COMPARING EFFECTS OF TWO GROUPING CONDITIONS TO TEACH ALGEBRAIC PROBLEM-SOLVING TO STUDENTS WITH MILD DISABILITIES IN INCLUSIVE SETTINGS

by

Amber Allmon Harris

A dissertation submitted to the faculty of
The University of North Carolina at Charlotte
in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in
Special Education

Charlotte

2009

Approved by:

____
Dr. David Pugalee

____
Dr. John Beattie

____
Dr. Claudia Flowers

____
Dr. Linda Swayne

ABSTRACT

AMBER ALLMON HARRIS. Comparing effects of two grouping conditions to teach algebraic problem-solving to students with mild disabilities in inclusive settings. (Under the direction of DR. DAVID PUGALEE)

This study compared two grouping conditions (Direct Instruction *vs.* an instructional package containing Direct Instruction, Peer Assisted Learning Strategies, and self-monitoring) on 6th and 7th grade special education students' abilities to solve algebraic equations in inclusive settings. Results show that there were no differences between experimental and comparison groups based on students' abilities to independently solve one-step equations. In addition to these findings, it was also suggested that students in both 6th and 7th grade levels had similar growth on posttests after ten days of instruction (with 7th graders scoring one point higher). Results indicated that students in experimental groups had higher retention rates than students in comparison groups for up to two weeks after instruction had ended. Finally, results suggested that there were no statistically significant differences in groups' abilities to generalize strategies to more complex problem solving; students in both treatment conditions scored approximately eight points higher on posttest measures for solving two-step algebraic equations.

ACKNOWLEDGMENTS

I would like to acknowledge and extend my heartfelt gratitude to the members of my committee, David Pugalee, John Beattie, Claudia Flowers, and Linda Swayne, for their support and encouragement which has made the completion of this study possible. I would like extend a special thank you to Diane Browder for inspiring me to become the person that I am today. I would also like to thank my favorite dinner partners, Susan Gibbs and Irene Meier for keeping me amused throughout the process. Most importantly, I would like to thank my parents, Dan and Rhonda Allmon, for teaching me the value of education and my husband, Rodney Harris, for teaching me to love life and all of the ups and downs that come along with it.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADD	attention deficit disorder
ANCOVA	analysis of covariance
ANOVA	analysis of variance
CBM	curriculum-based measurements
CP	contextualized word problems
CRA	concrete-to-representational-to-abstract
CSMC	Center for the Study of Mathematics Curriculum
DI	Direct Instruction
ED	emotional disorders
IDEIA	Individuals with Disabilities Education Improvement Act
IEP	individualized education program
LD	learning disabilities
NCEE	National Commission of Excellence in Educations
NCLB	No Child Left Behind
NCTM	National Council of Teachers of Mathematics
PALS	peer assisted learning strategies
STAR	search, translate, answer, and review

CHAPTER 1: INTRODUCTION

1.1 Statement of the Problem

Special educators and students with mild disabilities are increasingly being faced with the impact of high stakes assessments associated with mandatory laws, such as the newly reauthorized Individuals with Disabilities Education Improvement Act (IDEIA) of 2004 and No Child Left Behind Act (NCLB) of 2001. Along with these demands, many states (e.g., North Carolina, Virginia, and Maryland) are now requiring the completion of algebra courses, in addition to standardized algebra assessments, as requirements for high school graduation (Witzel, Smith, & Brownell, 2001). With these initiatives in mind, educators are placing many special education students in inclusive algebra settings where many of them struggle without much needed instructional support such as effective instructional materials, self-management strategies, or academic accommodations (Maccini & Gagnon, 2000; Steel & Steele, 2003).

Mathematics is a common area of difficulty for students with mild disabilities. For this reason, it is not only important for teachers to be aware of student challenges, but to also be familiar with instructional strategies that foster mathematical learning in a variety of special education settings (Montague, 2003). Established research findings suggest that students with disabilities are often at serious risk of math failure compared to their average non-disabled peer, because they do not possess the critical skills necessary for independent problem-solving (Montague & Applegate, 1993). Although many of these students can acquire basic problem-solving skills, they have difficulty relating them to real life experiences. In such cases, students must be taught how to become more competent problem solvers and how to apply these skills to everyday use. This can be accomplished through a variety of evidence-based practices, such as explicit instruction and self-regulation (Montague, Warger, & Morgan, 2000).

Students with math learning disabilities have been described as having “deficits in the ability to represent or process information in one or all of the many mathematical domains or in one or a set of individual competencies within each domain” (Geary, 2004, p. 4). Other characteristics exhibited by students with disabilities include difficulty with multi-step problems, misunderstandings of math language, inability to recall number facts, and failure to verify/recheck answers (Bryant, Bryant, & Hammill, 2000; Maccini & Gagnon, 2000; Miles & Forcht, 1995). Each of these characteristics can have a direct impact on multi-step problem solving, which warrants an urgent need for instructional attention to be given in this area of mathematics.

