ACADEMIC INTERVENTION: ACCELERATION AND REMEDIATION

by

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Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

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ABSTRACT

Eighth grade math students must pass a standards based test to be promoted to the next grade. Students who were at risk of failing the state’s annual test faced impending retention. The purpose of this quasi-experimental study was to see if an intensive nine-week (55 min per day) remedial Math Connection (MC) class for 67 suburban, eighth grade students identified as at risk of failing, could significantly increase the scores; concurrently, at this Title I school, they were compared with 122 eighth grade students who were not identified as at risk of failing. The dependent variable was measured using the AIMSweb tests (nonmultiple choice answer format). A quantitative quasi-experiment of nonequivalent control group design, pretest and posttest, was used with the AIMSweb tests. When controlling for pretest scores through an analysis of covariance (ANCOVA), results indicated that there was no significant difference between the AIMSweb scores for the math class group as compared with the no math class group. Future studies need to consider both efficient and effective processes of instruction and assessment formats for the remediation of students at risk of failing the state’s math summative assessment.

Keywords: math, remediation, FAPE, assessment, time on task, middle school
Dedication

I would like to dedicate this work to my husband David, to my children and their spouses, and my grandchildren. I have felt loved, encouraged, and supported throughout the process of obtaining my Doctorate of Education.
Acknowledgments

I would like to acknowledge my husband, David, who went above and beyond my expectations in helping me to achieve my goal. In addition, I would like to acknowledge my very patient and kind dissertation chair, Dr. Kenneth Gossett, who was an invaluable asset in assisting me through this process. My thanks also extend to the teachers who supported my efforts and their insights on the best ways in which to educate our nation’s children.
# Table of Contents

ABSTRACT .................................................................................................................. 3

Dedication .................................................................................................................. 4

Acknowledgments ..................................................................................................... 5

List of Tables .............................................................................................................. 8

List of Figures .......................................................................................................... 9

List of Abbreviation ................................................................................................. 10

CHAPTER ONE: INTRODUCTION ........................................................................... 11

Background ............................................................................................................... 11

Problem Statement .................................................................................................. 15

Purpose Statement ................................................................................................... 17

Significance of the Study ......................................................................................... 17

Research Question .................................................................................................. 19

Null Hypothesis ...................................................................................................... 19

Definitions ................................................................................................................ 19

CHAPTER TWO: LITERATURE REVIEW ............................................................... 21

Introduction .............................................................................................................. 21

Theoretical Framework ............................................................................................ 24

Related Literature .................................................................................................... 27

Formative Assessment ............................................................................................. 30

Testing Format ......................................................................................................... 51

CHAPTER THREE: METHODS ............................................................................. 57

Research Design ...................................................................................................... 57
List of Tables

Table 3.1: Frequencies Demographics.................................................................59
Table 4.1: Descriptive Statistics..........................................................................67
Table 4.2: Kolmogorov-Smirnov Test of Normality...........................................68
Table 4.3: Levene’s Test of Homogeneity of Variance.......................................69
Table 4.4: ANCOVA Table: Test of Homogeneity of Slopes............................70
Table 4.5: ANCOVA Adjusted Mean Scores for the Treatment Groups.............71
Table 4.6: ANCOVA Table: Assessing Difference in AIMSweb Posttest Scores....72
List of Figures

Figure 4.1: Box and whisker—AIMSweb for the control and treatment group ..................67

Figure 4.2: Scatterplots of AIMSweb scores for the control group ...............................69

Figure 4.3: Scatterplot of AIMSweb scores for the treatment group .............................70
List of Abbreviation

Common Core State Standards (CCSS)
Criterion Referenced Competency Test (CRCT)
Curriculum Based Measures (CBM)
Free Appropriate Public Education (FAPE)
General Linear Model (GLM)
Learning-Focused Schools (LFS)
Math Connection (MC)
Math Difficulty (MD)
No Child Left Behind (NCLB)
Response to Intervention (RTI)
Teacher Keys Effective System (TKES)
CHAPTER ONE: INTRODUCTION

Background

The Nation’s 2005 Report Card indicated that 31% of eighth grade math students lacked proficiency (U.S. Department of Education, 2006). With the high stakes testing and the ending of social promotion, students were at risk of retention based upon a state’s annual assessment (Huddleston, 2014). In order for an eighth grade student in the state of Georgia to have access to the subsequent high school math curriculum, the student must be able to meet the eighth grade standards as measured by the state’s end-of-the-year testing instrument, the Criterion Referenced Competency Test (CRCT). However, research has suggested that certain students have significant gaps in math and that these inequities deny access to future math curriculum (Dougherty, Goodman, Litke, & Page, 2015; Lukas & Beresford, 2010; Rickles, 2013; Rojas-LeBouef & Slate, 2012). Bishop and Forgasz (2007) suggested “without access to mathematics education there can be no equity” (p. 1146). In light of the inequities, educators have a two-fold fiduciary responsibility—seek to identify those who are at risk of failing and implement a series of interventions to bridge the academic gaps (Archer & Hughes, 2011; Courtade, Spooner, Browder, & Jimenez, 2012; Petscher, Young-Suk, & Foorman, 2012).

Historical Literature Overview

The history of differentiated instruction has its roots within early America’s one room school houses (Urban & Wagner, 2009). In this setting, one teacher was responsible for educating students in a wide range of grades and ability levels. Some early American schools used test based assessments to determine a student’s academic future (Huddleston, 2014; White, 1886; 1888). Some have estimated that in 1919 there were 190,000 one room schoolhouses in the United States (Gundlach, 2012; Urban & Wagner, 2009). In early 1889, Preston Search, a
school superintendent in Colorado, advocated that teachers should make it possible for students to work at their own pace without the fear of retention or failure (Urban & Wagner, 2009; Ventura, 2014). Search pushed his teachers to build an environment where students could be successful, progressing at the individual’s pace. However, by 1912, with the introduction of assessment tests, significant academic gaps were identified (Urban & Wagner, 2009; Ventura, 2014).

These academic gaps, along with the implementation of intelligence tests, suggested significant academic abilities existed between students. By the 1930s student ability and readiness to learn a certain concept or skill would soon be eclipsed by a pedagogy suggesting that students need to learn the way teachers teach and within the allotted time (Urban & Wagner, 2009; Ventura, 2014). A dichotomy of responses emerged. Students who did not learn were retained or socially promoted; however, retention often resulted in an increase of students "dropping out” (Allensworth, 2005; 2010; Jacob & Lefgren, 2009; Educational Commission of the States, 2005; Xia & Kirby, 2009).

**Society-at-large Discussion**

In the shadow of students dropping out emerged Federal legislation based on equal access and minimal outcomes. On the heels of the Civil Rights Movement emerged the legislative impetus that mandated the same standards being taught to and learned by each student. In 1975 the Federal legislators enacted the Individuals with Disabilities Education Act (IDEA) mandating not just equal access but also a minimum of equal outcomes in the expected learning; subsequently, the legislators mandated a FAPE for each student in public education. The full force of the mandate was renewed and modified IDEA (2004) and then finalized its inclusive No Child Left Behind (NCLB) expectations (U.S. Department of Education, 2006). Both IDEA and
NCLB suggests a student's epistemology should drive a teacher's pedagogy; the priority of each student's peculiarities impacting the individual's learning should inform the pedagogy.

These Federal expectations had to be measured by the states. Since the state of Georgia had sought to comply with both IDEA and NCLB mandates by measuring eighth grade math success through the state's CRCT math test, then educators must both identify and intervene for those students thought to be at risk of not meeting the standards (Georgia State Board of Education, 2001; Henry, Rickman, Fortner, & Henrik, 2005; Livingston & Livingston 2002; Mordica, 2006). In fact, students must pass the math test during the gateway grades of third, fifth, and eighth to be advanced to the next grade. FAPE was measurable through the standards based CRCT math assessment. Retention was the immediate consequence of not passing the eighth grade math test.

Assessment determined promotion to high school. Although the assessment had implications for FAPE effectiveness, the limited budgets impacted the efficiency, time on task. Relevant learning theories are informative and directional for supporting students at risk of failing the assessment. Although Piaget's stage of cognitive development suggests that learning is possible, historically, there was and still is much controversy over differentiated learning. The impetus of the debate has been identified in two opposing articles and the collection of responses found in blogs. Brenneman (2015) compiles the blogs of the debaters weighing in on the two published pieces, Jim Delisle's "Differentiation doesn’t work," and Carol Ann Tomlinson's timely response, "Differentiation, does, in fact, work."

While educators debate over effective learning strategies (Munk, Gibb, & Caldarella, 2010), what is most important is that educators both identify and address the learning of students at risk of failing the CRCT. Identification and implementation of student specific interventions
are not a suggestion, but rather, they are expedient in meeting the student's FAPE (Georgia Department of Education, 2008). While effective learning strategies are historically and currently debatable (Baker, Rieg, & Clendaniel, 2006; Flores & Kaylor, 2007), all would concur that time on task and repetitive learning target experiences must be considered for success in math interventions (Axtell, McCallum, Mee Bell, & Poncy, 2009).

**Conceptual Framework/Theory Overview**

U.S. education’s proclivity has reproduced a specific socioeconomic dominant group, the middle class. By perpetuating the middle class, others are underappreciated and undereducated. Sociologists, Bourdieu and Passeron, have “developed a theory of reproduction in education” that identifies “achievement gaps” as actually socioeconomic “opportunity gaps” (Huddleston, 2014, p. 5). Lareau (2003) has suggested that socioeconomic inequities contribute to academic gaps for the non-dominant groups. U.S. education has reproduced a middle class model consistent with certain dominate socioeconomic values, resources, and skills that exist in the local middle class; teachers teach to the middle to perpetuate these educational outcomes. The Bourdieu and Passeron (1990) theory suggests that non-dominant students need equitable opportunities to address the achievement (opportunity) gaps.

These equitable opportunities are possible. The theoretical base for this study includes Piaget’s stage of cognitive development, specifically, the concrete operational theory, the constructivist theory, and the behaviorist theory. While Piaget's stages identifies the student's cognitive maturity, suggesting that the student can learn, the constructivist and behaviorist theories connect the learning with both the learner and the environment (Ertmer & Newby, 2013; Sezer, 2010). What is most relevant is the opportunity and motivation to learn (Ertmer & Newby, 2013).
Piaget’s concrete operational theory suggests that cognitive development has matured in the learner to the point that the learner can both learn math rules and then apply those rules to physically perceived objects (Atherton, 2013). While behaviorists are creating extrinsic support through a positive and rewarding learning environment, constructivists suggest that the learners can take that information and connect it in such a way that implementation is evident by what the learner is able to construct and communicate (Ertmer & Newby, 2013). Thus, both direct instruction and time on task are expedient for learning the math rules, moving the rules from short term memory to long term memory (Barbash, 2012; Ertmer & Newby, 2013). Also, most will need manipulatives and visuals in implementing the rules learned; once again, time is indicative in learning, implementation, and retention. Piaget, behaviorists, and constructivists suggest that learning is made through connections (Ertmer & Newby, 2013). When middle schoolers make cognitive connections with the new learning, learning occurs with relevance to the learner's environment (Schrank & Wendling, 2009).

When students do not connect with learning the math standards, then remedial interventions must become student specific. In fact, specific learning disabilities have been targeted with specific strategies that support each student's learning (Schrank & Wendling, 2009). Both the constructivist and behaviorist theories suggest that remediation is possible (Ertmer & Newby, 2013; Schrank & Wendling, 2009; Sezer, 2010).

**Problem Statement**

The problem is that math proficiency, or the lack of it, empowers or retains a student's progress in the American public education system (Bicknell, 2009; Gordon, 2007; Klein, 2003). Educators were concerned with the Nation’s 2005 Report Card indicating that 31% of eighth grade math students lacked proficiency (U.S. Department of Education, 2006; National Academy
of Sciences, National Academy of Engineering, and Institute of Medicine, 2005). Eighth graders in the state of Georgia are retained if they are not proficient in math as measured by the state’s CRCT (Henry et al., 2005; Livingston & Livingston, 2002; Mordica, 2006). Historically, proponents of retention (Greene & Winters, 2007; 2009; Owen & Ranick, 1977) suggested that more time on task through retention should be considered; however, with some, the negative implications of retention eclipsed retention and empowered social promotion (Anagnostopoulos, 2006; Winters & Greene, 2012). McCombs, Kirby, and Mariano (2009) suggest that more time on task and more effective learning can support students in becoming successful without retention or social promotion. However, no research has examined the effectiveness of an intensive nine-week remedial math connection (MC) class to improve math scores on the Georgia CRCT eighth grade math test.

Given the low proficiency in math among eighth grade students, there is a need to intentionally offer equitable education to bridge the academic gaps for eighth grade students at risk of failing (Jitendra, 2013; Malmgren, McLaughlin, & Nolet, 2005; Munk et al., 2010; Schrank & Wendling, 2009). The academic gap between expected math proficiency and current levels of performance suggests a future inequity in limiting the access to the high school math curriculum. Therefore, it is imperative that compensatory interventions are identified and implemented. While most agree that there is a need for both more time on task and more effective means for learning, the intentional, equitable amount of time has not been addressed for bridging the math gap that would give eighth graders full access to the high school math curriculum. While the amount of time required (e.g., summer school, retention for another year, after school math, two math classes, more allotted time for the remediation) has been debated (Jacob & Lefgren, 2004; 2009; Matsudaira, 2007; Roderick & Nagaoka, 2005), the literature has
not considered students receiving an additional MC class for 55 minutes a day for 45 days. No research to date has addressed the impact of an additional MC class for 55 minutes a day for 45 days in order to bridge the inequity of math gaps for eighth grade students that are at risk of failing state mandated math assessments. The problem is that lack of math proficiency precludes a student's progress in the American public education system, specifically, in the state of Georgia.

