in their test scores for the year. However, when comparing the growth rates between both the intervention group and the control group, the intervention group’s females received an overall 15.479-point gain over the control group’s females.

Table 4.21 shows the data for the ANCOVA for null hypothesis two.

Table 4.21

**ANCOVA for Null Hypothesis Two**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Source</th>
<th>Type III Sum of</th>
<th>df</th>
<th>Mean</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
<th>Noncent. Parameter</th>
<th>Observed Power²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corrected Model</td>
<td>2443.748</td>
<td>2</td>
<td>1221.874</td>
<td>4.706</td>
<td>.012</td>
<td>.126</td>
<td>9.412</td>
<td>.770</td>
</tr>
<tr>
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<td>Intercept</td>
<td>6821.470</td>
<td>1</td>
<td>6821.470</td>
<td>26.273</td>
<td>.000</td>
<td>.288</td>
<td>26.273</td>
<td>.999</td>
</tr>
<tr>
<td></td>
<td>CRCT_2011</td>
<td>206.984</td>
<td>1</td>
<td>206.984</td>
<td>.797</td>
<td>.375</td>
<td>.012</td>
<td>.797</td>
<td>.142</td>
</tr>
<tr>
<td>Male</td>
<td>Groups</td>
<td>2356.201</td>
<td>1</td>
<td>2356.201</td>
<td>9.075</td>
<td>.004</td>
<td>.123</td>
<td>9.075</td>
<td>.843</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>16876.369</td>
<td>65</td>
<td>259.636</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>44381758.000</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corrected Total</td>
<td>19320.118</td>
<td>67</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>Corrected Model</td>
<td>5106.725</td>
<td>2</td>
<td>2553.362</td>
<td>8.431</td>
<td>.000</td>
<td>.184</td>
<td>16.862</td>
<td>.959</td>
</tr>
<tr>
<td></td>
<td>Intercept</td>
<td>6314.265</td>
<td>1</td>
<td>6314.265</td>
<td>20.849</td>
<td>.000</td>
<td>.218</td>
<td>20.849</td>
<td>.995</td>
</tr>
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After adjusting for pretests scores, there was a statistically significant difference between the groups’ posttests scores based on intervention for males at $\alpha = .05$, $F(1, 65) = 9.08$, $p = .00$, partial $\eta^2 = .12$, and for females at $\alpha = .05$, $F(1, 75) = 15.79$, $p = .00$, partial $\eta^2 = .17$, indicating that both males and females taking a direct-instruction mathematic intervention had statistically significant higher mean scale scores than both males and females not taking a direct-instruction mathematic intervention. As interpreted by Cohen, the effect size of .12 is medium for males and the effect size of .17 is large for females, indicating that 12% of the variance in the 2012 scores for males can be explained by the intervention and 17% of the variance in the 2012 scores for females can be explained by the intervention.

**Summary**

A one-way between-groups analysis of covariance utilizing a pretest-posttest non-equivalent groups design was conducted to test null hypothesis one: At-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention will not have statistically significant different mean scale scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention, while using their 2011 Georgia mathematic CRCT test scores as a control covariate to control for previous math achievement. The independent variable was the type of intervention (direct-instruction,
no intervention), and the dependent variable consisted of the scale scores on the mathematic subtest of the 2012 Georgia CRCT. Participants’ scale scores on the mathematic subtest of the 2011 Georgia CRCT were used as a covariate in this analysis.

Preliminary checks were conducted to ensure there was no violation of the assumptions of normality, linearity, homogeneity of variances, homogeneity of regression of slopes, and reliable measurement of the covariate. After adjusting for pretests mean scale scores, there was a statistically significant difference on the posttests mean scale scores of the mathematic subtest of the 2012 Georgia CRCT. At $\alpha = .05$, $F(1,143) = 25.11$, $p = .00$, partial $\eta^2 = .15$, $P = 0.99$, indicating a large effect size. Based upon the results, null hypothesis one was rejected. Both the intervention and control groups showed math achievement growth for the year. However, the intervention group achieved a statistically significant larger increase in their mean scale scores when compared to the control group, suggesting the mathematic intervention had a positive impact on student achievement and standardized test scores.

A one-way between-groups analysis of covariance, with the case file split by gender, was conducted to test null hypothesis two: Based on gender, at-risk sixth, seventh, and eighth-grade students who receive a direct-instruction math intervention will not have statistically significant different mean scale scores on the 2012 Georgia mathematic CRCT when compared to at-risk sixth, seventh, and eighth-grade students who do not receive a direct-instruction math intervention, while using their 2011 Georgia mathematic CRCT test scores as a control covariate to control for previous math achievement. The independent variable was the type of intervention (direct-instruction, no intervention), and the dependent variable consisted of the scale scores on the
mathematic subtest of the 2012 Georgia CRCT. Participants’ scale scores on the
mathematic subtest of the 2011 Georgia CRCT were used as a covariate in this analysis.

Preliminary checks were conducted to ensure there was no violation of the
assumptions of normality, linearity, homogeneity of variances, homogeneity of regression
of slopes, and reliable measurement of the covariate. After adjusting for pretests mean
scale scores, there was a statistically significant difference between groups based on
intervention for males at \( \alpha = .05, F(1, 65) = 9.08, p = .00, \) partial \( \eta^2 = .12, \) and for
females at \( \alpha = .05, F(1, 75) = 15.79, p = .00, \) partial \( \eta^2 = .17, \) indicating both males and
females taking a direct-instruction mathematic intervention had statistically significant
higher mean scale scores than both males and females not taking a direct-instruction
mathematic intervention. As interpreted by Cohen, the effect size of .12 is medium for
males and the effect size of .17 is large for females, indicating that 12\% of the variance in
the 2012 scores for males can be explained by the intervention and 17\% of the variance
in the 2012 scores for females can be explained by the intervention. Based upon the
results, null hypothesis two was rejected. The males and females for both the
intervention and control groups achieved math gains for the year. However, both the
males and females in the intervention groups achieved a statistically significant larger
increase in test scores than the males and females in the control groups, suggesting the
mathematic intervention had a positive impact on student achievement and standardized
test scores.

In conclusion, the findings for Research Questions One and Two suggest the SRA
Math Skillbuilder Program used as a mathematic intervention is significantly impacting
the mathematic achievement of the participants, resulting in an increase in the students’
standardized test scores. Both male and female participants in the experimental groups showed a statistically significant increase in their CRCT test scores when compared to the control groups.
CHAPTER FIVE: DISCUSSION

The purpose of this pretest-posttest non-equivalent groups design research study was to determine if the SRA Mathematic Skillbuilder program used as a mathematic intervention during a connections class was significantly affecting the math achievement of the students enrolled in the mathematic intervention program. The school incorporated the intervention program as its primary Response to Intervention tool for sixth, seventh, and eighth graders whom had been identified as at-risk for failure to meet the mathematic requirement for the Georgia CRCT and the school’s achievement requirements. Based upon the ANCOVA analyses, the mathematic intervention has resulted in a statistically significant positive increase in the mean scale test scores for the participants.

This chapter consists of five sections: (1) the findings of the study, (2) a discussion of the findings as they pertain to each hypothesis and the theoretical framework, (3) the study’s implications, (4) the study’s limitations, and (5) recommendations for future research.

Summary of the Findings

This study utilized a causal-comparative research design. A causal-comparative research design is exploratory in nature, and is used to determine if there is a possible cause-and-effect relationship between two or more variables. The results of a causal-comparative design should be interpreted with caution, and may offer only suggestive, and not conclusive, outcomes. The study utilized a pretest-posttest non-equivalent groups design. This design is commonly used in educational research when randomization is not possible (Gall et al., 2007, p. 416). All participants scored 815 or below on the mathematic subtest of the 2011 Georgia CRCT, and were considered
at-risk by the administrators. The experimental group for this study was non-randomly selected from School A, and consisted of 73 at-risk middle school students participating in a direct-instruction mathematic intervention in place of one of their connection classes during the 2011-2012 school year. The control group was randomly selected from School B and consisted of 73 at-risk middle school students not participating in a direct-instruction mathematic intervention during the 2011-2012 school year.