Maccini and Gagnon (2000) conducted a study to examine the perceptions of secondary general and special education teachers towards standards instituted by the National Council of Teachers of Mathematics [NCTM]. Using a survey, the authors concluded that special education teachers found effective instructional techniques (small group, teacher-directed instruction, and pacing) to be the most important components for teaching abstract concepts to both students with learning disabilities (LD) and emotional disorders (ED). On the other hand, regular education teachers believed that the use of manipulatives and cooperative learning were the most important aspects to teaching math to students with disabilities. This study also indicated that both special and general education teachers believed that the NCTM standards provided a solution to connecting students with disabilities to real-life problem solving. Teachers stated that the standards not only allowed for equal opportunities, but also provided students with disabilities access to the same math knowledge as students without disabilities.

In 1997 Carnine suggested that low mathematic achievement often experienced by students with disabilities could be attributed to mismatches between individual learning characteristics and instructional strategies used within the classroom setting. Instructional designs that often speed through introductions of new concepts and provide little repetitive review may negatively impact students with learning disabilities. Therefore, problem solving strategies which involve both math and/or language (e.g., vocabulary, language coding, and memorization) can become particularly challenging for students that continue to struggle with mathematics (Bryant, 2005; Geary, 2004; Hallahan, Kauffman, Weiss, & Martinez, 2005; Jordan, Hanich, & Kaplan, 2003)

Despite the obstacles that special education students often face when trying to solve multi-step equations, few researchers have examined the effects of algebra interventions on students with disabilities. A previous review of algebra-related literature revealed only six studies involving students with disabilities (Maccini, McNaughton, & Ruhl, 1999). In this review, researchers suggested the use of instructional sequences, which lead students through concrete, semiconcrete, and abstract levels. An example of this type of instruction is the Search, Translate, Answer, Review (STAR) instructional strategy. Maccini and Hughes (2000) examined the effects of the STAR strategy on algebraic problem solving involving integers. STAR involves searching a word problem, translating the words into a math problem, answering the problem, and reviewing the answer to make sure that it is correct. This strategy was taught in three separate phrases: (a) concrete-using manipulatives, (b) semiconcrete- using two-dimensional drawings, and (c) abstract- using numerical symbols. Results indicated that students did show improvements in solving equations involving integers and strategy use.

Witzel, Mercer, & Miller (2003) investigated the impact of a concrete-to-representational-to-abstract (CRA) algebra model on sixth and seventh-grade math students' ability to solve complex equations. Participants in the study were either (a) classified as LD or (b) at risk of math failure. The CRA model introduced the lesson, modeled new procedures, guided students through the procedures, and began students at an independent level. Results found that students in the CRA group outperformed comparison group students on multiple-variable equations and follow-up maintenance tests.

Other researchers have found computers as effective tools for teaching algebra to students with disabilities. For example, Bottge (1999) investigated the effects of teaching contextualized word problems (CP) using videodisc instruction (simulating real-life problem solving) with below-average and average-achieving middle school students in prealgebra classes. Six of the students in the remedial class were classified as having disabilities (e.g., LD, speech and language deficits, emotionally disabled, and Attention Deficit Disorder). Each videodisc accounted for the application of various math skills such as proportions, adding/subtracting money, and adding/subtracting fractions. Results indicated that students had higher performances on word problem posttests and were able to generalize problem solving skills to other tasks.

In a separate study, Kitz and Thorpe (1995) investigated the effectiveness of a Mastering Equations, Roots and Exponents videodisc instruction program (System Impact, Inc., 1989) on preparing 26 students with learning disabilities (LD) for college algebra. Students were randomly assigned to either videodisc instruction or a control group. The videodisc program consisted of mastery learning, stranded instruction, and support materials to teach equations, roots, and exponents. Participants in the control group received traditional direct instruction using text-based teaching methods. Results found that students who received videodisc instruction outperformed the comparison group on posttest measures (paper-and-pencil cumulative review of exponents, absolute values, equations, and inequalities), while also earning higher grades in their first semester college algebra class.

In more recent years, research involving algebra and special education students has indicated that students with mild developmental disabilities benefit from highly structured teacher-based instruction (Butler, Miller, Lee, & Pierce, 2001; Kroesbergen, 2003). Methods may include direct/explicit instruction (modeling), self-regulated instruction (mnemonics, structured worksheets, or graphic organizers) and computer-assisted instruction (Bottge, 1999; Scruggs & Mastropieri, 1997; Miller, Butler, & Lee, 1998). Each of these methods not only provides students with explicit instruction, but also allows for immediate feedback along with opportunities for drill-and-practice.