**Purpose Statement**

The purpose of this quantitative quasi-experimental study is to see if an intensive nine-week remedial MC class (based upon the eighth grader’s seventh grade math CRCT scores) can significantly increase scores. The dependent variables are the AIMSweb posttest scores in math. The independent variable is where one group participates in the nine-week remedial math connection class and the other group will not. Those who are in the remedial math connection class scored an 820 or lower on the previous year’s CRCT math scores or the present year’s math teacher’s recommendation that the student is at risk of failure. A covariate will be used, which will be the AIMSweb pretest scores. This will be used to control for differences in AIMSweb pretest scores between the control and treatment groups. Students deemed at risk will be preassigned to a treatment group based upon the previous year’s (2010) CRCT math scores (820 or lower), or the student’s 2010-2011 math teacher’s perception of the student being at risk of failing the CRCT.

**Significance of the Study**

The significance of this study is the consideration of the MC class being both an efficient and effective means of “catching kids up” (Beatty, 2012a; Takanishi, 2012). Most research has suggested that more time on task is needed for students who are behind (Beatty, 2012b; Span,
2012). Concomitantly, as states move toward the Common Core State Standards (CCSS) curriculum (or similar curriculum), pedagogy must address content, process, and assessment in light of each student’s epistemology. Also, the fiduciary responsibility, with both fiscal and time constraints, suggests that schools should implement an efficient and cost-effective program that provides a FAPE for each student.

This study seeks to better understand how to enable students to access the curriculum. Access to the future curriculum requires skills in both math and reading at each grade level. Remediation is possible (Clements & Sarama, 2011; Engel, Claessens, & Finch, 2013; Shapiro, 2011). Although students learn differently, all students can learn (Claessens, Engel, & Curran, 2013). Behaviorists’ and constructivists’ perspectives best support this quasi-experimental design based upon the research of acceleration and remediation (Ertmer & Newby, 2013; Sezer, 2010; Thompson, Thompson, & Thompson, 2002). Consequentially, this theory suggests that differentiation of learning must match the need of the student (Wiles et al., 2006).

The constructivist theory supports both Piaget’s cognitive aspect (Atherton, 2013) and Vygotsky’s (1978) social aspect in relation to eighth grade learners.

This study considers the literature suggesting that more time spent on math over and above what is allotted in the classroom can be effective (Hall, Strangman, & Meyer 2011; Stone, Engel, Nagaoka, & Roderick, 2005). This additional time, nine weeks, both remediates and accelerates, since the curriculum is based on an overview of Georgia’s standards based eighth grade math curriculum as assessed through the CRCT. Research has suggested that time frames such as summer school, retention, after school programs, and double math classes have impacted some learners (Jacob & Lefgren, 2004; 2009; Matsudaira, 2007). Economically, some school systems cannot afford these programs; however, an extra nine-week math class may be more
affordable if it can become efficient. An overview of the literature suggests a lack of research on an intense nine-week MC class (Foegen, Jiban, & Deno 2007; Gersten et al., 2009).

**Research Question**

The research question for this study was:

**RQ1:** While using the AIMSweb pretest scores as a control variable for previous math achievement, will at-risk eighth grade students who attend an intensive nine-week math connection class have statistically significant different mean scores as measured by the AIMSweb posttest when compared to students who do not receive the compensatory math instruction?

**Null Hypothesis**

The null hypothesis for this study was:

**H₀:** While using the AIMSweb pretest scores as a control variable, at-risk eighth grade students who attend an intensive nine-week math connection class will not have statistically significant different mean scores as measured by the AIMSweb posttest when compared to students who do not receive the compensatory math instruction.

**Definitions**

1. *AIMSweb* - A nonmultiple choice test format that helps evaluate a student’s math performance; some schools incorporate this as a part of an identification of a student’s need for interventions (AIMSweb, 2009a).

2. *Common Core State Standards (CCSS)* - Curricular standards that most states have adopted to implement (Porter, McMaken, Hwang, & Yang, 2011).

3. *Criterion Referenced Competency Test (CRCT)* - The state of Georgia’s annual summative assessment to measure a student’s status within a group (did not meet, meets,

4. **Free Appropriate Public Education (FAPE)** - The primary aim of Civil Rights in education, including No Child Left Behind, a Response to Intervention, and Georgia’s new assessment program, is that each student has an equitable opportunity to an education (U.S. Department of Education, 2007b).

5. **Learning-Focused Schools (LFS)** - A systemic pedagogy that seeks to teach a student the way the student learns best; the pedagogy considers the student’s epistemology (Thompson et al., 2002).

6. **Math Connection (MC)** - An extra nine-week small group, learning-focused math class that both remediated and accelerated the eighth grade CRCT math standards for students identified as at risk. Conversely, not-at-risk students were placed in other connection classes that were not math related (Williams, 1996).

7. **Math Difficulty (MD)** - This includes students who have been officially identified with a disability and other students who manifest math difficulties (Powell, Fuchs, & Fuchs, 2013).

8. **No Child Left Behind (NCLB)** - Legislation passed by Congress in 2001 to monitor student achievement data (Linn, Baker, & Betebenner, 2002).

9. **Response to Intervention (RTI)** - A systemic approach to identifying a student’s level of need and specific ways to support a student in meeting the need; it includes formative assessment through both progress monitoring and new ways of teaching for the way a student learns (Georgia Department of Education, 2008).
CHAPTER TWO: LITERATURE REVIEW

Introduction

This chapter introduces the literature review, connects the relevant theoretical framework, provides an overview of the literature, and summarizes the literature. In searching for relevant literature, certain keywords were used. They included: summer school, retention, time on task, after school, students at risk, remediation, acceleration, student achievement, middle school math, NCLB, RTI, CRCT, and high stakes testing. From these queries, the most recent and relevant research bibliographies were also considered.

High stake’s testing in the state of Georgia utilizing the annual CRCT has had students respond in multiple choice format. However, the proposed new testing suggests that the assessment will include constructed-response format. Conversely, as early as Linn, Baker, and Betebenner (1991), disparity and test inequalities between the two testing formats of multiple choice answers (MCA) and the open end question, the precursor to the constructed response (CR), have been argued. However, that disparity has greater implications for low-achieving students, including those with disabilities and those who may be in the process of being identified with a disability, and students at risk of failing. In fact, Powell’s (2012) research argued for MCA as a testing accommodation for students with a learning disability in math. Powell suggested that the third grade math students “responding in the multiple-choice format had a significant advantage over students answering in the constructed response format” (p. 3).

As NCLB (U.S. Department of Education, 2002) has left the shadow of high stakes testing on education in Georgia, the purpose of this research was to consider the academic intervention of remediation and acceleration to improve the eighth grade outcomes of both the CRCT and a corollary test, the AIMSweb. These scores could be quite suggestive for the state’s
math CRCT scores at a middle school in Georgia as impacted through the treatment of an extra math connection (MC) class. The administrators of NCLB consider the student’s performance on the standardized math test as an acceptable assessment of a student’s proficiency of the state’s standards (Marsh, Pane, & Hamilton, 2006). Caldwell (2008) argued that these standardized tests measure three things: “what a student comprehended and learned,” “the student’s socioeconomic status (SES),” and “the student’s inherited academic aptitude” (p. 183). Because states will continue to measure the success for each student, it is imperative to intervene for low achievers in both an effective and a cost and time efficient manner (Petscher et al., 2012).

Developing cognitive strategies to help at-risk middle school students with their math has become a growing concern (Krawec, Huang, Montague, Benikia, & Melia de Alba, 2012). Since the 1970s, time on task and mastery of content has been discussed by educators. John Carroll set the stage with his 1963 paper, A Model of School Learning (Carroll, 1989). Although the debate continues, some do not value the necessity of time exclusivity. “The study findings indicate that content coverage positively and significantly influences pupil achievement if it is the only predictor. There is no support for the hypothesis that time-on-task predicts achievement” (Oketch, Mutisya, Sagwe, Musyoka, & Ngware, 2012, p. 31). However, the quality of time has been purported to be significant (Marzano, Pickering, & Pollock 2001; Stonehill et al., 2011). In fact, Marzano et al. (2001) has suggested four qualifiers for most effective curriculums: explain, model, guide a practice, and allow for independent practice. This is consistent with Piaget's cognitive development theory, especially with the learner constructing meaning through both assimilation and accommodation (Atherton, 2013). Even with specific interventions, the process should be both effective and efficient (Redd et al., 2012). “It is clear that a limited number of
studies evaluate the effectiveness of an intervention with regard to the amount of instructional time needed to implement the intervention” (Bramlett, Cates, Savina, & Lauinger, 2010, p. 114).

As schools have attempted to address interventions for students at risk and better ways to include students with special needs in the general classroom, efficiency and effectiveness have become paramount (Cosier, Causton-Theoharis, & Theoharis, 2013). There is a need for teachers to consider individualistic epistemologies and rethink the teacher’s pedagogy. This can produce diverse interventions while seeking effective strategies that consider the individual student’s epistemology (Gersten et al., 2009; Nomi & Allensworth, 2013). In their study, Methe, Kilgus, Neiman, and Riley-Tillman (2012) looked at the math functions of addition and subtraction and analyzed the effect size through a meta-analyses of 47 effects in 11 studies (effect sizes ranged from 0.59 to 0.90). “Variables that appeared to moderate the effects were student age, time spent in intervention, and intervention type” (Methe et al., 2012, p. 230). They identified a need for future research “in basic arithmetic and rigorous experiments” for the purpose of establishing “an evidence base that accurately characterizes intervention effectiveness” (Methe et al., 2012, p. 230).

Historically, for interventions to be implemented, at least two things have become apparent: teachers need to be able to quickly identify the at-risk students and then discover effective strategies. Krawec (2013) had considered the epistemologies of three groups of students: learning disabled students (LD, n = 25); low-achieving students (LA, n = 30); and average-achieving students (AA, n = 29). What was most distinguishing was not that there were inequities in the groups’ ability to restate what the math problem was asking, but rather “the effect of visual representation of relevant information on problem-solving accuracy was dependent on ability; specifically, for students with LD, generating accurate visual
representations was more strongly related to problem-solving accuracy than for AA students” (Krawec, 2013, p. 80). Krawec’s research suggests that teachers need to understand the student’s proclivities for learning. A better informed epistemology is quite suggestive for a differentiated pedagogy, especially for forming approaches that what will allow the student to learn in different ways and on different days of complex content (Gamble, Kim, & An, 2012). Also, Yell and Walker (2010) suggested that, legally, these at-risk groups must be educated through effective interventions.

**Theoretical Framework**

Sociologists, Bourdieu and Passeron, have “developed a theory of reproduction in education” that identifies “achievement gaps” as actually socioeconomic “opportunity gaps” (Huddleston, 2014, p. 5). Lareau (2003) has suggested that socioeconomic inequities contribute to academic gaps for the non-dominant groups. U.S. education has reproduced a middle class model consistent with certain dominate socioeconomic values, resources, and skills that exist in the local middle class (Chapman, Tatiana, Hartlep, Vang, & Lipsey, 2014); teachers teach to the middle to perpetuate these educational outcomes. The Bourdieu and Passeron (1990) theory suggests that non-dominant students need equitable opportunities to address the achievement (opportunity) gaps.

These equitable opportunities are possible. The theoretical base for this study includes Piaget’s stage of cognitive development, specifically, the concrete operational theory, the constructivist theory, and the behaviorist theory. While Piaget's stages identifies the student's cognitive maturity, suggesting that the student can learn, the constructivist and behaviorist theories connect the learning with both the learner and the environment (Ertmer & Newby, 2013;
Practically, what is most relevant, is the opportunity and motivation to learn (Balfanz & Byrnes, 2006; Ertmer & Newby, 2013).

Piaget’s concrete operational theory suggests that cognitive development has matured in the learner to the point that the learner can both learn math rules and then apply those rules to physically perceived objects (Atherton, 2013). While behaviorists are creating extrinsic support through a positive and rewarding learning environment, constructivists suggest that the learners can take that information and connect it in such a way that implementation is evident by what the learner is able to construct and communicate (Ertmer & Newby, 2013). Thus, both direct instruction and time on task are expedient for learning the math rules and moving those rules from short term memory to long term memory (Barbash, 2012; Ertmer & Newby, 2013). Also, most will need manipulatives and visuals in implementing the rules learned; once again, time is indicative in learning, implementation, and retention. Piaget, behaviorists, and constructivists suggest that learning is made through connections (Ertmer & Newby, 2013). When middle schoolers make cognitive connections with the new learning, learning occurs with relevance to the learner's environment (Schrank & Wendling, 2009).

When students do not connect with learning the math standards (Dawn & Mendick, 2013), then remedial interventions must become student specific for each student. In fact, specific learning disabilities have been targeted with specific strategies that support each student's learning (Schrank & Wendling, 2009). Both the constructivist and behaviorist theories suggest that remediation is possible (Ertmer & Newby, 2013; Schrank & Wendling, 2009; Sezer, 2010).

Remediation is possible (Shapiro, 2011). Although students learn differently, all students can learn. While the behaviorist seeks to construct an environment for motivating the learner,
the constructivist seeks to encourage the learner to construct meaning from the learning environment (Wiles, Bondi, & Wiles, 2006). Constructivist research suggests that math achievement gaps among eighth grade students can be addressed through acceleration and remediation (Thompson et al., 2002). Consequentially, this theory suggests that differentiation of learning must match the need of the student (Wiles et al., 2006). The constructivist theory purports both Piaget’s cognitive aspect and Vygotsky’s (1978) social aspect (Atherton, 2013).

Constructivists use the social interaction of the teacher with the student to create a learning environment that supports the student’s learning by implementing a social cognitive process that is both suggestive and directional—modifying and adapting the learning to meet the student’s most specific needs—which subsequently empowers the learner by creating and perpetuating a sense of self-efficacy (Bandura, 1997; Marzano, 2003; Posner & Rudnitsky, 2006).