The purpose of this causal-comparative study was to determine if a direct-instruction mathematic intervention was significantly affecting the mathematic achievement of at-risk middle school students and therefore increasing their standardized test scores. The intervention school incorporated the direct-instruction mathematic program SRA Mathematic Skillbuilder as its primary Response to Intervention tool for sixth, seventh, and eighth-grade students identified as at risk of failure to meet the mathematic requirements of the mathematic subtest of the Georgia Criterion Referenced Competency Test and the school’s achievement requirements.

A between-groups ANOCVA was conducted to examine the effectiveness of the intervention. Preliminary analysis was run to ensure the assumptions of normality, linearity, homogeneity of variances, homogeneity of regression of slopes, and reliability of the covariate was met.

After adjusting for the covariate, the results of the ANCOVA suggest the direct-instruction mathematic intervention yielded a statistically significant increase in test scores for student participants when compared to students not receiving the intervention. When examined by gender, the direct-instruction mathematic intervention
program also yielded statistically significant results, with males and females in the intervention groups outperforming males and females in the control groups.

**Discussion of the Findings**

**Null Hypothesis One**

The first research question focused on whether or not participation in a direct-instruction mathematic intervention had an impact on at-risk middle school students’ standardized test scores when compared to at-risk students not participating in a direct-instruction mathematic intervention. The results from the standardized ANCOVA indicated a statistically significant difference in the mean scale scores on the mathematic subtest of the 2012 Georgia CRCT between the intervention group and the control group, suggesting that the direct-instruction mathematic intervention did have a significant impact on the at-risk middle school students’ mathematic standardized test scores for the year.

The direct-instruction mathematic intervention participants averaged a Georgia CRCT mathematic mean scale score of 795.38 in 2011, which is below proficiency level for the Georgia CRCT. After one year in the direct-instruction mathematic intervention program, the direct-instruction mathematic intervention participants experienced a 20.872 average gain from their 2011 Georgia CRCT mathematic scores. The participants’ overall average score for their 2012 posttest Georgia CRCT Mathematic Test was 816.252, which is a proficient score on the mathematic subtest of the Georgia CRCT and above the 815 cut score the school system uses to qualify students for the direct-instruction intervention program.
Null Hypothesis Two

The second research question focused on whether or not participation in a direct-instruction mathematic intervention during a connections class period had an impact, by gender, on at-risk middle school students’ standardized test scores when compared to at-risk students not participating in a direct-instruction mathematic intervention. It is important to understand if a direct-instruction mathematic intervention can help improve mathematic achievement for both males and females and increase their mathematic standardized test scores. The results from the ANCOVA indicate a statistically significant difference in the mean scale scores on the mathematic subtest of the 2012 Georgia CRCT between the intervention group and the control group, suggesting that the direct-instruction mathematic intervention did have a significant impact on the at-risk middle school students’ mathematic standardized test scores for both genders.

The male direct-instruction mathematic intervention participants averaged a Georgia CRCT mathematic mean scale score of 795.06 in 2011, which is below proficiency on the Georgia CRCT. After one year in the direct-instruction mathematic intervention program, the direct-instruction mathematic intervention participants experienced an 18.565 average gain from their 2011 Georgia CRCT mathematic scores. The participants’ overall average score for their 2012 posttest Georgia CRCT Mathematic Test was 813.625, which is a proficient score on the mathematic subtest of the Georgia CRCT.

The female direct-instruction mathematic intervention participants averaged a Georgia CRCT mathematic mean scale score of 795.67 in 2011. After one year in the
direct-instruction mathematic intervention program, the direct-instruction mathematic intervention participants experienced a 22.86 average gain from their 2011 Georgia CRCT mathematic scores. The participants’ overall average score for their 2012 posttest Georgia CRCT Mathematic Test was 818.53, which is a proficient score on the mathematic subtest of the Georgia CRCT and above the 815 cut score the school system uses to qualify students for the direct-instruction intervention program.

In conclusion, the findings for Research Questions 1 and 2 do suggest that a direct-instruction mathematic intervention can improve student mathematic achievement and increase mathematic standardized test scores for at-risk middle school students.

Theoretical Framework.

The direct-instruction mathematic intervention program, SRA Mathematic Skillbuilder, was developed for McGraw-Hill by Siegfried Engelmann. Theory of instruction was developed by Engelmann and Carnine, and used to study the most effective and efficient way to teach so that students can learn successfully (Engelmann & Carnine, 1991). Magliaro, Lockee, and Burton (2005) stated that Engelmann and Carnine’s theory is “rooted in behavioral theory, particularly the radical or selectivist behaviorism of Skinner” (p.41). The theory states that by using a direct-instruction mathematic intervention students will learn more effectively and efficiently and their achievement will improve. According to Engelmann and Carnine (1991), “the learning mechanism has attributes: a) the capacity to learn through examples any quality that is exemplified, and b) the capacity to generalize to new examples based on sameness of quality” (p. 4). SRA Mathematic Skillbuilder uses concrete examples, both positive and negative, to teach basic skills. The skills are taught repetitively until the concept is
learned. The program uses frequent assessments to determine when a concept has been learned and when the learner can move to the next skill.

The results of this study suggest that a direct-instruction mathematic intervention program based upon the theory of instruction can help improve both male and female at-risk students’ mathematic achievement and increase standardized test scores.

**Implications**

Practical implications which could prove beneficial for the school system and other middle schools were derived from this study. The data from this study suggests that a direct-instruction mathematic intervention could serve as an effective intervention tool to help at-risk middle school students improve their mathematic achievement and increase their standardized test scores. The data suggests the direct-instruction mathematic intervention is effective for both male and female students. The direct-instruction mathematic intervention program is currently being implemented in only one middle school in the school system. The data suggests the other middle schools in the school system, and other systems, could benefit from a direct-instruction mathematic intervention program similar to the intervention program currently implemented at the intervention school.

**Limitations**

Several limitations to this study must be addressed. This investigation has limited generalizability. The study is a causal-comparative study utilizing convenience samples, commonly used in the social sciences. A convenience sample is a type of nonprobability sample, and is less rigorous than random sampling. A causal-comparative design is a type of exploratory, nonexperimental design, and is less rigorous than experimental
designs; therefore, a causal-comparative design may only provide evidence suggesting that results are valid. The results are suggestive, not conclusive, and should be interpreted with caution.

The participating schools are limited to two Title I middle schools in one rural school district in Northwest Georgia; therefore, the results may not be applicable to other school districts with different geographical locations, different demographics, different age groups, or different standardized tests.

A during-school extended-time math class was used for the mathematic intervention. The intervention class was taught in place of one of the connection classes. The results may not be applicable to other types of extended time mathematic intervention programs, such as after-school programs, Saturday programs, or extended time at the end of class.

This study utilized an ex-post-facto design. The naturally occurring groups could not be manipulated. The naturally occurring independent variables could not be manipulated. Inability to manipulate the groups or independent variables presented a selection threat due to the possibility of non-equivalent groups. One way to control for a selection threat due to non-equivalent groups is to use homogeneous groups with similar demographics. The two Title I middle schools selected for this study have similar demographics. Further, matching students based on important characteristics can be used to control for a selection threat. Students in the control group and treatment group were matched based on previous years’ mathematic ability (covariate), grade level, socioeconomic status, and gender. Additionally, the statistical method of analysis of covariance was used to equalize groups. According to Gall et al., (2007), “analysis of
covariance allows researchers to determine whether a difference between two groups on a particular variable can be explained by another difference that exists between the two groups. An analysis of covariance is useful in causal-comparative studies because the researcher cannot always match comparison groups to all relevant variables except the one that is being studied. An ANCOVA provides a post hoc method of matching groups on different variables” (p. 318).

Since this study examined extreme (low) scores of at-risk students, another limitation is statistical regression. Rovai et al. (2013) stated, “The statistical regression threat to internal validity can occur when selecting participants on the basis of extremely low (or extremely high) scores on some tests, giving them some intervention, and then retesting them” (p. 109). According to Campbell and Stanley (1963), if a group is selected because of its extremity on a variable, its extremity is artificial, and it will regress toward the mean of the population from which it was selected. Statistical regression can be controlled as far as mean differences are concerned, no matter how extreme the group is, if both the experimental and control groups are assigned from this same extreme pool (Rovai et al., 2013). Both the experimental group and the control group consisted of at-risk middle school students scoring 815 or below on the previous year’s Georgia CRCT. This study utilized a control group consisting of no direct-instruction math intervention and similar mathematics ability achieved by matching the control group’s previous years mathematic ability with the treatment group’s previous year’s mathematic ability to control for statistical regression.