In summary, although existing studies have been associated with increasing the effectiveness of teaching algebra to students with disabilities, current instructional packages surrounding independent problem solving still remain unclear (Bottge, 1999; Maccini & Hughes, 2000; Witzel, et al., 2003). The majority of algebra studies involving students with disabilities focus on the use of one particular strategy to teach algebraic word problems (e.g., concrete manipulatives, mnemonics, self-regulation, cue cards, peer tutoring, or videodiscs) in resource or self-contained settings. These studies have neglected to teach students with disabilities to work independently without the use of teacher/peer prompting or computer-assisted instruction leading them step-by-step through the problem solving process.

Although the majority of states believe algebra to be a right of passage for high school graduation, mathematic educators see it as part of everyday problem solving. As an educator and organizer of "*The Algebra Project*," Robert Moses (1995), described algebra as the "new civil right." *The Algebra Project* (http://www.algebra. org/ index. html) is a program that seeks to provide quality math education for underprivileged and minority students. Supporters of the program maintain that algebraic problem solving is both "powerful" and "liberating." They not only believe that higher order processing is necessary for success on a daily basis, but it also equips students with skills needed for equal opportunity in the future job market. The idea of educational equality, along with previously stated findings, has led to development of this study.

1.2 Purpose of the Study

The purpose of this study is to investigate the use of an algebra instructional package that combines a set of strategies (Direct Instruction [DI], Peer Assisted Learning Strategies [PALS], and self-monitoring) to teach one-step algebraic equations to middle school students with mild disabilities in inclusive settings. The ultimate goal of this study is to promote student independence in solving algebraic equations (without the use of prompts expressed by teachers, peers, or computers).

The instructional package (an independent variable) for this study will be designed to lead students through the process of algebraic problem solving (teacher instruction, peer assisted instruction, self-monitoring, and independence). Participants within the study will be exposed to teacher modeling of step-by-step problem solving, while also learning to implement their own self-monitoring strategies through the use of cognitive prompts. The ultimate goal will be students' abilities to independently solve one and two-step algebraic equations. The intervention will be divided into five components: (1) piloting of pretest, (2) pretesting the present level of student performance before instruction begins, (3) instructional time given to students, (4) posttest measures taken at the end of the instructional phase, and (5) maintenance measures taken two weeks after instruction has ended. Teacher training will aim to increase both regular and special education teachers' abilities to use the instructional intervention and to ensure that all teachers have background knowledge on the importance of teaching algebra to students with disabilities.

Dependent measures collected throughout this study will include individual student's ability to complete one and two-step algebraic equations independently without the use of a self-monitoring checklist. Data will be collected based on students' abilities to correctly solve simple equations using a step-by-step problem solving strategy. Solutions to equations will be measured using a 3-point scale. Therefore, students will receive: (a) 3 points for writing the correct answer with all work shown, (b) 2 points for correct use of the problem solving strategy with all work shown, but not receiving the correct answer due to a fact error, (c) 1 point for an attempt to solve problem with all work shown, but not using the correct strategy, and (d) 0 points for not attempting to answer or show work**.** Because strategy-use will be included as part of dependent measures, students will be asked to use a “metacognitive process” of self-monitoring during daily problem solving. This is where students will share steps of the problem solving process with peers along with using a checklist to ensure each step has been completed. Generalization will be collected on more complex two-step algebraic equations.

1.3 Potential Contributions

Although previous studies suggest that current instructional strategies can account for possible solutions in teaching algebra to students with disabilities, continued research is needed. Maccini and Hughes (2000), stated that their research was limited by the fact that it only focused on one specific type of problem within algebra (solving equations involving integers); therefore, it is essential that future research begin to explore the effects of instructional strategies on the many facets surrounding the concept of algebra. The current study will address this issue by combining a variety of instructional strategies that have previously been show to benefit students with disabilities, along with also exploring abstract concepts (solving for more than one unknown variable and generalization to more complex equations).

Also noted is the importance of continued research in the areas of both problem solving and computation (Bottge, 1999). This study will ask several questions such as, “Can students with disabilities improve math computation skills through the process of problem solving?” and “Will students be able to generalize and maintain the effects of this multi-step strategy, leading to strategy use with more complex algebraic equations?” A benefit of this research is that it involves innovative instructional methods, while also using pretests and posttests for both computation and algebraic problem solving allowing researchers to determine whether students were able to improve both mathematical skills through the process of a given intervention.