Achievement gaps suggest that compensatory strategies must be implemented to close the gaps (Sobel & Taylor, 2006); if not, Judge and Watson (2011) suggested that the gap increases with each grade. However, with extra time on task, the diminishing of the gap is not guaranteed (Bennett et al., 2004). In fact, the meta-analysis of Lauer et al. (2006) suggested that for the time on task to effectively diminish the gap, the process must be student-specific based upon the content complying with the state standards.

Theoretically, each child can learn (Linn et al., 2002), learning is measurable, and if a student fails to learn, then academic intervention is essential. Therefore, the pedagogy and epistemology must be realigned. Research has suggested that these assumptions are possible through academic intervention (Hattie, 2009, 2011). Also, specific academic intervention is plausible if this realignment considers the theory of multiple intelligences (Gardner, 1999) and
differentiation (Tomlinson, 1995a) that is designed to meet the student’s needs (Hall et al., 2011). Practically, the luxury of time and money has been deprecated in the shadow of budget constraints. Therefore, there is an urgent need to be both efficient and effective to provide compensatory education for students who are at risk.

**Related Literature**

**Compensatory Education**

Compensatory education is possible (Krawec, 2013; Stone 1998; Valencia, 2012; Walston & McCarroll, 2010). Efficient and effective approaches must be identified and implemented (Shapiro, 2011). Hattie’s (2009, 2011) meta-analysis of previous studies suggested that the most effective influences can be identified. These previous studies researched influences impacting the learning of students. Hattie’s meta-analysis considered millions of students. Hattie systemically considered different influences on learning for over a period of 15 years; he was able to consider the data and establish a mean score (.40). The effect score assigned to each influence was based upon his meta-analysis of the data. Hattie systemically categorized these influences as student, home, school, curricula, teacher, and teaching and learning approaches; he then ranked the specific impact of each influence based upon the effect size on student learning relative to the mean.

When a student does not learn, the epistemology of the student needs to be considered (Foegen et al., 2007; Petscher et al., 2012; VanDerHayden & Burns, 2009). Once the learner’s proclivities are better understood, the learner’s specific pedagogy can better address academic gaps by seeking to individualize the learning during remediation. What a student knows, including skill sets, are quite suggestive for pedagogy and interventions (Clements & Sarama, 2011; Engel et al., 2013).
**Pedagogy and Epistemology**

Pedagogy and epistemology are relevant (Harlacher, Nelson, & Sanford, 2010). When a student does not learn from the pedagogy, it is expedient to discover how to facilitate learning in a manner in which the student learns best (Tomlinson, 1995b). Using the student’s epistemology to better address the ways and methods to support the learner is imperative; the teacher can better customize the differentiation of the curriculum (Dougherty et al., 2015). Perhaps specific learning style, small group, and direct instruction are just a few of the approaches that might improve the learning process (Rickles, 2013; Schatschneider et al., 2008). Learning that considers both the student’s interest and the scaffolding of the learning based on how a student learns best suggests improvement. Concomitantly, when both teacher and student succeed, then both teacher efficacy and student efficacy emerge into a collective student-teacher efficacy (Brown, 2010; Brown, Benkovitz, Muttillo, & Urban, 2011; Munk et al., 2010).

The ongoing challenge has been and remains to be how to best maximize the time needed to facilitate the bridging of the academic gaps (Burns & Gibbons, 2012; Goddard, Hoy, & Woolfolk-Hoy, 2004). Thus, if given enough time to intervene, and if the intervention is individualized, then perhaps the learning is impacted through teacher efficacy (Guskey & Passaro, 1998; Hall et al., 2011; Ross, 1994). Subsequently, this additional time for intervention could substantially impact a student’s summative learning outcome when aligned with the curriculum-based standards as measured by the CRCT (Silva, 2007; Siwatu, Polydore, & Starker, 2009; Siwatu & Starker, 2014; Tucker et al., 2005; Vaughan, 2002). With standards-based content, a differentiated process, and a relevant summative assessment, there is no need for a bell curve distribution of grades that expects a certain amount of failures; however, math proficiency suggests a pedagogy with a proclivity toward the student’s epistemology.
Proficiency at each academic grade level suggests that the United States can be globally competitive (Porter et al., 2011). The need to globally compete impacts the American public education system (Bicknell, 2009; Gordon, 2007; Klein, 2003); one 2005 report indicated that about two thirds of eighth grade math students lacked proficiency (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2005). Subsequently, the appropriation of the COMPETE Act, an allocation by the federal government of $33.6 billion to address math and its interdisciplinary deficits (Bicknell, 2009; Committee on Science and Technology, 2007), suggests that each institution must consider both the cost and the correlation of effectiveness in addressing the math gap.

Because gaps do exist, resulting in low achievers, it is therefore the responsibility of educators to provide a FAPE (Valero, 2012). To reverse the trend of a low achiever, educators must respond (Krawec et al., 2012). The variables of causation must be considered to reverse the trend (Blankstein, 2013; Dembosky, Pane, & Christina, 2006). Fischer and Frey (2007) found, “When comparing achievement data at aggregate levels, differences based on ethnicity and race, language, and gender are obvious” (p. 10); however, Goddard et al. (2004) argued for a greater significance in the faculty’s collective perception (Mojavezi & Tamiz, 2012). The collective perception of being able to effect change is much more consequential for the student’s outcomes than the student’s socioeconomic status (Goddard et al., 2004; Hattie, 2011). Although multiple causation including efficacy, socioeconomic status, ethnicity, religious beliefs, and/or poor learning environment exists, most would agree that a quintessential underlying factor in the diminishing of the gap is time (Bennett et al., 2004; Redd et al., 2012); however, effecting change requires an effective use of the time. It seems that both time and cost force educators to rethink the learning environment and how to use formative assessment to inform summative
assessment (Fuchs et al., 2008). Although other schools have addressed the problem of low achievers (Duffrin & Scott, 2008), what distinguishes this research is the limited treatment that the student will receive in light of time and cost restraints to reverse the low achievement as demonstrated in the pre and posttest outcomes of both the CRCT math test and a corollary test, the AIMSweb.

While many educators are highly focused on state testing, it is important to consider that over the course of a year, teachers can incorporate many opportunities to assess how students are learning and then use this information to make beneficial changes in both time on task and the learning process (Foegen et al., 2007; Petscher et al., 2012; VanDerHayden & Burns, 2009). This diagnostic use of assessment to provide feedback to teachers and students over the course of instruction is called *formative assessment*. It stands in contrast to *summative assessment*, which generally takes place after a period of instruction and requires making a judgment about the learning that has occurred, for example, through grading or scoring a test or paper (Boston, 2002, n.p.).

### Formative Assessment

Formative assessment, which informs summative assessment, could benefit the low achiever (Phelan, Choi, Vendlinski, Baker, & Herman, 2011). However, teachers need help in assessing and monitoring a student. Teacher perception of a student’s academic achievement is most important. Research has suggested that teachers have relative accuracy. Although the research sample of Eckert, Dunn, Codding, Begeny, and Kleinmann (2006) was quite limited, the results were quite suggestive for math remediation. While the teachers were limited in assessing a student’s ability to perform math functions, their strength was assessing addition. Conversely,
they were less likely to be able to assess a student’s math level as either mastery, instructional, or functional.

The social-cognitive theorist implemented formative assessment in the scaffolding of each learner (Kagan, 1994; Marzano, 2003; Vygotsky, 1978). Formative assessment suggests an early identification of an academic gap as opposed to the summative assessment. The summative assessment identifies a much larger gap that is most difficult to bridge in light of the need to learn new material. The larger the gap, the greater the challenge (Nomi & Allensworth, 2011).

As past approaches of remediation often resulted in students falling even more behind, Learning Focus Schools proposed a program of remediation and acceleration for a low achiever (Thompson et al., 2002). The goal was to “catch up” the low achiever through a continuity of remediation and acceleration; remediation aimed to bridge the gaps and acceleration sought to build confidence—namely, what one should have learned and a preview of what one should learn next, respectively. This form of acceleration is not preteaching; rather, it functions like a trailer for an upcoming movie; it activates prior knowledge, and introduces key concepts and vocabulary consistent with Piaget’s cognitive development theory.

Remediation and acceleration connects the learning and makes it visible (Hattie, 2011). The key is the formative assessment that scaffolds the learner through both remediation and acceleration. Succinctly stated:

When teachers know how students are progressing and where they are having trouble, they can use this information to make necessary instructional adjustments, such as reteaching, trying alternative instructional approaches, or offering more opportunities for
practice. These activities can lead to improved student success. (Boston, 2002, n.p.;
Fullan, Hill, & Crevola, 2006)

Even though in some learning environments “an enormous proportion of daily assignments are
simply never assessed—formally or informally—and no evidence exists by which a teacher
could gauge or report on how well students are learning essential standards” (Schmoker, 2006, p.
16), a school can intentionally implement formative assessment (Fisher & Frey, 2007), thus
creating a climate and culture change that significantly impacts the low achiever (Lukas &
Beresford, 2010).

Although the restructuring process to implement a formative assessment that can inform
summative assessment may result in different frameworks, Fisher and Frey (2007) identified four
essentials for the framework (p. 12). These four essentials are:

- Aligning with enduring understandings (Wiggins & McTighe, 2005).
- Allowing for differentiation (Tomlinson, 1999).
- Focusing on gap analysis (Bennett et al., 2004).
- Leading to precise teaching (Fullan et al., 2006).

The framework is quite suggestive. The premise of helping the low achiever
substantiates the fundamental assumption of NCLB that each student can learn; concomitantly,
learning is not innate. In fact, this framework of learning seems to be most effective; “effect
sizes ranged between .4 and .7, with formative assessment apparently helping low-achieving
students, including students with learning disabilities, even more than it helped other students
(Black & William, 1998)” (Boston, 2002, n.p.). In fact, low achievers often lose focus and
motivation, thinking that learning is innate. Conversely, Boston argued that the formative
feedback informs the learners of “any gaps that exist between their desired goal and their current
knowledge, understanding, or skill and guides them through actions necessary to obtain the goal” (Boston, 2002, n.p.).

Formative assessment both identifies the error and informs the pedagogy in a non-threatening manner. It encourages students to take risk without academic failure. This seems to enhance the learning for the low achiever as he/she is rewarded for “effort rather than be doomed to low achievement due to some presumed lack of innate ability” (Boston, 2002, n.p.). This new approach that includes formative assessment, consistent with the intent of NCLB, requires a paradigm shift; the learning environment must be reconstructed for the specific needs of each learner in anticipation of creating the construct of self-efficacy in each learner. The belief is that formative assessment helps support the expectation that all children can learn to high levels and counteracts the cycle in which students attribute poor performance to lack of ability and therefore become discouraged and unwilling to invest in further learning (Boston, 2002, n.p.).

When formative assessment is being aligned with the state standards, schools need to address sociopolitical inequity in the organization of mathematics (Valero, 2012). Inequities must consider three objectives—“identify desired results,” “determine acceptable evidence,” and “plan learning experiences and instruction” (Wiggins & McTighe, 2005, p. 9)—that essentially integrated the state CRCT standards (Fullan et al., 2006; Noell, 2005; Posner & Rudnitsky, 2006).

Grouping is relevant to the uniqueness of the student. The strategies of both individual and small group learning (Brown et al., 2011; Smith & Bell, 2014) are quite suggestive in addressing inequities. Tombar and Borich (1999) “urged educators to make classroom learning more of a joint cognitive venture among all classroom participants than a solitary enterprise” (p.
Formative assessment must consider the uniqueness of the student. In fact, “the ways people communicate and construct meaning…depend on social interaction and cultural context” (Maker & Schiever, 2005, p. 293), and the formative assessment “results indicate that many teachers find peer and self-assessment useful and that there is potential for greater classroom applicability” (Noonan & Duncan, 2005, n.p.). The consensus seems to be that, “There is little question that such grouping arrangements lead to higher degrees of complex learning in comparison to whole-group teaching methods” (Tombar & Borich, 1999, p. 189).

In addition, small group affords a systemic formative assessment (Cusumano, 2007; Fredriksson, Öckert, & Oosterbeek, 2013) that can better inform both the construct of learning and the cognitive outcome (Petscher et al., 2012). Subsequently, systemic implementation of a curriculum-based measurement (CBM) potentially diminishes the gap through early interventions (Hosp, Hosp, & Howell., 2007; Jiban & Deno, 2007). Although Espin, Scierka, Skare, and Halverson (1999) “examined the criterion-related validity of curriculum-based measures in written expression” (p. 5) of 147 tenth graders, it was the formative assessment approach of the CBM that was most useful. Espin et al. (1999) suggested this approach as “a systemic procedure for monitoring students’ progress in an academic area and making instructional decisions” (p. 5). In addition, “Underlying this approach is the value of economic efficiency—that is, promoting greater output with no increase in expenditure” (Ladd & Walsh, 2002); concomitantly, some students’ cognitive performances are impacted when passing the test is determinative for moving up to the next grade level, as seen in high stakes testing (Roderick, Bryk, & Jacob, 2002).

Formative assessment with CBM (Shinn, 2008; VanDerHayden & Burns, 2009) is both informative and directional for instruction (Safer & Fleischman, 2005). Formative assessment
“can lead to increased precision in how instructional time is used in class and can assist teachers in identifying specific instructional needs” (Espin et al., 1999, p. 48). How does this inform pedagogy? Pedagogically, the final report of the National Mathematics Advisory Panel (2008) suggested formative assessment as a tool to both inform and then give direction for future learning by stating, “Teachers’ regular use of formative assessments improves their students’ learning, especially if teachers have additional guidance on using the assessment results to design and individualize instruction” (p. 47). When a student has lost some confidence, formative assessment can reestablish success and a blending of confidence with self-efficacy. In fact, “For struggling students, frequent (e.g., weekly or biweekly) use of these assessments appears optimal, so that instruction can be adapted based on student progress” (p. 47). This scaffolding of learning suggests a need to research the “specific tools and strategies”; however, the pedagogy includes tutoring, computer assistance, and “a professional (teacher, mathematics specialist, trained paraprofessional)” (National Mathematics Advisory Panel, 2008, p. 47).