There are confounding variables associated with this study. Rovai et al. (2013) states that to help control for confounding variables, the groups should be as
homogeneous as possible. The schools were homogeneous based on demographics, and the groups were homogeneous based on previous mathematic ability, grade level, and gender. Rovai et al. (2013) also states that a statistical control, such as conducting an ANCOVA, may be used. The study used an ANCOVA for the statistical analyses.

Based upon interviews with the academic coaches and principals of the participating schools (P. Intervention School, personal communication, March 13, 2014; A. C. Intervention School, personal communication, March 17, 2014; A. C. Control School, personal communication, March 17, 2014; and P. Control School, personal communication, March 17, 2014), all participating math teachers were highly qualified teachers.

In 2002-03 Georgia adopted a basic definition of a highly qualified teacher as “one who holds a bachelor’s degree or higher, has a major in the subject area or has passed the state teacher content assessment, and is assigned to teach his/her major subject(s)” ("Highly Qualified Teachers," 2003, p. 6). The math curriculum taught at the two schools during the 2011 and 2012 school years was identical, and was based on the Georgia Performance Standards (GPS) mandated by Georgia law and were developed by the Georgia Department of Education. The regular math classes utilized the workshop method required by the county, where there is an opening during which instruction is given, work time during which the students work with the teacher as a facilitator; and a closing, during which the students present their findings and reflect (Poglinco et al., 2003). Every lesson involved teaching a prescribed Georgia standard using the prescribed curriculum provided by the Georgia Department of Education. The administrators made frequent classroom observations to ensure the standards were being
taught. Teachers taught a curriculum designed by the Georgia Department of Education, and followed a pacing guide designed by the Georgia Department of Education (Georgia Department of Education, 2013). The direct-instruction math intervention, *SRA Math Skillbuilder* by McGraw Hill (McGraw Hill Education, 2013), was taught by the same teacher using the same instructional method in each class. However, there are confounding variables beyond the control of the researcher that must be taken into consideration when interpreting the results, such as teacher experience, teacher motivation, teacher attitude, teaching style, student motivation, student attitude, etc. These can vary within each school and between the participating schools.

**Recommendations for Future Research**

Based on the limitations of this study, the following recommendations for future research are suggested:

1. This study utilized a causal-comparative research design. A similar study is needed that implements a more rigorous research design, including randomized groups and participants.

2. This study examined only one direct-instruction mathematic intervention program, SRA Mathematic Skillbuilder. Further research needs to be conducted to determine if other direct-instruction mathematic interventions are effective.

3. This study was conducted in a rural school district. Further research needs to be conducted to determine whether a direct-instruction mathematic intervention is effective in other demographic settings.
4. This study only examined at-risk middle school students. Further research needs to be conducted at the high school level to determine if a direct-instruction mathematic intervention is effective at the high school level.

5. If students passed the current year’s mathematic subtest of the Georgia CRCT, they are removed from the intervention program for the next year. A longitudinal study is needed to determine if removing the students from the intervention affects their future test scores.
References


Georgia Department of Education. (2011). *Validity and reliability for the 2011 criterion-referenced competency tests.* (Received as an email from Dr. Melodee Davis, Director of Assessment Research and Development on January 14, 2013.):

Georgia Department of Education. (2012). *Validity and reliability of the 2012 Criterion Referenced Competency Test.* (Received as an email attachment from Dr. Melodee Davis, Director of Assessment Research and Development on January 14, 2013.)


Georgia Department of Education. (2013). Curriculum frequently asked questions. Retrieved from

Georgia Department of Education. (2013). Glossary of commonly used terms. Retrieved from


HB 244, § 244 (2013).

http://www.bjs.gov/content/pub/pdf/ecp.pdf


APPENDIX A: INTERNAL REVIEW BOARD APPLICATION

IRB Application #________ __________

I. APPLICATION INSTRUCTIONS

To submit a protocol, complete each section of this form and email it and any accompanying materials (i.e. consent forms and instruments) to irb@liberty.edu. For more information on what to submit and how, please see our website at: www.liberty.edu/irb. Please note that we can only accept our forms in Microsoft Word format.

In addition, please submit one signed copy of the fourth page of the protocol form, which is the Investigator’s Agreement. Also submit the second page if a departmental signature is required for your study. Signed materials can be submitted by mail, fax (434-522-0506), or email (scanned document to irb@liberty.edu). Signed materials can also be submitted via regular mail or in person to our office: Green Hall, Suite 1837.

Please be sure to use the grey form fields to complete this document; do not change the format of the application. You are able to move quickly through the document by using the “Tab” key.

Note: Applications with the following problems will be returned immediately for revisions: 1) Grammar/spelling/punctuation errors, 2) A lack of professionalism (lack of consistency/clarity) on the application itself or any supporting documents, 3) Incomplete applications. Failure to minimize these errors will cause delays in your processing time.

II. BASIC PROTOCOL INFORMATION

Protocol Title:

Principal Investigator (PI):

Professional Title: School/Department:

Mailing Address:

Telephone: LU Email:

Check all that apply: ☐ Faculty ☒ Graduate Student ☐ Undergraduate Student ☐ Staff

This research is for: ☐ Class Project ☐ Master’s Thesis ☒ Doctoral Dissertation

☐ Faculty Research ☐ Other (describe):

Have you defended and passed your dissertation proposal? ☒ Yes ☐ No ☐ N/A

If no, what is your defense date?

Faculty Advisor:

School/Department:

Telephone: LU Email:

Non-key Personnel:
Name and Title:  
School/Department:  
Telephone:  
LU Email:  
Consultants:  
Name and Title:  
School/Department:  
Telephone:  
LU Email:  

Liberty University Participants:  
Do you intend to use LU students, staff, or faculty as participants or LU student, staff, or faculty data in your study? If yes, please list the department and/or classes you hope to enlist, and the number of participants/data sets you would like to enroll/use. If you do not intend to use LU participants in your study, please indicate “no” and proceed to the section titled “Funding Source.”

☐ No  ☐ Yes  
Number of participants/data sets  
Department  
Class(es)  

In order to process your request to use LU participants, we must ensure that you have contacted the appropriate department and gained permission to collect data from them. Please obtain the original signature of the department chair in order to verify this.

Signature of Department Chair  
Date  

Funding Source: If research is funded please provide the following:

Grant Name (or name of the funding source):  
Funding Period (month/year):  
Grant Number:  
Anticipated start and completion dates for collecting and analyzing data:  
Completion of required CITI research ethics training courses:  
Course Name  
Date  

III. OTHER STUDY MATERIALS AND CONSIDERATIONS  
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<td>Participant compensation?</td>
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<td>Advertising for participants?</td>
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<td>More than minimal psychological stress?</td>
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<td>Confidential material (questionnaires, surveys, interviews, photos, etc.)?</td>
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IV. INVESTIGATOR AGREEMENT & SIGNATURE PAGE*
BY SIGNING THIS DOCUMENT, THE INVESTIGATOR AGREES:

1. That no participants will be recruited or entered under the protocol until the Investigator has received the final approval or exemption email from the Chair of the Institutional Review Board.
2. That no participants will be recruited or entered under the protocol until all key personnel for the project have been properly educated on the protocol for the study.
3. That any modifications of the protocol or consent form will not be initiated without prior written approval, by email, from the IRB and the faculty advisor, except when necessary to eliminate immediate hazards to the participants.
4. The PI agrees to carry out the protocol as stated in the approved application: all participants will be recruited and consented as stated in the protocol approved or exempted by the IRB. If written consent is required, all participants will be consented by signing a copy of the approved consent form.
5. That any unanticipated problems involving risks to participants or others participating in the approved protocol, which must be in accordance with the Liberty Way (and/or the Honor Code) and the Confidentiality Statement, will be promptly reported in writing to the IRB.
6. That the IRB office will be notified within 30 days of a change in the PI for the study.
7. That the IRB office will be notified within 30 days of the completion of this study.
8. That the PI will inform the IRB and complete all necessary reports should he/she terminate University Association.
9. To maintain records and keep informed consent documents for three years after completion of the project, even if the PI terminates association with the University.
10. That he/she has access to copies of 45 CFR 46 and the Belmont Report.