Previous research by Calhoon and Fuchs (2003) employed a PALS method of teaching algebra to students with learning disabilities; their study focused on students with disabilities tutoring other students with disabilities in self-contained resource classrooms. With the present emphasis on least restrictive environments, it is important that future research focus on instructional methods used within inclusive settings. Therefore, the current study will implement PALS with peers that are not disabled and in general education inclusion classrooms. In addition, the study will be beneficial in determining whether both students with and without disabilities in inclusive settings can be successful in acquiring abstract reasoning skills that are needed to be successful in algebra.

Potential contributions of this study may provide educators with reliable strategies to assist students with problem solving in a variety of settings (e.g., self-contained resource classrooms, remedial math classes, prealgebra classes, and college math courses). Strategies for instructing students in higher order math skills are presently in high demand because of mandatory laws (IDEIA and NCLB) that require students with disabilities to have access to the general curriculum. Teachers are not the only persons being held responsible for teaching algebra to students with disabilities. Students are also being held accountable for what they have learned. Teaching students to work with peers, along with self-monitoring strategies, can lead to independence in problem solving. Self-monitoring strategies will make it easier for students to independently analyze and reexamine complex problems, which are necessary in moving to higher level math courses and eventually leading to a high school graduation.

1.4 Research Questions

This study will seek to answer the following research questions:

1. Is there a difference between experimental (instructional package including DI, PALS and self-monitoring) and comparison groups' (DI only) of middle school students' (with mild disabilities) abilities to independently solve one-step algebraic equations?
2. Is there a difference between the four individual "classroom assignments" and their students' abilities to independently solve one-step algebraic equations?
3. Is there a difference between experimental or comparison groups' ability to maintain the effects of multi-step strategy for at least two weeks after instruction has ended, leading to independence in solving one-step algebraic equations?
4. Is there a difference between experimental or comparison groups' ability to generalize the effects of multi-step strategy, leading to strategy use with more complex two-step algebraic equations?

1.5 Definitions

Since educational terms can often have multiple definitions, the following definitions will be used. Knowledge of these terms may be essential to the understanding of this study.

Behaviorally-Emotionally Disabled: A condition exhibiting one or more of the following characteristics, displayed over a long period of time and to a marked degree that adversely affects a child's educational performance: (a) An inability to learn not explained by intellectual, sensory, or health factors, (b) An inability to build or maintain satisfactory interpersonal relationships with peers or teachers, (c) Inappropriate types of behavior or feelings under normal circumstances, (d) A general pervasive mood of unhappiness or depression, or (e) A tendency to develop physical symptoms or fears associated with personal or school problems. This term includes schizophrenia, but does not include students who are socially maladjusted, unless they have a serious emotional disturbance (P.L. 105-17, the IDEA, 1997)

Generalization: “Expansion of student’s capability of performance beyond those conditions set for initial acquisition” (Alberto & Troutman, 1999, p. 495).

Inclusion: “the practice of educating all or most children in the same classroom, including children with physical, mental, and developmental disabilities” (McBrien & Brandt, 1997, p.7).

Individualized Education Program (IEP): A legal contract written for each child with a disability. IEP’s include student’s disability classification, student’s present level of performance, annual goals, an explanation of services, projected dates for duration of services, the extent to which a student will participate in the general education classroom, accommodations, and modifications (IDEA, 2004).

Maintenance: “The ability to perform a response over time, even after procedures have been withdrawn” (Alberto & Troutman, 1999, p. 496).

Mental Disability: “a significantly subaverage general intellectual functioning, existing concurrently with deficits in adaptive behavior and manifested during the developmental period, that adversely affects a child's educational performance.”

Mild Disabilities: “focuses on four high-prevalence disabilities including: mild mental retardation, learning disabilities, behavioral disorders, and ADD, as well as briefer consideration of other mild conditions such as Asperger Syndrome.

Other Health Impaired: “having limited strength, vitality, or alertness, including a heightened alertness to environmental stimuli, that results in limited alertness with respect to the educational environment, that (a) is due to chronic or acute health problems such as asthma, attention deficit disorder or attention deficit hyperactivity disorder, diabetes, epilepsy, a heart condition, hemophilia, lead poisoning, leukemia, nephritis, rheumatic fever, sickle cell anemia, and Tourette syndrome and (b) adversely affects a child's educational performance.”

Specific Learning Disability: " a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. Specific learning disability does not include learning problems that are primarily the result of visual, hearing, or motor disabilities of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage" (IDEA, 2004)

CHAPTER 2: REVIEW OF LITERATURE

The following review of literature is designed to provide a comprehensive and concise overview of empirical research, providing the rationale for why the current study is essential to special education. As such, this review will reflect both recent and seminal studies that are key to the development of the proposed study. Therefore, research reviews will begin from the early 1980's when the nation's math wars began. The review will take an in-depth look into two opposing viewpoints, which include the National Council for Teachers of Mathematics' (NCTM) "*An Agenda for Action: Recommendations for School Mathematics for the 1980s*" and the National Commission of Excellence in Educations' (NCEE) "A Nation at Risk". The review will then progress through to the present year of 2009.