Yeh (2010a; 2010b) considered 22 approaches that have been implemented to improve student achievement. He suggested that the rapid assessment of student daily and weekly achievement allows for the individualizing of the learning. His findings showed that rapid assessment with immediate adjustments to accommodate the epistemology of the learner is most cost-effective, more so than comprehensive school reform (CSR), cross-age tutoring, computer-assisted instruction, a longer school day, increases in teacher education, teacher experience or teacher salaries, summer school, more rigorous math classes, value-added teacher assessment, class size reduction, a 10% increase in per pupil expenditure, full-day kindergarten, Head Start (preschool), high-standards exit
exams, National Board for Professional Teaching Standards (NBPTS) certification, higher teacher licensure test scores, high-quality preschool, an additional school year, voucher programs, or charter schools. (p. 38)

Epistemologically, with the National Mathematics Advisory Panel (2008) suggesting both an efficient and effective means of helping “students with learning disabilities (LD) as well as low-achieving (LA) students” (p. 48), two presuppositions to learning are differentiation and immediate formative assessment. Systemically, the learner needs to be scaffolded based upon that assessment (Geary, Hoard, Nugent, & Byrd-Craven, 2009; Nomi & Allensworth, 2013). Concomitantly, the underlying strategy for both LD and LA is to include opportunities for students to engage in math talk, asking questions and working through the process of solving the problem out loud (Rosenzweig, Krawec, & Montaque, 2011). Although quite engaging and productive, math talk is merely a part of the essential kind of learning that should comprise mathematics instruction (Methe et al., 2012). However, foundational math skills and math concepts are quintessential for the math talk to occur with significance.

Internationally, the United States has fallen behind several countries academically. While the achievement gaps are a global concern, the most pronounced proclivity within the United States exists toward those of color, especially within low socioeconomic communities (Ross et al., 2001; Valero, 2012). The research of Balfanz and Byrnes (2006) considered three schools and four cohorts between fifth and eighth grades, where studies have found gains in mathematics achievement. Balfanz and Byrnes identified that these schools were “implementing whole-school reform models that incorporated research-based, proven curricula, subject-specific teacher training and professional development, multiple layers of teacher and classroom support, and school climate reforms” (p. 143). The researchers analyzed the data by applying a Binary
Logistic Regression model aimed at showcasing the factors that seemed to be a contributing factor in closing the gap. This middle school research is quite suggestive:

We conclude that various student, classroom, and school-level factors are all key in helping students to close the gap. WSR models, while often time and cost intensive, address issues at all of these levels and may be more able to affect the achievement gap than other, more simply implemented reforms. (p. 143)

The focus included three significant characteristics—attendance, behavior, and teacher efficacy—which, when combined, resulted in 77% of the middle school students reaching grade level. Both teacher and time on task can impact learning. Just as students need differentiation of learning, which impacts pedagogy informed by each student’s epistemology (Siegler et al., 2012), students also need different allotted time for learning different aspects of the math curriculum (Atherton, 2013; Tomlinson, 1999). Since the mid-1990s, Tomlinson has advocated differentiation, including mixed-ability classrooms (1995b) and being responsive to epistemologies that are quite suggestive for differentiation of both pedagogy and time on task. One time frame for all does not warrant expectations for mastering learning (Petscher et al., 2012).

**Differentiation and Disparity**

Time on task has relevance to both pedagogy and each student’s epistemology (Durwood, Krone, & Mazzeo, 2010; Krawec et al., 2012). However, what the teacher knows about the subject content can also impact the learning of each student. In fact, the National Center on Accessing the General Curriculum has proposed a chart that supports the above concerns for differentiation (Hall et al., 2011). The chart consists of four categories that define differentiation: mindset, ways to differentiate, epistemology, and instructional approaches. The
mindset for differentiation suggests that the learning environment can be most supportive with a substantial curriculum that teaches up, uses groups and tasks that are both sensitive and flexible, and utilizes assessments which are both informative and directional for both teaching and learning (Claessens et al., 2013; Clements & Sarama, 2011).

The differentiated learning environment is characterized by different cognitive and affective processes and products (Rosenzweig et al., 2011; Schellings & Broekkamp, 2011; Shapiro, Keller, Lutz, Santoro, & Hintz, 2006; Wormeli, 2006). Each student’s epistemology should be considered: the way the child learns best, the level of interest, and most of all, the student’s ability to learn the specific task. The chart lists several instructional approaches: “RAFTS; graphic organizers; scaffold reading; cubing; think-tac-toe; learning contracts; tiering; learning/interest centers; independent studies; intelligence preferences; orbitals; complex instruction; technology; web quests & web inquiry” (Hall et al., 2011, p. 5).

The differentiated classroom must be based upon some core beliefs, some core principles, and some core practices. For learning to be differentiated, the teacher must believe the following: all students can learn, diversity is normal, and failure is never an option (rather, it is informative as the teacher constructs learning for each student to succeed). For learning to be differentiated, the teacher must construct a positive learning environment, secure a core curriculum, utilize assessments that both inform and give direction for both teaching and learning, instruct based upon those assessments, and respond with flexibility. In addition, the teacher must practice proactive prescriptive learning based upon each student’s epistemology, instruction must be scaffold to meet a student’s need, teaching should challenge the student (the zone of proximal development), assignments should be both affective and cognitively sensitive
and relevant, and “flexible grouping strategies (e.g., stations, interest groups, orbital studies)” (Hall et al., 2011, p. 6) should be sensitive and relevant.

Teachers may make a significant difference. The value added by a teacher to a student has been measured (Crane, 2002; Lissitz, 2014; Rivkin, 2007). Researchers have measured the unit of growth attributed to a teacher’s impact for one year (Ross et al., 2001). This growth has been based on standardized tests. Because of the focus of NCLB, researchers have often focused on three subjects: reading, language arts, and mathematics (Stecher & Naftel, 2006; Sterbin, 2001; Stewart, 2006; Stronge & Tucker, 2000; Thum, 2002; 2003). In fact, some have argued that instead of proficiency, NCLB should move toward unit of growth in determining AYP (Viadero, 2006; Webster, 1998; Webster & Mendro, 1995). If learning is measurable, then researchers will propose to measure and even reward teachers who add value to student learning. But does the teacher need more resources to create the necessary value that is needed for at-risk students (Krawec, 2013)? Thompson et al. (2002) posed the following questions:

What can a school do if a student is one to three grades, or more, behind in reading or math? If teachers have students who are below grade level in their classrooms, what tools or strategies are available that would actually accelerate a student's learning in order to “catch him/her up?” (Thompson et al., 2002)

David Pupel’s (2001) book, Moral Outrage in Education, identifies disparity within American society. He believes, “The energy that is created from the interaction of triumphalism, timidity, and despair is surely entropic and hence only magnify our crises of poverty, inequality, and polarization” (Pupel, 2001, p. 68). These inequities have caused Pupel to purport a vision of reversal. Conversely, Pupel argued that we “reinstall our visions, dreams, and hopes for creating a loving and just world and to recover our confidence in the human capacity to overcome the
obstacles to them” (p. 69). Equitable resources for a FAPE may be an essential key in reversing the trend of teaching to the middle and enhancing the learning of each student.

The law requires that each student must be educated. The moral question must be asked, “Who will control the content, process, and assessment of that education?” In America, the resultant impact of education as stated by NCLB rests on the shoulders of the schools’ teachers and leaders (Gonzalez, Frankson, & Shealey, 2008; Marzano, 2003; Tschannen-Moran & Barr, 2004; Waters, Marzano, & McNulty, 2003). As Annual Yearly Progress (AYP) ultimately impacted the state and federal funding, myopically, each teacher and leader’s success became correlated to each school making AYP (Finnigan & Gross, 2007). Although local schools have much control over the implementation of the state standards, it is the state that ultimately controls the content, process, and assessment; the school’s accountability under the NCLB and its mandated AYP as the measure of success impact both local governance and funding. Subsequently, this fiduciary responsibility inversely impacts the school when student groups, those of lower socioeconomic status and/or those with disabilities, fail to meet AYP. To continue with local control, not only must the dominant group of students meet a certain minimum standard, but certain smaller student sub-groups must meet the minimum standard as well.

Conversely, in the shadow of financial limitations and NCLB’s mandates, schools have attempted to educate their various student groups in both an efficient and morally effective manner. To help determine AYP in the state of Georgia, an annual assessment, the Criterion Referenced Competency Test (CRCT), was administered to the middle school students. Also, each eighth grader had to meet expectations on the CRCT in both reading and math to qualify for
promotion to the ninth grade. This two-edged sword placed pressure on each of the stakeholders involved.

Although each state has a fiduciary responsibility to provide a FAPE, the content, process, and assessment has changed much since the desegregation of Brown v. Board of Education (1954; Donald, 2009; Ready, Edley, & Snow 2002). The desegregation practice has become an underlying factor of the American Education system—no one is to be excluded (U.S. Department of Education, 2007a). Although the history of compulsory, free public education has been well documented, the empowering and limiting of a local school board’s actions have been significantly impacted by both state and federal funding contingencies: Title I, socioeconomic student equal access and opportunities; Title IX, female equal access and opportunities; and the Individuals with Disabilities Education Act (IDEA), equitable access and opportunities for students with special needs (U.S. Department of Education, 2007). Often, children with special needs receive an Individual Educational Plan (IEP) that specifies an outline for their free access to the general education curriculum. However, even with these desegregation supports, disparity still exists (Domina, 2014; Donald, 2009; U.S. Department of Education, 2007a; Walston & McCarroll, 2010).

Since the desegregation order of the landmark case of Brown v. Board of Education (1954), inclusion of each child has become normative; however, academic disparity still exists (Barton, 2004; Dougherty et al., 2015; Fram, Miller-Cribbs, Horn, & Lee 2007; McDowell, Lonigan, & Goldstein, 2007; Rothstein, 2004). The desegregation order seems to have ignored the low-income schools (Talbert-Johnson, 2004). Black and Hispanic low-income students attend schools in which over two-thirds of students are identified as low income; conversely, less
than one-third are identified as low income within the context of White students (Martinez, 2012; Silverman, 2004).

Disparity is identifiable between the Black and White groupings of students (Goodman, 2012). From 1971 to 2005, the trend has been to close the gap—the reading gap for 9-year-olds improved from 44% to 29%, and for 13-year-olds, from 39% to 28%. In addition, after 1973, the academic achievement gaps in math narrowed as follows: the 9-year-olds improved from 35% to 26%, and the 13-year-olds improved from 46% to 34% (Donald, 2009; Perie, Grigg, & Donahue, 2005). According to The National Center for Education Statistics (2007), the learning gaps from 1990 to 2005 diminished for Blacks and remained about the same for Hispanics. The fourth graders’ gap of Black and White groupings diminished between the years 1990 and 2005, decreasing from 32 to 26 points. Conversely, during that same time frame, the disparity continued within the White-Hispanic groupings and remained at 20 points.

Concomitantly, the eighth graders reflected a similar diminishing between the Whites and Blacks of 34 points and a disparity between Whites and Hispanics of 27 points. The gaps still exist, and the National Education Association (2006) projects that the United States student demographics will increase from one-third of minority students to one-half in 2025; subsequently, coupled with the threat of school attrition, the paradigm must shift (Gonzalez et al., 2008).

Each student who is required to attend school has the entitlement of a FAPE; however, in the absence of a clear definition of appropriate, the courts have been interpreting FAPE consistent with one’s civil rights—one must not “be excluded from the participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance”; the FAPE must be “designed to meet their individual needs” (U.S.
Department of Education, 2007b, n.p.). The courts seem to advocate a view of moderation as they have set some boundaries of extremes. The U.S. Supreme Court rejected maximizing “the potential of each child with a disability” (Board of Education v. Rowley) and did not support offering the mere minimum, de minimus (Walczak v. Florida Union Free School District); instead, an appropriate education under the IDEA requires that the goal should seek student progress while avoiding “significant regression” (La Morte, 2005, p. 333).

Proficiency, not excellence, is the goal of a FAPE (Cortes, Goodman, & Nomi, 2013; Domina, 2014). Math proficiency has impelled the American public education system in the wake of failure (Bicknell, 2009; Gordon, 2007; Klein, 2003). The National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2005) report, which indicated that about two-thirds of eighth grade math students lacked proficiency, is more than a pedantic concern. Subsequently, the interdisciplinary concerns precipitated the COMPETE Act—an allocation by the federal government of $33.6 billion to address math and its interdisciplinary deficits (Bicknell, 2009; Committee on Science and Technology, 2007).

Measurable Outcomes

Learning is measurable. As NCLB mandated that a school’s subgroups must meet the preset minimal achievement standards as a criterion for meeting AYP, it is imperative for each stakeholder to seek and support both an efficient and effective means to bridge the academic gaps of each student. Potentially, the needs and desires of the majority can eclipse the needs and desires of an individual or subgroup. This study, in the shadow of NCLB’s mandated AYP, along with the state of Georgia’s self-imposed eighth grade mandate that each eighth grader must meet the minimal standard in both reading and math to be promoted to the ninth grade, sought both information and direction for the eighth grade curriculum design for “catching kids up” in
math. Concomitantly, within the achievement context, the outcomes of the subgroups can eclipse the success of the majority. For example, if the majority group exceeds the standards and the subgroups fail to meet the standards, this could preclude the school from meeting AYP.