__________________________________________________________
Principal Investigator (Printed) Principal Investigator (Signature) Date

FOR STUDENT PROPOSALS ONLY

BY SIGNING THIS DOCUMENT, THE FACULTY ADVISOR AGREES:

1. To assume responsibility for the oversight of the student’s current investigation, as outlined in the approved IRB application.
2. To work with the investigator, and the Institutional Review Board, as needed, in maintaining compliance with this agreement.
3. To monitor email contact between the Institutional Review Board and Principle Investigator. Faculty advisors are cc’d on all IRB emails to PIs.
4. That the Principal Investigator is qualified to perform this study.
5. That by signing this document you verify you have carefully read this application and approve of the procedures described herein, and also verify that the application complies with all instructions listed above. If you have any questions, please contact our office (irb@liberty.edu).

__________________________________________________________
Faculty Advisor (Printed) Faculty Advisor (Original Signature) Date

*The Institutional Review Board reserves the right to terminate this study at any time if, in its opinion, (1) the risks of further experimentation are prohibitive, or (2) the above agreement is breached.

V. PURPOSE

1. Purpose of the Research: Write an original, brief, non-technical description of the purpose of your project. Include in your description: Your research hypothesis or question, a narrative that explains the major constructs of your study, and how the data will advance your research.
hypothesis or question. This section should be easy to read for someone not familiar with your academic discipline.

VI. PARTICIPANT INCLUSION/EXCLUSION CRITERIA

1. Population: From where/whom will the data be collected? Address each area in non-scientific language. Enter N/A where appropriate.
   a. The inclusion criteria for the participant population including gender, age ranges, ethnic background, health status and any other applicable information: Provide a rationale for targeting this population.
   b. The exclusion criteria for participants:
   c. Explain the rationale for the involvement of any special population (Examples: children, specific focus on ethnic populations, mentally retarded, lower socioeconomic status, prisoners).
   d. Provide the maximum number of participants you seek approval to enroll from all participant populations you intend to use and justify the sample size. You will not be approved to enroll a number greater than this. If, at a later time, it becomes apparent you need to increase your sample size, you will need to submit a Change in Protocol Form.
   e. For NIH, federal, or state-funded protocols only: Researchers sometimes believe their particular project is not appropriate for certain types of participants. These may include, for example: women, minorities, and children. If you believe your project should not include one or more of these groups, please provide your justification for their exclusion. Your justification will be reviewed according to the applicable NIH, federal, or state guidelines.

2. Types of Participants: Check all that apply:
   - Normal Volunteers (Age 18-65)
   - Minors (under age 18)
   - Over age 65
   - University Students
   - Active-Duty Military Personnel
   - Discharged/Retired Military Personnel
   - Inpatients
   - Outpatients
   - Patient Controls
   - Fetuses
   - Cognitively Disabled
   - Physically Disabled
   - Pregnant Women
   - Participants Incapable of Giving Consent
   - Prisoners or Institutional Individuals
   - Other Potentially Elevated Risk Populations

VII. RECRUITMENT OF PARTICIPANTS

1. Contacting Participants: Describe in detail how you will contact participants regarding this study. Please provide all materials used to contact participants in this study. These materials could include letters, emails, flyers, advertisements, etc. If you will contact participants verbally, please provide a script that outlines what you will say to participants.
2. **Location of Recruitment**: Describe the location, setting, and timing of recruitment.

3. **Screening Procedures**: Describe any screening procedures you will use when recruiting your participant population.

4. **Relationships**: State the relationship between the Principal Investigator, Faculty Advisor (if applicable) and Participants. Do any of the researchers have positions of authority over the participants, such as grading authority, professional authority, etc.? Are there any relevant financial relationships? If yes, please answer number 5 below.

5. **Safeguarding for Conflicts of Interest**: What safeguards are in place to reduce the likelihood of compromising the integrity of the research? (Examples: Addressing the conflicts in the consent process, emphasizing the pre-existing relationship will not be impacted by participation in research, etc.).

**VIII. RESEARCH PROCEDURES**

1. **Description of the Research**: Write an original, non-technical, step-by-step description of what your participants will be required to do during your study and data collection process. Do not copy the abstract/entire contents of your proposal. *(Describe all steps the participants will follow. What do the data consist of? Include a description of any media use here, justifying why it is necessary to use it to collect data).*

*Also, please submit one copy of all instruments, surveys, interview questions or outlines, observation checklists, etc. to irb@liberty.edu with this application.*

2. **Location of the Study**: Please describe the location in which the study will be conducted (Be specific; include city and state).

3. **Will participant data be collected anonymously**? Describe.

**IX. DATA ANALYSIS**

1. Estimated number of participants to be enrolled in this protocol or sample size for archival data:

2. Describe what will be done with the data and the resulting analysis:

**X. PROCESS OF OBTAINING INFORMED CONSENT**

1. **Consent Procedures**: Describe in detail how you will obtain consent from participants and/or parents/guardians. Attach a copy of all Informed Consent/Assent Agreements. The IRB needs to ensure participants are properly informed and are participating in a voluntary manner. **Consider**
these areas: amount of time spent with participants, privacy, appropriateness of individual obtaining consent, participant comprehension of the informed consent procedure, and adequate setting. For a consent template and information on informed consent, please see our website. If you believe your project qualifies for a waiver of the signature requirement on the informed consent document, note that here and describe how you will provide participants with the informed consent document. Then go to section XV, and answer its questions.

2. **Deception:** Are there any aspects of the study kept secret from the participants (e.g. the full purpose of the study)?
   a. ✗ No
   b. ☑ Yes
      i. If yes, describe the deception involved and the debrief procedures. Attach a post-experiment debriefing statement and consent form offering participants the option of having the data destroyed:

3. **Is any deception used in the study?** (Are participants given false information about any aspect of the study?)
   a. ✗ No
   b. ☑ Yes
      i. If yes, describe the deception involved and the debrief procedures. Attach a post-experiment debriefing statement and consent form offering participants the option of having the data destroyed:

4. **Will participants be debriefed?**
   a. ☑ No
   b. ✗ Yes
      i. Attach a copy of your Debriefing Statement. If the answer to protocol question IX (3) is yes, then the investigator must debrief the participant. If your study includes participants from a participant pool, please include a debrief statement.

**XI. PARENTAL/GUARDIAN PERMISSION***

1. **Does your study require parental/guardian permission?** (If your intended participants are under 18, parental/guardian consent is required in most cases.)
   a. ☑ Yes
   b. ☑ No

2. **Does your study entail greater than minimal risk, without potential for benefit?**
   a. ☑ Yes (If so, consent of both parents is required.)
   b. ✗ No

*Please refer to the Office for Human Research Protections (OHRP) regulations (45 CFR 46.408) to determine whether your project requires parental consent and/or child assent. This is particularly applicable if you are conducting education research.

**XII. ASSENT FROM CHILDREN AND WITNESS SIGNATURE**

1. **Is assent required for your study?** Assent is required unless the child is not capable (age, psychological state, sedation), or the research holds out the prospect of direct benefit that is only available within the context of the research. If the consent process (full or part) is waived, assent may be also. See our website for this information.
   a. ☑ Yes
   b. ✗ No

2. **Please attach assent document(s) to this application.**
XIII. WAIVER OR MODIFICATION FOR REQUIRED ELEMENTS IN INFORMED CONSENT PROCESS

1. Waiver or modification for required elements in informed consent is sometimes used in research involving a deception element. See Waiver of Informed Consent on the IRB website (link above). If requesting a waiver of consent, please address the following:
   a. Does the research pose greater than minimal risk to participants (greater than everyday activities)?
   b. Will the waiver adversely affect participants’ rights and welfare? Please justify.
   c. Why would the research be impracticable without the waiver?
   d. How will participant debriefing occur (i.e. how will pertinent information about the real purposes of the study be reported to participants, if appropriate, at a later date)?

XIV. CHECKLIST OF INFORMED CONSENT/ASSENT

1. Attach a copy of all informed consent/assent documents. Please see our Informed Consent materials and Informed Consent template to develop your document.