2.1 Innovative Reforms for Extraordinary Students

In 1980, *"An Agenda for Action: Recommendations for School Mathematics for the 1980s"* (NCTM) was only a foreshadowing of what was to come for mathematics instruction. This report established eight specific recommendations for improving public mathematics education. With these recommendations, the NCTM suggested that students were no longer expected to learn basic computation before moving on to more complex problem solving. The report stated that math curriculum should focus on problem solving at all grade levels. Teachers were encouraged to assess students' performances based on their abilities to problem solve, work collaboratively, and effectively solve math problems with the use of calculators, computers, and manipulatives.

More significantly, this report changed the views of educators, politicians, and parents by drawing much needed attention to the use of higher level thinking skills. Teachers in grades K-12 were expected to use a variety of teaching methods, including mathematical discussions and everyday problem solving techniques to meet the needs of students at varying levels. Rather than creating "one-size fits all" curriculum and assessments, teachers began to examine the needs of individual students and make accommodations based on diversity of the student population. Textbook companies also took part in the reform by promoting series of texts that focused more on logical reasoning than basic mathematical computations (Center for the Study of Mathematics Curriculum [CSMC], 2007).

Another critical look at public education was published just three years later in 1983. *"A Nation at Risk"* (NCEE) reported a decline in our nation's academic achievement beginning in the year 1963. The authors stated that between the years of 1975 and 1980, there was an increase of 72 percent in college remedial math courses. This accounted for more than a quarter of our public college students that need remediation before moving on to higher level mathematics' courses. The NCEE noted international discrepancies in our students' math and science scores, stating that American students never scored in first or second place, but scored in last place in 7 out of 19 academic tests. Recommendations by the NCEE included an increase in college math skills, hiring and training of more qualified teachers, and more rigorous textbooks.

Although both of these reports were intended to seek reform in public education, they were by far mostly recognized for their impact on the development of the NCTM's first standards document in 1989 (http://www.nctm.org/standards/focalpoints.aspx?id=260). The first standards document for mathematics was released by NCTM in 1989. These standards were, first and foremost, intended to "ensure quality, to indicate goals, and to promote change" (NCTM, 1989, p. 2). To assist in public education's reform, along with creating mathematically literate US citizens, the NCTM developed a list of five goals (NCTM, 1989, p. 1):

1. Learn to value mathematics.

> Students should have numerous, varied learning experiences that illuminate the cultural, historical, and scientific evolution of mathematics. These experiences should be designed to evoke students' appreciation of mathematics' role in the development of contemporary society and to promote their understanding of relationships among the fields of mathematics and the disciplines it serves: the humanities and the physical, social, and life sciences.

2. Learn to reason mathematically

> Skill in making conjectures, gathering evidence, and building an argument to support a theory are fundamental to do mathematics. Therefore, sound reasoning should be valued as much as students' ability to find correct answers.

3. Learn to communicate mathematically

   To express and expand their understanding of mathematical ideas, students need to learn the symbols and terms of mathematics. This goal is best accomplished in the context of problem solving that involves students in reading, writing, and talking in the language of mathematics. As students strive to communicate their ideas, they will learn to clarify, refine and consolidate their thinking.

4. Become confident of their mathematical abilities.

   Study that relates to everyday life and builds students' sense of self-reliance will lead them to trust their thinking skills and apply their growing mathematical power. School mathematics should prompt students to realize that doing mathematics is a common, familiar human activity.

5. Become mathematical problem solvers.

   Problem solving is the process through which students discover and apply the power and utility of mathematics. Skill in problem solving is essential to productive citizenship.

By 1994, the NCTM had established several task forces to determine appropriate resources for closing achievement gaps in all areas of mathematics education. One particular group, the Algebra Working Group, acknowledged the notion that “children can develop algebraic concepts at an early age” and “all students can learn algebra” (NCTM, 1994, p. 5). This reaffirmed the NCTM’s commitment to goals and assessment standards previously stated (Middleton & Goepfert, 1996).

In 2000, the ongoing debate surrounding mathematics education continued. Much resistance came from parents and educators over the usefulness of these standards. Therefore, the NCTM began consulting with the American Mathematical Society, along with several other well respected organizations, to create an updated version of the standards called *"Principles and Standards for School Mathematics"* (NCTM, 2000). Building on earlier reform initiatives, the NCTM identified five content standards of mathematics instruction. These content standards include (a) number and operations, (b) measurement, (c) data analysis and probability, (d) geometry, and (e) algebra. Although NCTM standards are often criticized for their lack of research base, they are still considered a vital effort to reform American's mathematical instruction (Hofmeister, 2004).