The NCLB math challenge was that each school achieves “math excellence” (U.S. Department of Education, 2006). What is inferred is that the goal is quintessential for both international leadership and national security; it is most important that eighth graders achieve at a level that will grant each student access to the high school math curriculum, which in turn will grant students access to the universities’ curriculum. The NCLB advocates “scientifically based methods with long-term records of success to teach math and measure student progress. There is a need to “establish partnerships with universities to ensure that knowledgeable teachers deliver the best instruction in their field” (U.S. Department of Education, 2006, n.p.). As the U.S. Department of Education advocates a *highly qualified teacher* for each child, then it seems quite equitable for schools to provide more than one teacher to help bridge academic gaps for LD and LA students.

The presupposition and underlying implication of NCLB is that each child can learn (Linn et al., 2002). Researchers have assumed that learning is measurable. Because this implication of NCLB is measurable through criteria predetermined by the state of Georgia, if a student fails to learn, academic intervention is quintessential. Best practices have suggested academic intervention for remediation (Stonehill et al., 2011). Academic intervention is possible because of the theory of multiple intelligences (Gardner, 1999); consequentially, appropriate differentiation (Tomlinson, 1995a) best accommodates each child’s intelligence as well as learning strategies. Best practices for remediation suggest that time on task and practice making permanent be provided (Nomi & Allensworth, 2009). As time is most important, the
intervention(s) must be both efficient and effective (Gersten et al., 2009; Nomi & Allensworth, 2011). Thus, when a teacher discovers that a student did not learn from his/her teaching methods, thereby causing the student to miss a significant amount of learning, it becomes expedient to discover how to facilitate learning in a manner in which the student learns best and to correlate the pedagogy with the student’s epistemology, including, but not limited to, content, process, and assessment (Nomi, 2012; Nomi & Allensworth, 2013; Tomlinson, 1995b; 1999).

A pedagogy that includes the differentiation of the content, process, and assessment to accommodate high student interest and how a student learns is something that a teacher can control—teacher efficacy; however, more time is often needed to facilitate the bridging of academic gaps (Goddard et al., 2004; Gersten et al., 2009). Thus, if given enough time to intervene and if the intervention is individualized, the learning is impacted because of teacher efficacy (Guskey & Passaro, 1998; Ross, 1994). Subsequently, it could substantially impact a student’s summative learning outcome when aligned with the curriculum-based standards as measured by the CRCT (Silva, 2007; Siwatu et al., 2009; Siwatu & Starker, 2014; Tucker et al., 2005; Vaughan, 2002).

When instruction matches student needs, significant learning occurs (Wiles et al., 2006). Neal and Schanzenbach (2010) examine some of the impact the Chicago Public Schools high stakes testing had on the learning. Subsequently, there was a shift in pedagogy addressing certain student needs in both math and reading. Subsequently, there was an increase “in the middle of the achievement distribution but not among the least academically advantaged students;” they suggest “that changes in proficiency requirements induce teachers to shift more attention to students who are near the current proficiency standard” (p. 263).
Piaget’s cognitive development theory suggests that all underlying approaches must consider that when instruction matches the student’s needs, significant learning often occurs (Atherton, 2013). Not only should the learning be individualized, but the teacher must frequently check for understanding, allowing him/her to identify both academic progress and/or gaps (Marzano, 2003; Posner & Rudnitsky, 2006). Success in learning could suggest empowerment, if done appropriately. As the student learning is scaffolded, the student may develop a sense of empowerment through self-efficacy (Wehmeyer et al., 2012); however, teachers need the appropriate time and context to accomplish both the appropriate education and self-efficacy (Gamble et al., 2012).

**Time on Task**

Students who are low performing often need more time than allotted for the learning and mastering of the content and skills (Cortes et al., 2015; Farbman, Christie, Davis, Griffith, & Zinth, 2011; Patall, Cooper, & Allen, 2010); however, researchers have suggested that how and when that time is allotted could have negative and positive effects. Traditionally, the time most utilized has been either summer school or retention. In fact, retained students scored 0.19 to 0.31 standard deviations below comparable students who had not been retained. Moreover, a variety of studies have found that retention is associated with an increased likelihood of dropping out (E.M. Shulz et al., 1986; Russell W. Rumberger, 1987; James B. Grissom and Lorrie A. Shepard, 1989; Michelle Fine, 1991; Melissa Roderick, 1994). Several more recent studies have found moderate, positive effects of retention (Nancy L. Karweit 1991; Louisa H. Pierson and James P. Connell 1992; Karl L. Alexander, Doris R. Entwisle, and Susan L. Dauber 1995; A. Gary Dworkin, Jon Lorence,

Jacob and Lefgren (2009) argued that the retention of children and its future impact seems to be relative. Xia and Kirby (2009) considered the impact of New York’s test retention policy on fifth graders longitudinally from 2006-2009. Their review of 91 studies suggests that the negatives outweigh the positives. Winters and Greene (2012) considered the impact of Florida’s test retention policy of third graders during their following five years. The third graders were required to go to summer school and receive a high-quality teacher for the next year. “Exposure to these interventions has a statistically significant and substantial positive effect on student achievement in math, reading, and science;” however, “the effect of the treatment dissipates over time” (p. 305). Previously, Jacob and Lefgren (2004) found “no consistent differences in the performance of retained versus promoted students in the short-run” (Jacob & Lefgren, 2009, p. 2). Rather than exploring only the short-term academic focus, they considered “the direct academic consequences of summer school and grade retention for those students who fail to meet the promotional standards” (Jacob & Lefgren, 2009, p. 2). They argued that if the first retention is in the sixth grade, then the dropout rate seems minimal to none; conversely, there seems to be a negative correlation of retention in elementary school with eighth graders’ self-efficacy. In fact, “retaining low-achieving eighth grade students in elementary school substantially increases the probability that these students will drop out of high school” (p. 4).

As previously noted, research suggests that the differentiation of the content, process, and assessment to accommodate high student interest and how a student learns is something that a teacher can control—teacher efficacy; however, sometimes students need more time. Both
students and teachers need more time to facilitate the bridging of the academic gaps (Goddard et al., 2004); however, the intervention must be individualized for effectiveness (Guskey & Passaro, 1998; Ross, 1994). Subsequently, student assessments can be impacted if given enough time and if each student is scaffolded through the best practices (Phelan et al., 2011).

Powell et al. (2013) suggested interventions for students with math difficulties (MD); this includes students who have been officially identified with a disability and those who manifest math difficulties. Teacher recommendation is operative for identifying students with MD. The difficulties experienced by students with MD are primarily with foundational concepts. In addition, many students struggle with one-to-one correspondence, language comprehension, reading difficulties, and visual spatial limitations, even after they would be expected to perform beyond these concepts to meet grade-level standards (Powell et al., 2013, p. 38).

When a student is at risk of failing, schools are to implement interventions (Jenkins, Schiller, Blackorby, Thayer, & Tilly, 2013; Silva, 2007). Relative responses to interventions (RTI) could substantially impact a student’s summative learning outcome when aligned with the curriculum-based standards as measured by the CRCT (Silva, 2007; Siwatu, et al., 2009; Siwatu & Starker, 2014; Tucker et al., 2005; Vaughan, 2002). Although research has shown that there are numerous methodologies which may be used to catch students up, retention is still a consideration by some (Brown, 2007; Brown et al., 2011; Smith & Bell, 2014).

Retention has mixed reviews in the literature (Orfield, Losen, Wald, & Swanson, 2004), as some have purported an opportunity to be proactive before retention is required. A student at risk of failing can be identified and RTI implemented (Burns & Gibbons, 2012). RTI suggests that a student at risk of failing needs interventions that could include both more time on task and individualized learning (Nomi & Allensworth, 2011). In fact, if identified early enough, students
at risk can be offered specific interventions to support them in the learning process. Some research has suggested that a remedial math class is an acceptable RTI that teachers can implement to meet the student’s need through “organization, affiliation, and product-focus lessons” (Adams, 2011, p. 75; Bottge et al., 2004; Flores & Kaylor, 2007).

Summer school offers an opportunity to remediate students who have failed to meet standards during the previous school year (Stone et al., 2005). Proponents of summer school believe that schools should remediate. If remediation is deemed a necessity, it then becomes a matter of how, when, and for how long (Foegen et al., 2007; Nomi & Allensworth, 2011; Redd et al., 2012). There is a need in the literature to answer the above questions. In addition, both more time on task and the practice of repetition making permanent are two presuppositions that need to be considered. The lack of research suggests a need for this study and subsequent studies to better determine an appropriate amount of time and the necessary best practices to address meeting the needs of compensatory education for children at risk of failing (Cortes et al. 2015; Foegen et al., 2007; Nomi & Allensworth, 2011).

While more time on task and practice making permanent are past approaches for addressing remediation, some suggests more differentiation within that remedial time frame (Kommer, 2006; Sax, 2006; Valero, 2012). Since a student did not learn from the initial learning process, then the student needs to be taught in a different way (Brown et al., 2011; Smith & Bell, 2014). Some have suggested differentiation for even gender peculiarity (Ai, 2002; Carr & Alexeev, 2011; Ganley et al., 2013; Lindberg, Hyde, Petersen, & Linn, 2010). Although gender distinctiveness is relevant to some studies, it seems to be a moot point to others (Din, Song, & Richardson, 2006; Forgasz & Rivera, 2012; Kane & Mertz, 2012; Lukas & Beresford, 2010).
The report of the National Mathematics Advisory Panel (2008) suggested that formative assessment can be both informative and directional; both informing a teacher’s pedagogy and directing the scaffolding process. Studies have shown that students need more individualized pedagogy; therefore, “teachers’ regular use of formative assessments improves their students’ learning, especially if teachers have additional guidance on using the assessment results to design and individualize instruction” (National Mathematics Advisory Panel, 2008, p. 47). In fact, “For struggling students, frequent (e.g., weekly or biweekly) use of these assessments appears optimal, so that instruction can be adapted based on student progress” (National Mathematics Advisory Panel, 2008, p. 47). Although the research is not conclusive on the “specific tools and strategies,” the panel suggestions include tutoring, computer assistance, and “a professional (teacher, mathematics specialist, trained paraprofessional)” (National Mathematics Advisory Panel, 2008, p. 47). Results of formative assessment “can lead to increased precision in how best to use instructional time” and can “assist teachers in identifying specific instructional needs” (National Mathematics Advisory Panel, 2008, p. 48).

Thus, the panel’s conclusion of efficient and effective means of helping “students with learning disabilities (LD) as well as low-achieving (LA) students” (National Mathematics Advisory Panel, 2008, p. 48) is quite suggestive for this research. The underlying strategy for both LD and LA is to receive, on a regular basis, some explicit systematic instruction that includes opportunities for students to ask and answer questions and think aloud about the decisions they make while solving problems (Schellings & Broekkamp, 2011). This type of instruction can be incorporated without compromising the mathematics instruction that every student receives (Rosenzweig et al., 2011). However, it does seem essential for building proficiency in both computing and translating word problems into appropriate mathematical
equations and solutions (Krawec et al., 2012). A specific proportion of this time should be
dedicated to ensuring that students possess the foundational skills and conceptual knowledge
necessary for understanding the mathematical concepts they are learning at their grade level

**Testing Format**

High stakes testing in the state of Georgia utilizing the annual CRCT has had students
respond in multiple choice format. However, the proposed new testing suggests that the
assessment will include constructed-response format. Conversely, as early as Linn et al. (1991),
disparity and test inequalities between the two testing formats of multiple choice answers (MCA)
and the open end questions, the precursor to the constructed response (CR), have been argued
(Katz, Bennett, & Berger, 2000).

Research is mixed on the relevance of test reliability being impacted by the two distinct
testing formats. Since 1958, Powell (2012) has considered the impact of incorrect answers with
multiple choice tests and has identified three concerns—selective reasoning, Piaget’s reasoning
stages, and change in answers after repeated opportunity—all of which are consistent with
development theory in reasoning. Powell’s research, along with that of others, suggests that the
understanding of the question is more operative than the correct answer. For example, rote
memory facilitating a correct answer lacks consistency in validating acquisition of knowledge.
Thus, testing may not communicate to the teacher effectiveness or depth of knowledge (Iorio &
Adler, 2013). Instead, Powell suggested using a selection-pattern-analysis to evaluate the
student’s understanding.

Haladyna (1999) suggested that test reliability can be threatened through constructed
response; however, the multiple choice format offers more consistency in establishing reliability. Bridgeman (2005) and Lukhele, Thissen, and Wainer (1994) argued that there is no relative difference. On the other hand, there are those who have argued, based on their research, that format does have relevance. Both the high school research of Bennett, Rock, and Wang (1991) and Garner and Engelhard (1999) suggested that format has relevance. In fact, their research found that, for whatever reason, high school students correctly answered a greater amount of multiple choice questions than constructed responses.

Both multiple choice answers and constructed responses have distinct advantages and disadvantages. While the state of Georgia suggests that a depth of knowledge must be demonstrated through the CR, some would argue that the MCA demonstrates depth of knowledge by being able to recognize the best answer. In fact, as far as recognizing the best answer, the MCA outweighed the CR relative to the complexity of the answer. Caygill and Eley (2001) established that a student’s proficiency to recognize the correct answer outweighed the ability to construct an answer at the same level. Also, Ku (2009) suggested that the two types of testing formats are administratively quite suggestive. While Bennett et al.’s (1991) research argued for the reliability of the MCA, Lukhele et al.’s (1994) research argued for both the efficiency and effectiveness of the MCA.

Although some research has suggested that the multiple choice format is much more efficient, there are others who have challenged its veracity in all situations relative to depth of knowledge. Some have argued that the MCA format benefits readers with limited proficiency, minorities, females, and those with low socioeconomic status (Bloom’s Taxonomy, 1956; Garner & Engelhard, 1999; Griffin & Nix, 1991; Hambleton & Murphy, 1992) in demonstrating what they can recognize.
Although the research is divided on the relevance of multiple choice format versus constructed response, the fact remains that Georgia state assessments will contain both. Subsequently, educators must respond. Tankersley (2007) suggested that because the rules for testing are changing, teachers must prepare students by utilizing teaching strategies for constructive answers; “educators must know and understand the ‘rules’ by which the score is kept” (Tankersley, 2007, p. 3). Learning must include ways “that allow students to build the skills, learn self-assessment, and provide a supportive and meaningful environment” (Tankersley, 2007, p. 3). In particular, testing accommodations for students with special needs will be impacted as students move from recognizing the depth of knowledge answer to constructing the same depth of knowledge answer.