XV. WAIVER OF SIGNED INFORMED CONSENT DOCUMENT Archival Data

1. Waiver of signed consent is sometimes used in anonymous surveys or research involving secondary data. This does not eliminate the need for a consent document, but it does eliminate the need for a signature(s). If you are requesting a waiver of signed consent, please address the following (yes or no):
   a. Does the research pose greater that minimal risk to participants (greater than everyday activities)?
   b. Does a breach of confidentiality constitute the principal risk to participants?
   c. Would the signed consent form be the only record linking the participant and the research?
   d. Does the research include any activities that would require signed consent in a non-research context?
   e. Will you provide the participants with a written statement about the research (an information sheet that contains all the elements of the consent form but without the signature lines)?

XVI. PARTICIPANT PRIVACY AND CONFIDENTIALITY Archival Data

1. **Privacy:** Describe what steps you will take to protect the privacy of your participants. Privacy refers to persons and their interest in controlling access to their information.

2. **Confidentiality:** Please describe how you will protect the confidentiality of your participants. Confidentiality refers to agreements with the participant about how data are to be handled. Indicate whether the data are archival, anonymous, confidential, or confidentiality not assured and then provide the additional information requested in each section. The IRB asks that if it is possible for you to collect your data anonymously (i.e. without collecting the participants’ identifiable information), please construct your study in this manner. Data collection in which the participant is not identifiable (i.e. anonymous) can be exempted in most cases.
   a. Are the data archival (e.g. data already collected for another purpose)?*
      i. Yes (please answer b-e below)
      ii. No (please skip to 3)

   *Please note: if your study only includes archival data, answer no to 2-b, 2-c, 2-d, and leave 2-e blank.
b. Are the data publicly accessible?
   i. ☐ Yes (Please answer below)
      1. Please provide the location of the publicly accessible data (website, etc.).
   ii. ☒ No (Please answer below)
      1. Please describe how you will obtain access to this data and provide the board with proof of permission to access the data.

c. Will you receive the data stripped of identifying information, including names, postal addresses, telephone numbers, email addresses, social security numbers, medical record numbers, birth dates, etc.?
   i. ☐ Yes (see below)
      1. Please describe who will link and strip the data. Please note that this person should have regular access to the data and he or she should be a neutral third party not involved in the study.
   ii. ☒ No (see below)
      1. If no, please describe what data will remain identifiable and why this information will not be removed.

b. Are the data publicly accessible?
   i. ☐ Yes (Please answer below)
      1. Please provide the location of the publicly accessible data (website, etc.).
   ii. ☒ No (Please answer below)
      1. Please describe how you will obtain access to this data and provide the board with proof of permission to access the data.

3. Are the data you will collect anonymous? (Data do not contain identifying information including names, postal addresses, telephone numbers, email addresses, social security numbers, medical record numbers, birth dates, etc., and cannot be linked to identifying information by use of codes or other means. If you are recording the participant on audio or videotape, etc., this is not considered anonymous data).
   a. ☐ Yes (see below)
      i. Describe the process you will use to collect the data to ensure that it is anonymous.
   b. ☒ No

4. Can the names of the participants be deduced from the data?*
   a. ☐ Yes (see below)
      i. Please describe:
   b. ☒ No

*If you agree to the following, please type your initials: I will not attempt to deduce the identity of the participants in this study:

5. Will your data contain identifying information and/or be linked to identifying information by use of codes or other means? Please note that if you will use participant data (such as photos, videos, etc.) for presentations beyond data analysis for the research study (classroom presentations, library archive, conference presentations, etc.) you will need to provide a materials release form to the participant.
   a. ☒ Yes (see below)
i. Please describe the process you will use to collect the data and to ensure the confidentiality of the participants. Verify that the list linking codes to personal identifiers will be kept secure by stating where it will be kept and who will have access to the data.

b. ☐ No

6. Will you handle and store the data in such a way as to prevent a breach in confidentiality? Please note that if you will use participant data (such as photos, videos, etc.) for presentations beyond analysis for the research study (classroom presentations, library archive, conference presentations, etc.) you need to provide a materials release form to the participant.
   a. ☑ Yes (see below)
   b. ☐ No (see below)

i. Please describe why confidentiality will not be assured.

7. Please describe how you will maintain confidentiality of the data collected in your study. This includes how you will keep your data secure (i.e. password protection, locked files), who will have access to the data, and methods for destroying the data once the three year time period for maintaining your data is up.

8. Media Use: If you answer yes to any question below, in question VI (1), Description of Research, please provide a description of how the media will be used and justify why it is necessary to use the media to collect data. Include a description in the Informed Consent document under “What you will do in the study.”
   a. Will the participant be audio recorded? ☐ Yes ☑ No
   b. Will the participant be video recorded? ☐ Yes ☑ No
   c. Will the participant be photographed? ☐ Yes ☑ No
   d. Will the participant be audio recorded, video recorded, or photographed without their knowledge? ☑ Yes
   ☐ No
   e. If yes, please describe the deception and the debriefing procedures: Attach a post-experiment debriefing statement and a post-deception consent form offering participants the option of having their tape/photograph destroyed.
   f. If a participant withdraws from a study, how will you withdraw them from the audiotape, videotape, or photograph? Please include a description in the Informed Consent document under “How to withdraw from the study.”

*Please note that all research-related data must be stored for a minimum of three years after the end date of the study, as required by federal regulations.

XVII. PARTICIPANT PRIVACY AND CONFIDENTIALITY Interview Data

9. Privacy: Describe what steps you will take to protect the privacy of your participants. Privacy refers to persons and their interest in controlling access to their information.

10. Confidentiality: Please describe how you will protect the confidentiality of your participants. Confidentiality refers to agreements with the participant about how data are to be handled. Indicate whether the data are archival, anonymous, confidential, or confidentiality not assured and then provide the additional information requested in each section. The IRB asks that if it is possible for you to collect your data anonymously (i.e. without collecting the participants’ identifiable information), please construct your study in this manner. Data collection in which the participant is not identifiable (i.e. anonymous) can be exempted in most cases.

   a. Are the data archival (e.g. data already collected for another purpose)?*
      i. ☐ Yes (please answer b-e below)
      ii. ☑ No (please skip to 3)
b. **Are the data publicly accessible?**
   i.  □ Yes (Please answer below)
       1. Please provide the location of the publicly accessible data (website, etc.).
   ii. □ No (Please answer below)
       1. Please describe how you will obtain access to this data and provide the board with proof of permission to access the data.

c. **Will you receive the data stripped of identifying information, including names, postal addresses, telephone numbers, email addresses, social security numbers, medical record numbers, birth dates, etc.?**
   i. □ Yes (see below)
       1. Please describe who will link and strip the data. Please note that this person should have regular access to the data and he or she should be a neutral third party not involved in the study.
   ii. □ No (see below)
       1. If no, please describe what data will remain identifiable and why this information will not be removed.

d. **Can the names of the participants be deduced from the data set?**
   i. □ Yes (see below)
       1. Please describe.
       2. Initial the following: I will not attempt to deduce the identity of the participants in this study:
   ii. □ No

e. **Please provide the list of data fields you intend to use for your analysis and/or provide the original instruments used in the study.**

11. **Are the data you will collect anonymous?** (Data do not contain identifying information including names, postal addresses, telephone numbers, email addresses, social security numbers, medical record numbers, birth dates, etc., and cannot be linked to identifying information by use of codes or other means. If you are recording the participant on audio or videotape, etc., this is not considered anonymous data).
   a.  □ Yes (see below)
       i. Describe the process you will use to collect the data to ensure that it is anonymous.
   b.  □ No

12. **Can the names of the participants be deduced from the data?**
   a.  □ Yes (see below)
       i. Please describe:
   b.  □ No

*If you agree to the following, please type your initials: I will not attempt to deduce the identity of the participants in the study:

13. **Will your data contain identifying information and/or be linked to identifying information by use of codes or other means?** Please note that if you will use participant data (such as photos, videos, etc.) for presentations beyond data analysis for the research study (classroom presentations, library archive, conference presentations, etc.) you will need to provide a materials release form to the participant.
a. ☑ Yes (see below)
   i. Please describe the process you will use to collect the data and to ensure the confidentiality of the participants. Verify that the list linking codes to personal identifiers will be kept secure by stating where it will be kept and who will have access to the data.

b. ☐ No

14. Will you handle and store the data in such a way as to prevent a breach in confidentiality?
Please note that if you will use participant data (such as photos, videos, etc.) for presentations beyond analysis for the research study (classroom presentations, library archive, conference presentations, etc.) you need to provide a materials release form to the participant.
   a. ☑ Yes (see below)
   b. ☐ No (see below)
      i. Please describe why confidentiality will not be assured.