2.2 Issues in Inclusion

Inclusion can be defined as "a process in which children and adults with disabilities have the opportunity to fully participate in all community activities offered to people who do not have disabilities" (Special Education Programs [Department of Education/Office of Special Education and Rehabilitative Services], 1996, p.7). Over the past two decades, many proponents and critics of inclusion have written articles discussing its positive and negative aspects. Understanding the pros and cons of inclusion can assist parents, students, administrators, special educators, and regular educators in developing preferred school-wide and community-based inclusive programs.

Over the past two decades, the field of special education has continued to have many debates concentrating on the pros and cons of including students with disabilities within the general education classroom (Crockett & Kauffman, 1998). Although federal laws are in place that mandate educating students with disabilities within the least restrictive environment (i.e., *Individuals with Disabilities Education Act (IDEA)* and *No Child Left Behind (NCLB)*), parents, teachers, and support associations have continued to voice concerns that students' needs are not always met within inclusive settings (Mclesky, Henry, & Axelrod, 1999). With this in mind, we are left to ask, "Does inclusion really work?" and "How can we give students with disabilities access to the general curriculum without neglecting the individualized instruction that is often needed?"

Decisions of how to best educate students with disabilities have fluctuated from one extreme to another. That is, individuals who believe that any type of inclusion is unfavorable and those who support abolishing special education all together by fully including all students with disabilities in the general education classroom (radical inclusionists). There are also individuals who believe that providing both special and general education services is the key to academic and social success for students with disabilities (responsible inclusionists). Therefore, the following paragraphs will provide an array of theories related to inclusion, along with successful attributes of inclusion that ensure every child with a disability receives a "free appropriate public education."

2.2.1 Noninclusion

Critics of inclusion have stated that, "the rationale for restructuring for inclusion is based on moral values, not research data showing that one model is superior to another in outcomes" (Kauffman, Bantz, & McCullough, 2002, p.150). Although many inclusionists believe that special education is considered a "separate system," advocates for special education suggest that it should be seen as a service and not a place. Dr. James

M. Kauffman, a noted professional in the field of special education, and retired from the University of Virginia, Charlottesville, Virginia, has an extensive number of publications, including books and research articles focusing on myths about special education and the negative aspects of inclusion. In an interview with Dr. Kauffman (personal communication, April, 18, 2005), he stated:

> As an across-the-board policy for all students with disabilities, placement in regular schools and regular classes is just plain illegal. The law demands that placement decisions be made on a case-by-case basis, and then only after appropriate education is defined. And it requires the availability and consideration of a full continuum of alternative placements (including special schools and special classes), regardless whether advocates call for full inclusion.
>
> I hope people won't be taken in by the idea that inclusion in regular classrooms and schools are important because we live in an inclusive society. I think we neither live in nor want an inclusive society--one in which there are no requirements of interest or competence, never mind other qualifications such as age or gender for participation in any activity. No, I think we want and should have (and social justice requires) a society in which you have to meet certain requirements to participate in lots of activities. Exceedingly few occupations, recreational activities, and privileges have absolutely no requirements associated with them. No, in our society there are lots of options for most people, but there are also requirements for almost every one of those options.

Although special education is often criticized for its low expectations and labeling of students, the success of special education should not be dependent on the correspondence of special and general education teachers. Its success should be based on the quality of instruction (academic and social competence) provided by special education teachers. Placement in special education classes means that students do receive instruction that is "different" and "superior" to that of the instruction they have previously received in a general classroom setting. Special educators not only individualize instruction to students' specific needs, but they also provide more intensive services in small group settings (Kauffman & Pullen, 1996).

Noninclusionists feel that inclusion fosters the perception that every student is "normal," but does not foster the expectations of capabilities. They believe that inclusion places students with disabilities into regular education settings and offers them extreme accommodations, while lowering student expectations. It ignores students' disabilities and forces them to work primarily on academics rather than teaching them the skills needed to lead fulfilling adult lives (Kauffman, McGee, & Brigham, 2004). Therefore, when schools begin to focus on inclusion, special education must shift from teaching students to become independent to teaching them to become dependent on modifications and accommodations that are necessary to survive in a general education setting.