Students with disabilities are frequently granted accommodations for high-stakes standardized tests to provide them an opportunity to demonstrate their academic knowledge without interference from their disability. One type of possible accommodation, test response format, concerns whether students respond in multiple-choice or constructed-response format. (Powell, 2012, p. 3)

An experimental study was conducted to assess the performance differences of third grade students, identified as having mathematical difficulties, on a test of mathematics problem solving as a function of response format. It was found that “students responding in the multiple choice format had a significant advantage over students answering in the constructed response format” (Powell, 2012, p. 3). While some students may have been impacted more than others by the change in the testing format, this study sought to study the impact of the math-related testing format on low performers. As such, the literature suggests that the multiple choice format has implications for low achievers, particularly students who qualify for a testing accommodation.
As suggested by Fuchs and Fuchs (2001), an accommodation if appropriate, provides students with disabilities with a differential boost over students without disabilities. With a differential boost, students with disabilities benefit substantially more from the accommodation than students without disabilities. Determining whether this accommodation of multiple-choice format provides a differential boost for students with disabilities requires additional research, in which the performance of students with and without disabilities is directly compared on a constructed-response and multiple-choice version of the same mathematics test. (Powell, 2012, p. 8)

Educators have no choice in the matter of test format on the state level. Therefore, whether the state of Georgia uses the multiple choice answer or constructed-response format, a student must have a core of knowledge to answer correctly. In addition, it is essential that students become familiar with the new testing format. What is most disconcerting is that a student with cognitive disabilities such as long-term retrieval and executive functioning may be at a distinct disadvantage. Strategies that consider both the retention of knowledge (Roediger, Agarwal, Kang, & Marsh, 2010) and the recognition of that same knowledge (Johnson, Hedner, & Olsson, 2012) are both indicative of the educators’ mandate to give each child a FAPE. Not only does the new testing format suggest new challenges for students who might be disadvantaged, but the results have implications for educators in particular. With the new Teacher Keys Effective System (TKES), the stakes for educators are being raised in the realm of accountability, especially if there is not relative growth in testing scores. However, new strategies will be implemented as educators seek to give each student a FAPE (Chan, 2010; Tankersley, 2007).
Summary

Compensatory education is possible. As schools have attempted to address interventions for students at risk and find better ways to include students with special needs in the general classroom, efficiency and effectiveness have become paramount (Cosier et al., 2013). As every child can learn, educators must discover each student’s epistemology and scaffold the learning through formative assessment, bridging each gap along the journey toward proficiency in the assigned task. Appropriate differentiated interventions can make a difference (Gersten et al., 2009; Nomi & Allensworth, 2011). In the shadow of a plethora of interventions available, this research considered the following question: Was attendance in a nine-week MC class an effective means for improving math scores of those who were identified as low-achieving eighth grade students at a Georgia middle school?

This quasi-experiment did not allow for randomization; rather, the students were assigned based upon the academic need. Sometimes randomization precludes the neediest from receiving the much needed treatment. Ethically, when an individual or group is most needy, it is acceptable to systematically select those who are most needy; perhaps this is a more equitable and intentional systemic process that is quite suggestive and predictable—removing any uncertainty of the criteria used for determining the ones receiving the treatment (Berk & Rauma, 1983; Rossi, Lipsey, & Freeman, 2004; Trochim, 1984).

There were two key assumptions regarding this research. First, if students should show significant improvement from the AIMSweb pretest to the posttest, the pretest, treatment, and posttest should be most informative and quite suggestive. Second, since the eighth grade curriculum is aligned to the state of Georgia’s summative assessment, the CRCT, these results will help to realign and redirect the instruction for future curriculum and instruction. If effective,
it may prove to be an efficient approach in addressing the low achievers; concomitantly, it may be directional for each student’s eligibility for promotion to the ninth grade.
CHAPTER THREE: METHODS

Research Design

This quantitative study used a quasi-experiment nonequivalent control group design; a pretest and posttest were used with the AIMSweb tests. The AIMSweb tests served as both the pretest and posttest. Groups were preassigned based on a cutoff score or a math teacher’s recommendation. The AIMSweb data were used to consider growth, if any, that the math connection class might have contributed.

Presently, the trend towards the quasi-experimental design seems to be increasing due to necessities created by preassigned groups (Aiken, West, Schwalm, Carroll, & Hsuing 1998; Berk, Barnes, Ahlman, & Kurt, 2010; Shadish, Galindo, Wong, Steiner, & Cook, 2011). In fact, Imbens and Lemieux (2008) have identified that since the late 1990s, the field of economics has experienced an increase in quasi-experimental designs” (Angrist & Lavy, 1999; Black, 1999; Card et al., 2006; Chay & Greenstone, 2005; Chay et al., 2005; DiNardo & Lee, 2004; Lee, 2007; Van Der Klaauw, 2002)” (p. 618). The independent variable was the extra nine-week math class—those who participated and those who did not. The dependent variable was the AIMSweb posttest score for each student. The covariate was the AIMSweb pretest scores for each student.

Research Question

The research question for this study was:

RQ1: While using the AIMSweb pretest scores as a control variable for previous math achievement, will at-risk eighth grade students who attend an intensive nine-week compensatory math class have statistically significant different mean scores as measured by the AIMSweb posttest when compared to students who do not receive the compensatory math instruction?
Null Hypothesis

The null hypothesis for this study was:

\[ H_0: \text{While using the AIMSweb pretest scores as a control variable, at-risk eighth grade students who attend an intensive nine-week math connection class will not have statistically significant different mean scores as measured by the AIMSweb posttest when compared to students who do not receive the compensatory math instruction.} \]

Participants and Setting

The participants for this study consisted of a convenience sample of 189 eighth graders. Although this Georgia suburban, Title I middle school houses sixth, seventh, and eighth graders, only the eighth graders were selected for participation. The limited focus had both economic and equitable concerns; an eighth grader had to pass the math CRCT as a requirement to be promoted to the high school. To be able to access higher mathematics courses, it was imperative that the eighth grader be well prepared academically for the challenges of high school freshmen courses.

This study was limited to just one school. Again, this was a Georgia suburban middle school in suburban Atlanta with 688 total students. The student population was ethnically diverse (Black = 53%, White = 26%, Multi-Racial = 9%, Asian = 7%, Other = 5%). The percentage of students eligible for free lunch was 32% and those eligible for reduced lunch was 10%. The number of participants sampled was 189, which exceeded the required minimum for a medium effect size (Cook & Campbell, 1979; Olejnik & Algina 2000; Shadish, Cook, & Campbell, 2002). According to Gall, Gall, and Borg (2007), 96 students is the required minimum for a medium effect size with “statistical power of .7 at the .05 alpha level” (p. 145).

The treatment group was based upon one of two criteria: to be in the treatment group, (a) a student had to have a score of 820 or below on the previous year’s seventh grade CRCT state’s
annual math assessment, or (b) a student had to be referred to the group by the student’s eighth grade math teacher because the student was at risk of failing. The control group was all other students who took the seventh grade math state standardized CRCT tests and were assigned to a non-math connection class.

The current study administered the AIMSweb test to 189 respondents who were included in this study. The participants were almost equally split female (51.9%) and male (48.1%). Only 13.2% of participants were classified as gifted overall, with the treatment group having 10.4% gifted and the control group having 14.8% gifted. The majority of respondents were African American (55%), followed by Whites (30.2%), and Asians (6.9%). Table 3-1 contains the frequencies for gender, gifted, and ethnicity by control and treatment groups.

Table 3.1

*Frequencies: Demographics*

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th></th>
<th>Treatment</th>
<th></th>
<th>Total (189)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>62</td>
<td>50.8%</td>
<td>36</td>
<td>53.7%</td>
<td>98</td>
<td>51.9%</td>
</tr>
<tr>
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<td>49.2%</td>
<td>31</td>
<td>46.3%</td>
<td>91</td>
<td>48.1%</td>
</tr>
<tr>
<td>Gifted</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>104</td>
<td>85.2%</td>
<td>60</td>
<td>89.6%</td>
<td>164</td>
<td>86.8%</td>
</tr>
<tr>
<td>Yes</td>
<td>18</td>
<td>14.8%</td>
<td>7</td>
<td>10.4%</td>
<td>25</td>
<td>13.2%</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>10</td>
<td>8.2%</td>
<td>3</td>
<td>4.5%</td>
<td>13</td>
<td>6.9%</td>
</tr>
<tr>
<td>African American</td>
<td>62</td>
<td>50.8%</td>
<td>42</td>
<td>62.7%</td>
<td>104</td>
<td>55.0%</td>
</tr>
<tr>
<td>Hispanic</td>
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<td>2.5%</td>
<td>2</td>
<td>3.0%</td>
<td>5</td>
<td>2.6%</td>
</tr>
<tr>
<td>Indian</td>
<td>1</td>
<td>0.8%</td>
<td>0</td>
<td>0.0%</td>
<td>1</td>
<td>0.5%</td>
</tr>
<tr>
<td>White</td>
<td>41</td>
<td>33.6%</td>
<td>16</td>
<td>23.9%</td>
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<td>30.2%</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>4.1%</td>
<td>4</td>
<td>6.0%</td>
<td>9</td>
<td>4.8%</td>
</tr>
</tbody>
</table>

All eighth graders were given the opportunity to participate; however, logistically they were required to be available and willing to participate on the days of both the pre and posttest.
Also, these middle school MC classes were preassigned, but students could request a change in schedule. Students were placed into the additional MC class based upon two factors. One factor for consideration was the score from the 2010 mathematics section of the CRCT. Those students scoring at or below 820 (the 25th percentile) were candidates for the MC class. A secondary factor for the class was teacher recommendation. Teacher recommendations came from the current 2010-2011 school year mathematics general education classroom instructors who were familiar with the students’ abilities and whether the students were at risk of failing the CRCT for the current testing year. The assistant principal then placed those students who qualified for the additional class into the program; therefore, the groups were nonrandomized.

**Instrumentation**

The AIMSweb (nonmultiple choice format) tests measure math performance. The AIMSweb has been used by many researchers (Graney, Missall, Martinez, & Bergstrom, 2009; Lembke, Hampton, & Beyers, 2012; Riccomini & Witzel, 2009; Shapiro & Gebhardt, 2012). Both tests were administered by trained certified teachers in accordance with secured testing procedures and regulations utilizing paper and pencil on separate designated days. Confidentiality was maintained by assigning each student a number.

**AIMSweb**

The AIMSweb (AIMSweb, 2009) is a norm-referenced assessment that adheres to the National Council of Teachers of Mathematics Principles and Standards (NCTM, 2006) and the Stanford Achievement Test, Tenth Edition (Stanford 10). It is a web based solution that provides real-time information to teachers and schools for students in grades 2-8.

The purpose of the AIMSweb was to monitor and report student progress in math and identify at risk students early (AIMSweb, 2009). The school utilizes both the AIMSweb and the
CRCT, a criterion based assessment tool, to measure curriculum specific information established by the Georgia Department of Education (GaDOE). So, one test provides feedback on GaDOE specific standards, and the AIMSweb provides feedback on performance related to national norms.

The AIMSweb was administered. There were a total of 30 questions both in the pretest and posttest. The 10 minute time frame tested both computation and processing speed associated with the students’ grade level. Computation skills were assessed. For example, mathematic computation included column addition, basic facts, decimals, reducing, and exponents. Scoring was based upon recording the number correct. Both pretest and posttest scores were recorded, compared, and analyzed through web based software.

Experienced item writers with expertise in mathematics curriculum created approximately 11,200 items in accordance with grade-level and domain-specific criteria. Three pilot studies were conducted to evaluate the items and finalize probe design prior to the field test. A national field test was conducted at each grade. Forty-four clones of the anchor probe were constructed, consisting of items parallel to the anchor-probe items. Each clone had the same sequence of item types as the anchor probe. All probes were administered to a national field test sample of 6,550 students in the spring of 2009.

To assess the construct validity of the AIMSweb math test, AIMSweb scores were correlated with the North Carolina End of Grade math test and the Illinois Standards Achievements test. The correlation coefficient of the AIMSweb math scores for all covered grades (2-8) ranged from .60 to low .70. Based on Cohen’s effect size standards, correlation coefficients of .5 or above are considered strong (Cohen, 1988). Additionally, Chronbach’s
alpha reliability scores ranged from .80 to .88, indicating acceptable reliability (Field, 2012; Pallant, 2013).

**Procedures**

All approvals were granted, school and then IRB, for the study (See Appendixes A for school approval and B for IRB approval). Initially, the MC class was for students who scored an 820 or below on the previous year’s CRCT in math; however, some teachers were concerned that there were other students who were at risk of failing the 2011 CRCT. Because there was a lack of content correlation between the seventh and eighth grade CRCT, the administrator followed the teacher’s recommendation by extending the class to those recommended by the student’s 2010-2011 math teacher, even if they had scored above 820 on the previous year’s math CRCT.

The county in which the middle school is located uses the AIMSweb program to track the progress of its students in the areas of reading, writing, and mathematics. The middle school eighth grade math teachers use the *Georgia GPS Edition COACH Standards-Based Instruction Math Grade 8* book (2008), along with the scope and sequence chart provided by the county, as a guide for classroom instruction. The *COACH* (2008) book contains a pretest and a posttest as well as mini-lessons and practice questions to aid classroom instructors in preparing students for the CRCT given in the spring of each school year. The eighth graders were given the AIMSweb pretest during the first week of the 2010-2011 school year; the posttest was administered in the spring before the CRCT, but after the completion of the MC. These pretest scores, in turn, were used to provide this researcher with a baseline for the study.