15. Please describe how you will maintain confidentiality of the data collected in your study. This includes how you will keep your data secure (i.e. password protection, locked files), who will have access to the data, and methods for destroying the data once the three year time period for maintaining your data is up.

16. Media Use: If you answer yes to any question below, in question VI (1), Description of Research, please provide a description of how the media will be used and justify why it is necessary to use the media to collect data. Include a description in the Informed Consent document under “What you will do in the study.”
   a. Will the participant be audio recorded? ☑ Yes ☐ No
   b. Will the participant be video recorded? ☑ Yes ☐ No
   c. Will the participant be photographed? ☑ Yes ☐ No
   d. Will the participant be audio recorded, video recorded, or photographed without their knowledge? ☐ Yes ☑ No
   e. If yes, please describe the deception and the debriefing procedures: Attach a post-experiment debriefing statement and a post-deception consent form offering participants the option of having their tape/photograph destroyed.
   f. If a participant withdraws from a study, how will you withdraw them from the audiotape, videotape, or photograph? Please include a description in the Informed Consent document under “How to withdraw from the study.”

*Please note that all research-related data must be stored for a minimum of three years after the end date of the study, as required by federal regulations.

XVIII. PARTICIPANT COMPENSATION

1. Describe any compensation that participants will receive. Please note that Liberty University Business Office policies might affect how you compensate participants. Please contact your department’s business office to ensure your compensation procedures are allowable by these policies.

XIX. PARTICIPANT RISKS AND BENEFITS

1. Risks: There are always risks associated with research. If the research is minimal risk, which is no greater that every day activities, then please describe this fact.
   a. Describe the risks to participants and steps that will be taken to minimize those risks. Risks can be physical, psychological, economic, social, legal, etc.
b. Where appropriate, describe any alternative procedures or treatments that might be advantageous to the participants.

c. Describe provisions for ensuring necessary medical or professional intervention in the event of adverse effects to participants or additional resources for participants.

2. Benefits: Describe the possible direct benefits to the participants. If there are no direct benefits, please state this fact.

   a. Describe the possible benefits to society. In other words, how will doing this project be a positive contribution and for whom (keep in mind benefits may be to society, the knowledge base of this area, etc.)?

3. Investigator's evaluation of the risk-benefit ratio: Please explain why you believe this study is still worth doing even with any identified risks.
APPENDIX B: IRB APPROVAL LETTER

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

March 10, 2014

Charles David Moore
IRB Exemption 1801.03.1014: The Effects of a Direct-Instruction Mathematic Intervention on Standardized Test Scores of At-Risk Middle School Students

Dear Charles,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and that no further IRB oversight is required.

Your study falls under exemption category 46.101 (b)(2,4), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46.

(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:
(i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Please note that this exemption only applies to your current research application, and that any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

If you have any questions about this exemption, or need assistance in determining whether possible changes to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,

Fernando Garzon, Psy.D.
Professor, IRB Chair
Counseling

(434) 592-4054

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1971 UNIVERSITY BLVD, LYNCHBURG, VA 24515 IRB@LIBERTY.EDU FAX (434) 522-0506 www.liberty.edu
APPENDIX C: LETTER REQUESTING SUPERINTENDENT OF SCHOOLS APPROVAL

October 1, 2013

David Moore

Chattanooga Valley Middle School
davidmoore@walkerschools.org
(706)820-0735

Superintendent,

My name is David Moore. I am a 7th grade math teacher at Chattanooga Valley Middle School. I am working towards the fulfillment of my doctoral degree in curriculum and instruction through Liberty University and I am working on my dissertation.

My study, entitled “The Effects of a Direct-Instruction Math Intervention on Standardized Test Scores of At-risk Middle School Students” seeks to help in the understanding of how a direct-instruction math intervention conducted during the connections class affects at-risk students’ standardized math test scores. I am seeking your approval to conduct the study. The study is comparing the CRCT test scores of at-risk students who participated in a connections class math intervention and at-risk students who did not participate in a connections class math intervention. I will need the CRCT mathematic subtest scores for students attending Chattanooga Valley Middle School and Lafayette Middle School for the school years of 2011 and 2012. This is archived data.

Students will not be participating in the study. I will not use the system, school, nor student names in my research. All information will be kept confidential per Walker Counties' policies and Liberty Universities' policies. My Chair is the superintendent of a school system in New York. My research will pass through a review process by the internal review board at Liberty University before I am allowed to collect data.

A copy of the study will be provided to you when completed. I feel this study will be of benefit to you and the Walker County school system. I will be glad to meet with you to discuss any questions or concerns you may have. I appreciate your time and any help provided. Please let me know if you approve of my study or the next step. Thank you.

Sincerely,
David Moore
March 3, 2014

To Whom It May Concern:

David Moore, a teacher at [REDACTED], has contacted my office in regard to his proposed study for the completion of his dissertation. Mr. Moore has requested the 2011 and 2012 CRCT results for [REDACTED] Middle and [REDACTED] Middle Schools. He has assured me that he will not use any student, personnel, or school names in his study. In order to maintain privacy and confidentiality, Mr. Moore will delete all student names and all data will be kept in a password-protected computer. The data requested by Mr. Moore is readily available as archived data. Mr. Moore has also requested permission to interview the principal and academic coach at each participating school.

I have approved the release of data requested by Mr. Moore and have given permission for Mr. Moore to interview the principal and academic coach at each participating school. If you have any questions, please do not hesitate to contact my office at [REDACTED].

Sincerely,

[REDACTED]
Superintendent
[REDACTED]

BOARD OF EDUCATION
APPENDIX E: INTERVIEW CONSENT FORM

CONSENT FORM

The Effects of a Direct-Instruction Mathematic Intervention on Standardized Test Scores of At-Risk Middle School Students

Charles David Moore
Liberty University
Education Department

You are invited to be in a research study to understand if a direct-instruction mathematic intervention results in a statistically significant difference in the mean scale scores of at-risk middle school students who participated in a direct-instruction mathematic intervention taught during a connection class period and at-risk middle school students who did not participate in a direct-instruction mathematic intervention. You were selected as a possible participant because you have an administrative position at the participating schools, knowledge of the mathematic programs at the participating schools, and a stake in the success of at-risk mathematic students. I ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by Charles David Moore, Education Department at Liberty University.

Background Information:

The purpose of this study is to help understand if a direct-instruction mathematic intervention taught during a connection class period can help improve mathematic academic achievement and increase standardized test scores of at-risk middle school students.

Procedures:

If you agree to be in this study, I would ask you to do the following things: sign a consent form, and participate in a 15-minute interview to be conducted at your school. The interview will consist of answering a questionnaire about the mathematic program at your school. Your response will be recorded in a word document stored on a password-protected computer. Your name will be kept confidential and will not be used in the study.
**Risks and Benefits of being in the Study:**

The research is minimal risk, which is no greater than every day activities. The data will be kept on a password-protected computer and no identifying information will appear in the study.

The benefits to participation are the study will help the administrators at the participating schools and educators in general understand if a direct-instruction mathematic program taught during a connections class period can help improve the standardized test scores of at-risk middle school students.

**Confidentiality:**

The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely and only the researcher will have access to the records.

All data will be stored on a password-protected computer kept in the sole possession of the researcher. All data will be destroyed after a period of three years. The data will be used for this study only and will not be used for any other reason, now or in the future.

**Voluntary Nature of the Study:**

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University, [School Name], or [School Name]. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

**Contacts and Questions:**

The researcher conducting this study is Charles David Moore. You may ask any questions you have now. If you have questions later, you are encouraged to contact him at (423) 667-2679. The researcher’s faculty mentor is Dr. Ralph Marino, Jr., and you may contact him at (607) 795-2404 or email him at rmarino@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, you are encouraged to contact the Institutional Review Board, 1971 University Blvd, Suite 1837, Lynchburg, VA 24502 or email at irb@liberty.edu.