2.2.2 Responsible vs. Radical Inclusion

Although critics of inclusion believe that it forces special educators to change their mission, proponents of inclusion insist that it not only benefits students academically, but also socially (Kauffman, 1994). Advocates of inclusion often fall into two separate categories. These categories consist of responsible and radical inclusionists. Responsible inclusionists feel that both special and general education teachers should work cooperatively to determine what is best for special education students, while radical inclusionists feel that all students should be included in regular education (both in the classroom and in extracurricular school activities). Each of these categories will be further detailed in the following paragraphs (Fuchs & Fuchs, 1994).

2.2.3 Responsible Inclusion

Many concerns surrounding inclusion have largely focused on meeting students' needs through adaptations/modifications of general education curriculum and instruction. Advocates of responsible inclusion have claimed that individualized instruction is the quintessential guide to modifying curriculum for all students. Within this model, it is typical that special education teachers are responsible for reducing curriculum capacity and teaching remedial skills within the general education classroom. Therefore, regular and special education teachers must work cooperatively in modifying the general educator's lesson plans based on the needs of individual students (Fuchs & Fuchs, 1994).

Responsible inclusion has been defined as "the development of a school-based education model that is student centered and that bases educational placement and service provision on each student's needs" (Vaughn & Schumm, 1995, p. 265). Followers of this philosophy want to make sure that all students' academic and social needs are sufficiently being met. They are mostly concerned with making sure that students are provided with appropriate academic instruction.

Responsible inclusionists' primary goal is to place all students with disabilities into the regular education setting, unless their needs cannot be met there. They feel that a continuum of special and general education placement options should be made available to all students with disabilities. In addition, they believe that when radical inclusionists try to eliminate this continuum, they are also eliminating parents' rights, according to

IDEA (1997). By radically including all students with disabilities into regular education classrooms, the individualized education plan (IEP) process of determining the most beneficial placement for a child is violated. Therefore, responsible inclusionists simply want others to realize that placing a child with disabilities into regular education is not always appropriate. For instance, students that are deaf or blind may need a more restrictive environment, such as self-contained schools designated specifically for their instruction (Wright, 1999).

Responsible inclusionists claim that there is little data-based evidence that reflects the effects of radical inclusion on students with high-incidence disabilities, for example learning disabilities (LD) in reading, written language, or math. In fact, they argue that the existing evidence indicates that students with LD are not academically successful in the regular education classroom because of large group instruction with no individualization (Vaughn & Schumm, 1995). This led special education researchers to develop an inclusion model that consists of a set of eight specific guidelines for schools to follow. These guidelines are (a) putting the student first, (b) providing adequate resources, (c) developing and implementing school-based inclusive models, (d) maintaining a continuum of services, (e) continuously evaluating service delivery, (f) ongoing professional development, (g) discussing and developing an inclusion philosophy, and (h) developing and refining curriculum approaches to meet the needs of all students. Through the implementation of these guidelines, schools are more readily able to be effective in their inclusion efforts.

2.2.4 Radical Inclusion

On the other hand, many advocates for inclusion argue that the continuum of special education placements should be eliminated altogether. These people are referred to as radical inclusionists. Stainback and Stainback (1992) described radical inclusion as, "An inclusive school or classroom that educates all students in the mainstream. No students, including those with disabilities, are relegated to the fringes of the school by placement in segregated wings, trailers, or special classes" (p. 34). This type of inclusion would abolish the entire idea of special education, including its teachers and classroom structures.

Other advocates of radical inclusion claim that by putting an end to the continuum of special education services, it also puts an end to labeling and special education classes. They believe that it is necessary to provide services and support within a completely integrated classroom environment. This is not to say that they are in favor of discarding all students with disabilities into the regular education classroom without the obligation of providing support. Radical inclusionists believe that specialized services should be available to all students, including those with or without disabilities, in all classrooms (Fuchs & Fuchs, 1994).

Radical inclusionists often blame special education for the insufficient acts of general education. They claim that since the implementation of special education, general education teachers have lost their ability to adapt curricula or modify instructional methods to meet the individual needs of students (Stainback & Stainback, 1992). They feel that special education has made it too easy for regular educators to get rid of unwanted students. Therefore, the elimination of special education would assist in holding general educators responsible for students that they would ordinarily “dump” into special education.

Whereas one of the goals of radical inclusionists is to cease special education in general, the ultimate goal is to promote social competence of students. The explanation for this objective is to help students with disabilities to become active and productive members of the community. Teaching students with disabilities skills that are needed for daily living will encourage them to be successful with both social and environmental factors. Snell (1991) declared that the three most important benefits of radical inclusion are that it (a) promotes social skills development, (b) improves attitudes of peers without disabilities towards students with disabilities, and (c) builds friendships between students with and without disabilities. Therefore, radical inclusionists may measure the success of students with disabilities in terms of their social acceptance by teachers and peers without disabilities.