Since the middle school utilizes both the AIMSweb and the *COACH* (2008) curriculum, teachers had been trained in both the teaching and assessment aspects. Trained teachers
administered, scored, and recorded both the AIMSweb pretest and posttest; scores were confidentially maintained on a private computer. Once the post test scores were matched to the pretest, the computer software generated a student ID number for each student, demographic data, and then all names were deleted. This was the same procedure for the CRCT test scores. Also, the students who were recommended by their present year teachers to participate in the MC class were identified. Three teachers checked all the data for accuracy.

Sixty-seven students who were assigned to the treatment group, those receiving the nine-week Math Connection (MC) class, were given additional math instruction for 55 minutes a day for 45 consecutive school days. Connection classes are any classes that are non-academic which serve as electives. Six special connection classes were created for the students in the treatment group. These 67 students were divided into six separate classes utilizing certified math teachers and implementation of the COACH (2008) curriculum, an overview of the standards tested by the CRCT. The students were assigned based upon perceived need. The coursework in the treatment connection class was guided by a COACH (2008) workbook. The students and instructor worked through each page of the COACH (2008) workbook for 45 consecutive days, at which time they completed the entire workbook. The COACH (2008) workbook was modeled after the CRCT.

Data Analysis

To answer the research question, an ANCOVA was used. The analysis of covariance (ANCOVA) examines differences between two or more groups on a continuous variable, while controlling for the effects of one or more variables (Ary et al., 2010; Tabachnick & Fidell, 2012). In this analysis, AIMSweb pretest scores were the covariate, AIMSweb posttest scores were the dependent variable as distinguished in the two groups of eighth graders (general vs. at-risk).
Before an analysis of covariance (ANCOVA) was conducted, several preliminary tests were completed to determine if the assumptions needed to perform an ANCOVA were met. These assumptions include normality, homogeneity of variance, linearity, and homogeneity of regression slopes (Edmonds & Kennedy, 2013; Field, 2012; Tabachnick & Fidell, 2012). Normality was tested using the Kolmogorov-Smirnov test, where a $p$ value of less than .05 indicates non-normality. Levene’s test of homogeneity of variance was used to assess homogeneity of variance, where a $p$ value of less than .05 indicates a violation in the assumption of homogeneity of variance. The assumption of linearity was checked by generating a scatterplot between pretest and posttest scores for control and treatment groups. If the distribution of scores for both groups is linear, then the assumption of linearity holds. If the distribution of scores is curvilinear for at least one of the two groups, then the assumption of linearity is violated. Finally, the assumption of homogeneity of regression slopes was assessed to evaluate if there was an interaction between the covariate and the dependent variable. If the interaction term in the ANCOVA is significant, meaning a $p$ value of less than .05, then there is a violation in the assumption of regression slopes.

By using an analysis of covariance (ANCOVA), the two groups’ differences in student math performance on the AIMSweb pre and posttests were controlled for and better understood. The ANCOVA allowed for the distinction, if any, of the impact of the MC class (treatment group) in relation to the group that did not receive the MC class (control group) (Ary, Jacobs, Razavieh, & Sorensen, 2010).
CHAPTER FOUR: FINDINGS

Research Question

The research question for this study was as follows:

**RQ1:** While using the AIMSweb pretest scores as a control variable for previous math achievement, will at-risk eighth grade students who attend an intensive nine-week math connection class have statistically significant different mean scores as measured by the AIMSweb posttest when compared to students who do not receive the compensatory math instruction?

**Null Hypothesis**

The null hypothesis for this study was:

**H01:** While using the AIMSweb pretest scores as a control variable, at-risk eighth grade students who attend an intensive nine-week math connection class will not have statistically significant different mean scores as measured by the AIMSweb posttest when compared to students who do not receive the compensatory math instruction.

**Descriptive Statistics**

There were a total of 189 respondents who took part in this study. The descriptive statistics include the variables measured by the AIMSweb pretest scores and the AIMSweb posttest scores. These descriptors include the range, mean, median, and standard deviation. The descriptive statistics for the AIMSweb pretest and post scores are located in Table 4.1.
Table 4.1

*Descriptive Statistics for AIMS Web Pretest, Posttest Test Scores*

<table>
<thead>
<tr>
<th>Test</th>
<th>Range</th>
<th>M</th>
<th>Median</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIMS Web Pretest</td>
<td>3-25</td>
<td>10.54</td>
<td>10.00</td>
<td>3.50</td>
</tr>
<tr>
<td>AIMS Web Posttest</td>
<td>4-28</td>
<td>11.98</td>
<td>11.00</td>
<td>4.55</td>
</tr>
<tr>
<td><strong>Treatment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIMS Web Pretest</td>
<td>2-14</td>
<td>7.48</td>
<td>7.00</td>
<td>2.81</td>
</tr>
<tr>
<td>AIMS Web Posttest</td>
<td>4-19</td>
<td>9.12</td>
<td>8.00</td>
<td>3.52</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIMS Web Pretest</td>
<td>2-25</td>
<td>9.46</td>
<td>9</td>
<td>3.58</td>
</tr>
<tr>
<td>AIMS Web Posttest</td>
<td>4-28</td>
<td>10.96</td>
<td>10</td>
<td>4.42</td>
</tr>
</tbody>
</table>

**Results**

**Data Screening**

Data screening was conducted on each group’s AIMSweb pretest and posttest scores regarding data inconsistencies and extreme outliers. Frequency distributions were generated for each of the two variables across all respondents and scanned for inconsistencies. No data errors or inconsistencies were identified. Additionally, the box and whisker plots revealed no extreme outliers. Outliers were observed, however, but the ANCOVA is a robust test, meaning mild violations in skewness, normality, and equal variances will still yield p values within ± .02 of the true p value (Boneau, 1960; Posten, 1984; Schmider et. al., 2010). See Figure 4.1 for the box and whisker plots for the AIMSweb pretest and posttest scores by group.
Figure 4.1: Box and whisker plots of AIMSweb pretest and posttest scores by control and treatment groups reveals no extreme outliers.

Assumptions

An Analysis of Covariance (ANCOVA) was used to test for significant differences in AIMSweb posttest scores between control and treatment groups when controlling for AIMSweb pretest scores. The ANCOVA required the assumptions of normality, linearity, bivariate normal distribution, the assumption of equal variances, and the assumption of homogeneity of regression slopes. Results of the Kolmogorov-Smirnov test indicated that there was a violation in normality for both the AIMSweb pretest, KS(189) = .108, p < .001 and the AIMSweb posttest, KS(189) = .126, p < .001. See Table 4.2. Results of Levene’s test of homogeneity of variance indicated that there was no violation in homogeneity of variance for the AIMSweb pretest, F(1, 187) =
3.023, \( p = .084 \) or the AIMSweb posttest, \( F(1, 187) = 3.032, p = .083 \). See Table 4.3. To assess linearity and bivariate normal distribution, a series of scatterplots were generated between the AIMSweb pretest and posttest variables for each group. The results revealed that the majority of the plots for the control group formed the desired cigar shape for the AIMSweb pretest, but for the treatment group, there was slight heteroscedasticity as the pretest and posttest values increased. See Figures 4.2 and 4.3. The assumption of homogeneity of regression slopes was assessed to evaluate if there was an interaction between the covariate and the dependent variable. If the interaction term in the ANCOVA is significant, meaning a \( p \) value of less than .05, then there is a violation in the assumption of regression slopes. Results indicated that the pretest AIMSweb group interaction term was not significant, \( F(1, 185) = .013, p = .911 \). Therefore, there was no violation in the assumption of homogeneity of regression slopes. See Table 4.4. Given the results of the tests of assumptions, it was deemed appropriate to perform the ANCOVA as there was no violation in the assumption of regression slopes, and the ANCOVA is robust to violations of normality, skewness and equal variances (Boneau, 1960; Posten, 1984; Schmider et. al., 2010).

Table 4.2

<table>
<thead>
<tr>
<th></th>
<th>Statistic</th>
<th>Df</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>AW PRE</td>
<td>.108</td>
<td>189</td>
<td>.000</td>
</tr>
<tr>
<td>AW POST</td>
<td>.126</td>
<td>189</td>
<td>.000</td>
</tr>
</tbody>
</table>
Table 4.3

*Levene’s Test of Homogeneity of Variance*

<table>
<thead>
<tr>
<th></th>
<th>Levene Statistic</th>
<th>df1</th>
<th>df2</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>AW PRE Based on Mean</td>
<td>3.023</td>
<td>1</td>
<td>187</td>
<td>.084</td>
</tr>
<tr>
<td>AW POST Based on Mean</td>
<td>3.032</td>
<td>1</td>
<td>187</td>
<td>.083</td>
</tr>
</tbody>
</table>

*Figure 4.2:* Scatterplots of AIMSweb pretest and posttest scores from the control group has the desired cigar shape.
Figure 4.3: Scatterplots of the AIMSweb pretest and posttest scores for the treatment group display slight heteroscedasticity at the higher pretest and posttest score levels.

Table 4.4

ANOVA Table: Test of Homogeneity of Slopes

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>1554.452²</td>
<td>3</td>
<td>518.151</td>
<td>45.210</td>
<td>.000</td>
</tr>
<tr>
<td>Intercept</td>
<td>243.125</td>
<td>1</td>
<td>243.125</td>
<td>21.213</td>
<td>.000</td>
</tr>
<tr>
<td>Treatment</td>
<td>2.002</td>
<td>1</td>
<td>2.002</td>
<td>.175</td>
<td>.676</td>
</tr>
<tr>
<td>AWPRE</td>
<td>936.964</td>
<td>1</td>
<td>936.964</td>
<td>81.752</td>
<td>.000</td>
</tr>
<tr>
<td>Treatment * AWPRE</td>
<td>.145</td>
<td>1</td>
<td>.145</td>
<td>.013</td>
<td>.911</td>
</tr>
<tr>
<td>Error</td>
<td>2120.289</td>
<td>185</td>
<td>11.461</td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>26390.000</td>
<td>189</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>3674.741</td>
<td>188</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Null Hypothesis One**

**H01:** While using the AIMSweb pretest scores as a control variable, at-risk eighth grade students who attend an intensive nine-week math connection class will not have statistically significant different mean scores as measured by the AIMSweb posttest when compared to students who do not receive the compensatory math instruction.

A one-way analysis of covariance (ANCOVA) was conducted to determine if there was a statistically significant difference in mean scores on the AIMSweb post math tests between the treatment and control groups. The independent variable was the extra nine-week math class — those who participated and those who did not. The dependent variable was the AIMSweb posttest score for each student. The covariate was the AIMSweb pretest score for each student. Necessary assumptions were considered and analyzed. The results indicated that there was no significant difference in adjusted mean scores between the control group ($M_{adj} = 11.13, SE = .32$) and the treatment group ($M_{adj} = 10.65 SE = .44$) when controlling for pretest scores, $F(1, 186) = .730, p = .394$. The eta squared effect size measure was $\eta = .004$, indicating .4% of the variability in posttest scores was accounted for by treatment group. Based on Cohen’s (1988) guidelines where .01 is a small effect, .06 a medium effect, and .14 a large effect, the effect was small. See Tables 4.5 and 4.6.

**Table 4.5**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>$M_{adj}$</th>
<th>SE</th>
<th>95% CI LL</th>
<th>95 CI UL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>122</td>
<td>11.13</td>
<td>.32</td>
<td>10.509</td>
<td>11.758</td>
</tr>
<tr>
<td>Treatment Group</td>
<td>67</td>
<td>10.65</td>
<td>.44</td>
<td>9.787</td>
<td>11.518</td>
</tr>
</tbody>
</table>
Table 4.6

ANCOVA Table: Assessing Difference in AIMSweb Posttest Scores

<table>
<thead>
<tr>
<th></th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
<th>Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>1554.307</td>
<td>2</td>
<td>777.153</td>
<td>68.170</td>
<td>.000</td>
<td>.423</td>
</tr>
<tr>
<td>Intercept</td>
<td>273.636</td>
<td>1</td>
<td>273.636</td>
<td>24.003</td>
<td>.000</td>
<td>.114</td>
</tr>
<tr>
<td>AWPRE</td>
<td>1201.537</td>
<td>1</td>
<td>1201.537</td>
<td>105.396</td>
<td>.000</td>
<td>.362</td>
</tr>
<tr>
<td>Treatment</td>
<td>8.318</td>
<td>1</td>
<td>8.318</td>
<td>.730</td>
<td>.394</td>
<td>.004</td>
</tr>
<tr>
<td>Error</td>
<td>2120.434</td>
<td>186</td>
<td>11.400</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>26390.000</td>
<td>189</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>3674.741</td>
<td>188</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER FIVE: DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Discussion

The purpose of this quantitative quasi-experimental study was to see if an intensive nine-week remedial math connection class (based upon the eighth grader’s seventh grade math CRCT scores) can significantly increase scores. The dependent variable is the AIMSweb posttest scores in math. The independent variable is where one group participates in the nine-week remedial math training and the other group will not. Given the low proficiency in math among eighth grade students, there is a need to intentionally offer equitable education to bridge the academic gaps for eighth grade students at risk of failing (Jitendra, 2013; Malmgren et al., 2005; Munk et al., 2010; Schrank & Wendling, 2009).