You will be given a copy of this information to keep for your records.
Statement of Consent:

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature: ___________________________ Date: ______________

Signature of Investigator: ___________________________ Date: ______________

IRB Code Numbers: 1801.031014

IRB Expiration Date: 3/10/2015
Guiding Questions for the Principal and Academic Coach Interview

1. Tell me about the class schedule for mathematic classes at your school. How many days a week do the mathematic classes meet and for how long each day? Are the classes based on heterogeneous or homogeneous mathematic ability?

2. What type of instructional model is used in the mathematic class (workshop/inquiry, direct-instruction, teacher centered, student centered, etc.)?

3. Do you offer math specific interventions to struggling students during the math class? If so, please describe:
   a. Is this intervention conducted during the regular math class or during a connections class?
   b. What type of intervention is offered?
   c. Are these used as an intervention?
   d. What type of instructional model is used for the intervention (workshop/inquiry, direct-instruction, teacher centered, student centered, etc.)?
   e. Is a specific mathematic intervention used? If so, what is the name of the mathematic intervention used?

4. How are students identified for mathematic interventions (Test scores/teacher recommendation/academic grades/other)?

5. If you offer a separate intervention math course:
   a. Is the class used as a connections course?
      i. How many days per week?
      ii. What is the time length?
   b. Do you use CRCT scores to determine student placement?
      i. What is the cut-off score?
   c. Do all students under this score take a math intervention class?
      i. If not, how do you determine which students take the course?
   d. Are resource students included?
      i. If so, are they taught the same material?
   e. Is placement fluid (students move in and out throughout the year)?
      i. If so, how do you determine when students are ready to move in or come out of the course?
   f. Are the classes based on heterogeneous or homogeneous mathematic ability?
   g. What type of instructional model is used (workshop/inquiry, direct-instruction, teacher centered, student centered, etc.)?
APPENDIX G: CONSENT FORM – PRINCIPAL OF INTERVENTION SCHOOL

CONSENT FORM

The Effects of a Direct-Instruction Mathematic Intervention on Standardized Test Scores of At-Risk Middle School Students

Charles David Moore
Liberty University
Education Department

You are invited to be in a research study to understand if a direct-instruction mathematic intervention results in a statistically significant difference in the mean scale scores of at-risk middle school students who participated in a direct-instruction mathematic intervention taught during a connection class period and at-risk middle school students who did not participate in a direct-instruction mathematic intervention. You were selected as a possible participant because you have an administrative position at the participating schools, knowledge of the mathematic programs at the participating schools, and a stake in the success of at-risk mathematic students. I ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by Charles David Moore, Education Department at Liberty University.

Background Information:

The purpose of this study is to help understand if a direct-instruction mathematic intervention taught during a connection class period can help improve mathematic academic achievement and increase standardized test scores of at-risk middle school students.

Procedures:

If you agree to be in this study, I would ask you to do the following things: sign a consent form, and participate in a 15- minute interview to be conducted at your school. The interview will consist of answering a questionnaire about the mathematic program at your school. Your response will be recorded in a word document stored on a password-protected computer. Your name will be kept confidential and will not be used in the study.

Risks and Benefits of being in the Study:

The research is minimal risk, which is no greater than every day activities. The data will be kept on a password-protected computer and no identifying information will appear in the study.

The benefits to participation are the study will help the administrators at the participating schools and educators in general understand if a direct-instruction mathematic program taught during a
connections class period can help improve the standardized test scores of at-risk middle school students.

Confidentiality:

The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely and only the researcher will have access to the records.

All data will be stored on a password-protected computer kept in the sole possession of the researcher. All data will be destroyed after a period of three years. The data will be used for this study only and will not be used for any other reason, now or in the future.

Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University, [Institutional Name], School, or [Institutional Name] School. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The researcher conducting this study is Charles David Moore. You may ask any questions you have now. If you have questions later, you are encouraged to contact him at (423) 667-2679. The researcher’s faculty mentor is Dr. Ralph Marino, Jr., and you may contact him at (607) 795-2404 or email him at marino@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, you are encouraged to contact the Institutional Review Board, 1971 University Blvd, Suite 1837, Lynchburg, VA 24502 or email at irb@liberty.edu

You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature: _______________________________ Date: 3-13-14

Signature of Investigator __________________________ Date: 3-13-14

IRB Code Numbers: 1801.031014

IRB Expiration Date: 3/10/2015
Guiding Questions for the Principal and Academic Coach Interviews

1. Tell me about the class schedule for mathematic classes at your school. How many days a week do the mathematic classes meet and for how long each day? Five days for 70 minutes each day. Are the classes based on heterogeneous or homogeneous mathematic ability? Heterogeneous.

2. What type of instructional model is used in the mathematic class (workshop/inquiry, direct-instruction, teacher centered, student centered, etc.)? Workshop/inquiry.

3. Do you offer math specific interventions to struggling students during the math class? If so, please describe:
   a. Is this intervention conducted during the regular math class or during a connections class? During the regular math class, students in Tier 2 receive accommodations according to their IEP’s. This may include extended time on test and work, calculators, small group instruction, and working in pairs.
   b. What type of intervention is offered? The Tier 2 interventions mentioned in question 3a.
   c. Are these used as an intervention? Yes.
   d. What type of instructional model is used for the intervention (workshop/inquiry, direct-instruction, teacher centered, student centered, etc.)? N/A.
   e. Is a specific mathematic intervention used? N/A.

4. How are students identified for mathematic interventions (Test scores/teacher recommendation/academic grades/other)? The students scored 815 or below on the prior year’s mathematic subtest of the Georgia CRCT.

5. If you offer a separate intervention math course:
   a. Is the class used as a connections course? Yes.
      i. How many days per week? Alternating days.
      ii. What is the time length? 70 minutes.
   b. Do you use CRCT scores to determine student placement? Yes.
      i. What is the cutoff score? 815.
   c. Do all students under this score take a mathematic intervention class? Yes.
      i. If not, how do you determine which students take the course? We also look at student mathematic performance in the classroom.
   d. Are resource students included? No.
      i. If so, are they taught the same material? N/A
   e. Is placement fluid (students move in and out throughout the year)? Yes. Students may enter or leave the intervention at the end of the semester.
      i. If so, how do you determine when students are ready to move in or come out of the course? Success in the intervention program and classroom based on assessments.
   f. Are the classes based on heterogeneous or homogeneous mathematic ability? Homogeneous.
   g. What type of instructional model is used (workshop/inquiry, direct-instruction, teacher centered, student centered, etc.)? Direct-instruction.

Signature _____________________________ Date 3-13-14
APPENDIX I: CONSENT FORM – ACADEMIC COACH AT INTERVENTION SCHOOL

CONSENT FORM

The Effects of a Direct-Instruction Mathematic Intervention on Standardized Test Scores of At-Risk Middle School Students

Charles David Moore

Liberty University

Education Department

You are invited to be in a research study to understand if a direct-instruction mathematic intervention results in a statistically significant difference in the mean scale scores of at-risk middle school students who participated in a direct-instruction mathematic intervention taught during a connection class period and at-risk middle school students who did not participate in a direct-instruction mathematic intervention. You were selected as a possible participant because you have an administrative position at the participating schools, knowledge of the mathematic programs at the participating schools, and a stake in the success of at-risk mathematic students. I ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by Charles David Moore, Education Department at Liberty University.

Background Information:

The purpose of this study is to help understand if a direct-instruction mathematic intervention taught during a connection class period can help improve mathematic academic achievement and increase standardized test scores of at-risk middle school students.

Procedures:

If you agree to be in this study, I would ask you to do the following things: sign a consent form, and participate in a 15-minute interview to be conducted at your school. The interview will consist of answering a questionnaire about the mathematic program at your school. Your response will be recorded in a word document stored on a password-protected computer. Your name will be kept confidential and will not be used in the study.

Risks and Benefits of being in the Study:

The research is minimal risk, which is no greater than every day activities. The data will be kept on a password-protected computer and no identifying information will appear in the study.

The benefits to participation are the study will help the administrators at the participating schools and educators in general understand if a direct-instruction mathematic program taught during a
connections class period can help improve the standardized test scores of at-risk middle school students.