The research question asked if while using the AIMSweb pretest scores as a control variable for previous math achievement, will at-risk eighth grade students who attend an intensive nine-week MC class have statistically significant different mean scores as measured by the AIMSweb posttest when compared to students who do not receive the compensatory math instruction. The null hypothesis was that there was no statistically significant difference in posttest scores, when controlling for pretest scores, between those in the nine-week MC class and those who did not receive the nine-week MC class. An ANCOVA was conducted to answer the research question and test the null hypothesis. The results of the ANCOVA indicated that there was no statistically significant difference between eighth grade students who took the nine-week math connection class and those eighth grade students who did not. Therefore, the null hypothesis was not rejected.
Interpretation of Findings

The findings of the research question and the related null hypothesis showed that there was no significant difference in AIMSweb posttest scores between eighth graders who were in a remedial nine-week MC course and those who did not take the nine-week MC course. Although the results were not significant, they were positive in that eighth grade students who had been identified as needing math remediation had scored equally as well on the AIMSweb posttest as eighth graders who did not need remediation. Therefore, the nine-week MC class was effective at improving math performance of the remedial group from the pre-test to the post-test by one point.

Findings in Context of the Literature

Researchers have suggested that more time spent on remediation tasks such as summer school, retention, after school programs, and double math classes have impacted some learners (Jacob & Lefgren, 2004, 2009; Matsudaira, 2007). Furthermore, Methe et al. (2012) looked at the math skill remediation and analyzed the effect size through a meta-analyses of 47 effects in 11 studies (effect sizes ranged from 0.59 to 0.90). They found that the variables that appeared to moderate the effects were student age, time spent in intervention, and intervention type. No research has examined the effectiveness of an intensive nine-week remedial MC class to improve math scores on the Georgia CRCT eighth grade math test. Thus, the findings of this study extend the literature on time spent on remediation by concluding that the nine-week MC class, which provided additional time spent on math remediation, indeed had a positive effect by one point from the pretest to the posttest.
Findings in Context of the Theoretical Framework

The first theoretical framework used for this study was Piaget’s stage of cognitive development, specifically, the concrete operational theory. Piaget’s concrete operational theory suggests that cognitive development has matured in the learner to the point that the learner can both learn math rules and then apply those rules to physically perceived objects (Atherton, 2013). The findings of this study revealed that eighth grade students in the nine-week MC class improved their performance in math to be equal to that of their non-remediated peers. This aligns with Piaget’s concrete operational theory since the students were able to learn math rules and apply them to a physically perceived object in the form of test questions on a standardized math exam. Based on Piaget’s theory, the students in the nine-week MC class demonstrated the matured cognitive development necessary to learn.

A second theoretical framework used for this study was the constructivist theory. Constructivists suggest that the learners can take information and connect it in such a way that implementation is evident by what the learner is able to construct and communicate (Ertmer & Newby, 2013). Constructivists use the social interaction of the teacher with the student to create a learning environment that supports the student’s learning by implementing a social cognitive process that is both suggestive and directional—modifying and adapting the learning to meet the student’s most specific needs—which subsequently empowers the learner by creating and perpetuating a sense of self-efficacy (Bandura, 1997; Marzano, 2003; Posner & Rudnitsky, 2006). Thus, both direct instruction and time on task are expedient for learning the math rules and then moving those rules from short term memory to long term memory (Barbash, 2012; Ertmer & Newby, 2013). The nine-week MC class was an interactive learning environment between certified math teachers and students needing remedial math assistance. The guidance
from the math teachers was suggestive and directional in nature. The teachers did not give students the answers to the workbook problems, but rather encouraged students to think about the math problem in ways that were relevant for them. Based on the results of the study, the students in the MC class were able to connect with information that was taught and then communicate their knowledge in the desired manner via the AIMSweb posttest. The results, therefore, support the constructivists theory of learning.

Conclusions

Based upon the previous discussion and the existing body of literature, it seems that some students need more time on task to succeed in eighth grade math. Acceptance of failure cannot be a consideration. Educators must find both effective and efficient pedagogy to educate each student, FAPE.

Perhaps “we can overcome” failure through a collective efficacy that says “we can do it” (Blankstein, 2013; Hattie, 2009, 2011). Collective efficacy seems to be essential in addressing failure. The “concept of the ‘throw away’ students is itself discarded. Even the most abused and troubled children self-correct as they mature” (Blankstein, 2013, p. 113). Learning obstacles do exist: family opposition, language and culture distinctiveness, learning styles, more time on task needed to become proficient, learning disabilities and other health impairments, and socioeconomic status. “In high performing schools, these variables are addressed in a proactive manner so they do not become barriers to the successful achievement of all students” (Blankstein, 2010, p. 113).

Compensatory education is possible. As every child can learn, educators must discover each student’s epistemology and scaffold the learning through formative assessment, bridging each gap along the journey toward proficiency in the assigned task. Interventions can make a
difference (Gersten et al., 2009; Nomi & Allensworth, 2011). For example, those gaps are quite challenging when students have learning disabilities; however, acceptance of those disabilities and supporting them with an Individual Educational Plan (IEP) can be compensatory. Concomitantly, when each student’s barrier to learning is addressed, success is inevitable. Sometimes the “challenge is getting all staff members to believe” and to then “act on this information in a sustained, concerted, systemic manner” (Blankstein, 2010, p. 113).

An IEP identifies and implements how a student can learn, even those who lack motivation. The epistemology informs the team how to best support the learning of a student at risk of failing. Student success is based on the student’s epistemology and the learning being scaffolded in light of formative assessment and subsequent gaps being bridged until the student can learn and implement the strategies without the support. Success is growth as measured by the collected data assessing the individual goals.

Pedagogy must be informed by each student’s epistemology. Thus, nine weeks (55 minutes per day) may not be enough time on task for the remediation of some students at risk. Early formative assessment can assist in a FAPE for each student; remediation for the most “needy” is imperative to insure future access to the curriculum. If not, this inequitable access has future socioeconomic consequences both on the individual and global level (i.e., global competitiveness). Therefore, efficiency and effectiveness seem to be corollaries; however, the questions of how much time is needed, and what are the research-based strategies that can facilitate the individual learner must be assessed early to develop learner specific strategies.

While the schools move toward implementing a curriculum that is, or is similar to, the Common Core, future researchers must consider the implications of the shift in both content and assessment. Identification of inequities suggests the need for compensatory education that gives
access to a math curriculum (FAPE). In the wake of NCLB, educators still have the political pressure to become both effective and time-efficient.

As schools move toward the new state assessments and with a limited amount of research considering the impact of those attending a MC class as a measure upon student achievement (Adams, 2011), new research will be considered. In relation to standardized testing, researchers have suggested that content, processes, and assessments are quite directional for the remediation process (Iorio & Adler, 2013; Powell, 2012). Tests like the AIMSweb are more challenging than the CRCT as the answers are open ended for the AIMSweb, but multiple choice for the CRCT. This open ended format could have an impact of test outcomes for certain students. Perhaps many states moving toward the new testing format can find this research to be both informative and directional for student achievement as measured by the new testing format, the new state assessments. As FAPE is the goal, and budgets drive education, the question of effectiveness and efficiency must propel future research.

Education is a public trust. Those charged with the fiduciary oversight must be held accountable at all levels, especially using research-based praxis. Research-based praxis suggests learning is possible. Pedagogy must transcend past failures and bridge academic gaps through equitable education (Martinez & McGrath, 2014; Rickles, 2013). To ignore both the epistemology and research-based praxis is to fail the learner and public trust.

Academic gaps suggest failure with socioeconomic implications (Goodman, 2012). Sociologists Bourdieu and Passeron’s “theory of reproduction in education” has identified “achievement gaps” that are actually socioeconomic “opportunity gaps” (Huddleston, 2014, p. 5). Lareau (2003) has suggested that these socioeconomic inequities have contributed to academic gaps for the non-dominant groups. U.S. education has reproduced a middle class
model consistent with certain dominate socioeconomic values, resources, and skills that exist in
the local middle class families; teachers teach to the middle to perpetuate these educational
outcomes. Bourdieu and Passeron’s (1990) theory suggests that non-dominant students need
equitable opportunities to address the achievement (opportunity) gaps.

A child left behind infringes upon a nation's collective efficacy. Academic gaps in math
have socioeconomic implications (Domina, 2014). Just as reading facilitates the quality of one’s
life, so does math. Perhaps economic success, including jobs and global competition, is
contingent on one’s proficiency in math. Perhaps each gap bridged suggests better collaboration
as a nation, which, in turn, strengthens the nation’s global position.

Implications

Positive Social Change

Although the results were not significant, they were positive. The results demonstrated
that students who were identified early as needing math help were successfully remediated
within the same school year. One of the implications of the findings is that subject level
academic disparities in middle school may need not extend beyond a single school year. If
student weaknesses are identified in the beginning of the school year, the study shows that
effective remedial action in math among middle school students can be taken to erase the
performance deficit by the end of the same school year. If more academic institutions added
diagnostic formative assessments to their curriculum and supplied effective remedial assistance
to those who needed it, then, based on the research findings, this could significantly improve the
overall education of students in the United States.
Policy Makers, Administrators, and Teachers

The literature suggests that more time spent on math over and above what is allotted in the classroom can be effective (Hall et al., 2011; Stone et al., 2005). However, the breadth of effectiveness of after school math, summer school, retention for another year, and two math classes has been debated (Jacob & Lefgren, 2004, 2009; Matsudaira, 2007; Roderick & Nagaoka, 2005). The results of this particular nine-week MC program imply that math remediation should be further explored and considered over remediation approaches such as summer school, after school math, and school retention for another year. The MC program needs to be replicated in other schools, districts, and states to evaluate if the positive results are consistent across populations. However, in this study no significant difference was found and the true effectiveness of MC programs are still debatable.

Limitations

Sample Limitations

The sample for this study was selected from a single school in the Metro Atlanta Georgia area. This was a Georgia suburban middle school in suburban Atlanta with 688 total students. The student population was ethnically diverse (Black = 53%, White = 26%, Multi-Racial = 9%, Asian = 7%, Other = 5%). The percentage of students eligible for free lunch was 32% and those eligible for reduced lunch was 10%. The results of this study may not be generalizable to a) schools outside of Metro Atlanta, Georgia, b) schools that are not ethnically diverse, or c) schools that have a greater proportion of students eligible for the free lunch and reduced lunch programs. Additionally, this study was only conducted among middle school students. It is not known if the effects apply to lower or higher grades.
Statistical Power Limitations

The study was further limited by the sample size and the size of the effect. A power analysis assuming a .8 effect size, .05 probability level, two groups, and one covariate yields a sample size of 128. The effect size and probability levels are the desired standards for social scientific research (Field, 2012; Pallant, 2013). The current sample of 189 was ample in size based on the initial assumptions. However, the results indicated that the effect size was very small, such that the power was only .136, which is much lower than the desired level of .80. As a result, instead of there being an 80% chance of detecting a significant effect if one actually existed in the real world, the chance was only 13.6%.

Methodological Limitation

A cut-off sampling approach is a possible threat to validity. Cut-off samples are not representative of the overall population (Calonico, Cattaneo, & Titiunik, 2014; Cook, 2008). To lessen the effect of the cut-off sampling approach impacting statistical tests that rely on population estimates such as means or proportions, an ANCOVA was used. An ANCOVA controls for the nonequivalent groups; the ANCOVA examines differences between two or more groups on a continuous variable, while controlling for the effects of one or more variables (Ary et al., 2010; Tabachnick & Fidell, 2012).

Ethical Procedures

This study was conducted based upon permission granted and the ethical standards indicated by the Liberty University (See Appendixes A, School Approval and B, IRB Approval). Following the standards of the Liberty University (IRB) ensured the ethical protection of all research participants. Each participant’s confidentiality and anonymity was maintained. Data was archived by the school. The researcher collated the relevant data. Data was archived
without nomenclature; student data was identifiable through computer generated identification numbers. All student assessment data was stored according to the school’s policy. Research data was stored securely online under the username and password of the researcher. Both during the data analysis and after the final completion of the research, all was and will continue to be conducted under secure processes. However, the data will be kept by the researcher indefinitely.

**Recommendations for Future Research**

**Sample Recommendations**

Given the study’s limitation due to the sample, I would recommend that the study be replicated in the future with a larger sample size, as the effect was found to be very small. To accurately calculate the needed sample size, the effect size measures should be set to small instead of medium, maybe even very small, given the results of an eta square value of .004. Additionally, future studies should also include samples from other school districts within and outside of Georgia. The variation in sample also needs to include schools that are less diverse ethnically, as well more economically challenged, exceeding the 32%/10% free/reduced lunch ratio. High school students should also be examined as a sample population, along with younger elementary school aged children.

**Instrument Recommendation**

This study was limited to comparing students on the AIMSweb test, which is a standardized math test. Future research can be conducted in other subject matter areas with other standardized measurements, as a limitation of this study was that it may be only generalizable to those in the eighth grade math subject area; other skills could include English, reading, and writing ability. Future studies should be conducted in English, reading, and writing to determine
if early identification of low performance in English, reading, and writing can also be corrected within one school year.
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APPENDIX A SCHOOL APPROVAL

Liberty University
IRB
Lynchburg, VA

December 1, 2010

To Whom it May Concern:
[Name], learning specialist here at [School Name], has permission to conduct her study on the benefits of an additional math class to assist eighth graders in achieving higher test scores on the statewide mandated CRCT. I realize that the information she obtains through pre and post testing will be kept confidential and that no students’ privacy will be invaded.

Sincerely,

[Name]
Principal

[Handwritten signature]
APPENDIX B IRB APPROVAL

January 7, 2011

Barbara Franklin
IRB Approval 1027.010711: Academic Intervention: Acceleration and Remediation

Dear Barbara,

We are pleased to inform you that your above study has been approved by the Liberty IRB. This approval is extended to you for one year. If data collection proceeds past one year, or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. The forms for these cases were attached to your approval email.

Please retain this letter for your records. Also, if you are conducting research as part of the requirements for a master’s thesis or doctoral dissertation, this approval letter should be included as an appendix to your completed thesis or dissertation.

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

Fernando Garzon, Psy.D.
Professor, IRB Chair
Counseling
(434) 592-4054

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