Confidentiality:

The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely and only the researcher will have access to the records.

All data will be stored on a password-protected computer kept in the sole possession of the researcher. All data will be destroyed after a period of three years. The data will be used for this study only and will not be used for any other reason, now or in the future.

Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relationships with Liberty University, [redacted], Middle School, or [redacted] Middle School. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The researcher conducting this study is Charles David Moore. You may ask any questions you have now. If you have questions later, you are encouraged to contact him at (423) 667-2679. The researcher’s faculty mentor is Dr. Ralph Marino, Jr., and you may contact him at (607) 795-2404 or email him at rmarino@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, you are encouraged to contact the Institutional Review Board, 1971 University Blvd, Suite 1837, Lynchburg, VA 24502 or email at irb@liberty.edu

You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature: __________________________ Date: 3/17/14

Signature of Investigator: __________________________ Date: 3/17/14

IRB Code Numbers: 1801.031014

IRB Expiration Date: 3/10/2015
APPENDIX J: GUIDING INTERVIEW QUESTIONS - ACADEMIC COACH AT INTERVENTION SCHOOL

Guiding Questions for the Principal and Academic Coach Interviews

1. Tell me about the class schedule for mathematic classes at your school. How many days a week do the mathematic classes meet and for how long each day? Are the classes based on heterogeneous or homogeneous mathematic ability? Regular classes meet every day for 70 minutes. Math remedial classes meet on alternating days for 70 minutes each time. Regular classes are heterogeneous grouped while math remedial groups are homogeneously grouped.

2. What type of instructional model is used in the mathematic class (workshop/inquiry, direct-instruction, teacher centered, student centered, etc.)? A workshop/inquiry instructional model is used whole group while direct instruction is used for small group and individual support.

3. Do you offer math specific interventions to struggling students during the math class? If so, please describe:
   a. Is this intervention conducted during the regular math class or during a connections class? Tier 2 interventions only were used for intervention in the regular class. Tier 3 was used in the connections class.
   b. What type of intervention is offered? Small group, extended time and calculator use.
   c. Are these used as an intervention? Yes
   d. What type of instructional model is used for the intervention (workshop/inquiry, direct-instruction, teacher centered, student centered, etc.)? Instructional model varied including workshop/inquiry, direct instruction and computer based instruction and assessment.
   e. Is a specific mathematic intervention used? If so, what is the name of the mathematic intervention used? Various interventions were used for instruction.

4. How are students identified for mathematic interventions (Test scores/teacher recommendation/academic grades/other)? CRCT scores, grades, teacher recommendation and mathematics screeners were used to identify students for mathematic interventions.

5. If you offer a separate intervention math course:
   a. Is the class used as a connections course? Yes
      i. How many days per week? Alternating days (2 one week and 3 the next week)
      ii. What is the time length? 70 minutes each class
   b. Do you use CRCT scores to determine student placement? Yes
      i. What is the cut-off score? 815 CRCT
   c. Do all students under this score take a math intervention class? No
      i. If not, how do you determine which students take the course? Teacher recommendation and screeners
   d. Are resource students included? Yes
      i. If so, are they taught the same material? Not always because they have a separate IEP that must be met.
   e. Is placement fluid (students move in and out throughout the year)? At the end of the semester they were able to move out or in as needed.
      i. If so, how do you determine when students are ready to move in or come out of the course? Grades, screeners, and 9 weeks exams.
   f. Are the classes based on heterogeneous or homogeneous mathematic ability?
   Homogenous
g. What type of instructional model is used (workshop/inquiry, direct-instruction, teacher centered, student centered, etc.)? Direct-instruction, small group, individual, and computer based.

Signature ___________________________________________ Date 3/17/14
APPENDIX K: CONSENT FORM – ACADEMIC COACH AT CONTROL SCHOOL

CONSENT FORM

The Effects of a Direct-Instruction Mathematic Intervention on Standardized Test Scores of At-Risk Middle School Students

Charles David Moore
Liberty University
Education Department

You are invited to be in a research study to understand if a direct-instruction mathematic intervention results in a statistically significant difference in the mean scale scores of at-risk middle school students who participated in a direct-instruction mathematic intervention taught during a connection class period and at-risk middle school students who did not participate in a direct-instruction mathematic intervention. You were selected as a possible participant because you have an administrative position at the participating schools, knowledge of the mathematic programs at the participating schools, and a stake in the success of at-risk mathematic students. I ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by Charles David Moore, Education Department at Liberty University.

Background Information:

The purpose of this study is to help understand if a direct-instruction mathematic intervention taught during a connection class period can help improve mathematic academic achievement and increase standardized test scores of at-risk middle school students.

Procedures:

If you agree to be in this study, I would ask you to do the following things: sign a consent form, and participate in a 15- minute interview to be conducted at your school. The interview will consist of answering a questionnaire about the mathematic program at your school. Your response will be recorded in a word document stored on a password-protected computer. Your name will be kept confidential and will not be used in the study.

Risks and Benefits of being in the Study:

The research is minimal risk, which is no greater than every day activities. The data will be kept on a password-protected computer and no identifying information will appear in the study.

The benefits to participation are the study will help the administrators at the participating schools and educators in general understand if a direct-instruction mathematic program taught during a
connections class period can help improve the standardized test scores of at-risk middle school students.

Confidentiality:

The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely and only the researcher will have access to the records. All data will be stored on a password-protected computer kept in the sole possession of the researcher. All data will be destroyed after a period of three years. The data will be used for this study only and will not be used for any other reason, now or in the future.

Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University, Liberty University Academy School, or Liberty Middle School. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The researcher conducting this study is Charles David Moore. You may ask any questions you have now. If you have questions later, you are encouraged to contact him at (423) 667-2679. The researcher’s faculty mentor is Dr. Ralph Marino, Jr., and you may contact him at (607) 795-2404 or email him at mmarino@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, you are encouraged to contact the Institutional Review Board, 1971 University Blvd, Suite 1837, Lynchburg, VA 24502 or email at irb@liberty.edu

You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature: __________________________ Date: 3/7/14

Signature of Investigator: __________________________ Date: 3/7/14

IRB Code Numbers: 1801.031014

IRB Expiration Date: 3/10/2015
Guiding Questions for the Principal and Academic Coach Interviews

1. Tell me about the class schedule for mathematic classes at your school. How many days a week do the mathematic classes meet and for how long each day? Are the classes based on heterogeneous or homogeneous mathematic ability?
   All classes meet each day. Approx. 65 minutes. Heterogeneous grouping, as ability levels are different, though they are all struggling in some area.

2. What type of instructional model is used in the mathematic class (workshop/inquiry, direct-instruction, teacher centered, student centered, etc.)?
   Workshop model mainly. Also, some direct instruction and a nice blend of student and teacher centered.

3. Do you offer math specific interventions to struggling students during the math class? If so, please describe:
   a. Is this intervention conducted during the regular math class or during a connections class?
      The regular remedial math class
   b. What type of intervention is offered? Small group and individual based on deficiency
   c. Are these used as an intervention? yes
   d. What type of instructional model is used for the intervention (workshop/inquiry, direct-instruction, teacher centered, student centered, etc.)?
      Direct instruction and a blend of student and teacher centered.
   e. Is a specific mathematic intervention used? If so, what is the name of the mathematic intervention used? Not that I am aware of, though they do rely heavily on RTI data because most math RTI students are in this remedial math class, as they typically score 815 or less on the CRCT

4. How are students identified for mathematic interventions (Test scores/teacher recommendation/academic grades/other)? Test scores of 815 or less as well as grades

5. If you offer a separate intervention math course: N/A
   a. Is the class used as a connections course?
      i. How many days per week?
      ii. What is the time length?
   b. Do you use CRCT scores to determine student placement?
      i. What is the cut-off score?
   c. Do all students under this score take a math intervention class?
      i. If not, how do you determine which students take the course?
   d. Are resource students included?
      i. If so, are they taught the same material?
   e. Is placement fluid (students move in and out throughout the year)?
      i. If so, how do you determine when students are ready to move in or come out of the course?
   f. Are the classes based on heterogeneous or homogeneous mathematic ability?
   g. What type of instructional model is used (workshop/inquiry, direct-instruction, teacher centered, student centered, etc.)?