2.2.5 Making Inclusion a Success

Though there has been research both supporting and opposing inclusion, it is particularly important to identify attributes of school-wide inclusive programs that help to make them successful (Hastings & Oakford, 2003). Effectiveness of inclusive programs should be evaluated based on their outcomes rather than the beliefs of individuals. Although much research on inclusion has indicated that it is profitable for both students with and without disabilities, the debate that still remains is, “How can we give students with disabilities access to the general curriculum while also providing individualized instruction?”

The good news is that teachers, administrators, and parents alike are now able to provide responsible inclusion techniques which allow students of all ages access to the general curriculum (without neglecting their individual needs for instruction). As a result of many years of research, we have come to know that successful evidenced-based inclusion practices do exist (Bucalos & Lingo, 2005; Fuchs, Fuchs, Mathes, & Simmons, 1997; Hasselbring, 1994; Slavin, 1995; Vaughn, Gersten, & Chard, 2000)

A study by White, Swift, and Harman, (1992) revealed that approximately 86 percent of surveyed parents of children with disabilities in inclusive settings said that their child had improved in academics and 62 percent felt that their child's behavior had also improved. Schattman and Benay (1992) found that students with disabilities in inclusive settings often work with more talented teachers, are more likely to create friendships with same-age peers, and are exposed to higher quality coursework than those in self-contained special education settings. The following paragraphs will provide further details supporting the use of effective inclusion practices.

2.2.6 Research-based Inclusion Practices

Bucalos & Lingo (2005) explore the many characteristics of inclusion that have shown potential for student achievement over the past two decades. In this article authors are particularly candid about the challenges faced by students with mild disabilities in inclusion settings. One overall concern faced by students in both middle and high school inclusion settings is the issue of accountability. As stated in Chapter 1, students with mild disabilities are increasingly being confronted with the impact of high stakes assessments (e.g., End-of-Grade testing in reading, writing, and mathematics and End-of-Course testing in Algebra, Geometry, Biology, Chemistry, etc.) required by state and federal mandates. Because of such mandates many of these students are being placed in inclusive settings and left to struggle without additional instructional supports (Steel & Steele, 2003). To reconcile these concerns, Bucalos & Lingo (2005) created a list of research-based inclusion practices that work. Among these practices are differentiated instruction, anchoring of instruction, cooperative learning, peer tutoring, and strategic learning.

Differentiated instruction refers to teachers using an assortment of instructional strategies to create a classroom environment where teachers and students work together rather than the teacher always directing student learning (Tomlinson, 1999). Another effective inclusion practice is that of anchoring instruction. The idea of anchoring instruction allows students to gain responsibility for their own understanding. It supports the use of cognitive/mental models to help students conduct their own informed decisions about the content that they are studying (Hasselbring, 1994). This allows students to work on his/her own without continuously relying on the teacher for direct instruction.

Cooperative learning and peer tutoring encourage inclusion techniques that often work hand in hand. In each of these instructional methods students are typically divided into heterogeneous groups/pairs. Students are often assigned to groups/pairs based on ability levels. Students with higher levels of achievement are grouped with students with lower levels of understanding. Clear instructions and teacher monitoring are important to ensure that students work towards an ultimate task. The use of both peer tutoring and cooperative learning can also be effective in that students are allowed to verbally share thoughts and opinions, while receiving immediate responses from peers and/or group members (Fuchs et al., 1997; Slavin, 1995; Vaughn et al., 2000).

Strategic learning is an especially beneficial inclusion technique in that many students with disabilities lack the skills to formulate their own strategies for memorizing or comprehending subject matter (Bucalos & Lingo, 2005). In strategic learning teachers do not simply give students strategies and expect them to use them on their own. Teachers take class time to model the step-by-step processes of using strategies while also making certain that students receive repeated practice in using the new technique.

Inclusion has not only been identified as an effective practice for students with disabilities, but has also been linked to higher academic success for students without disabilities (Hines & Johnson, 1996; Logan, et al., 1995; Staub & Peck, 1995). For example, Farlow (1996) found that one particular student without disabilities, (who was acting as a peer tutor for a middle school student with Down Syndrome) was able to improve his failing social studies grades to passing grades for the school year. A separate study by Staub and Peck (1995) found that students without disabilities who were taught in inclusive settings had (a) less fear when facing individual differences, (b) higher levels of understanding the thoughts and feelings of others, (c) greater levels of self-concept, (d) caring and accepting friendships, and (e) increased personal values.

Although many educators and researchers continue to debate over the proper aspects of inclusion, one thing remains clear. Years and years of high-quality research has provided us with a plethora of opportunities to delve deep into challenges and resolutions of inclusion. In knowing these details, we are now able to provide students with necessary supports to help them move forward in their quest for content mastery.

2.3 Evidence-based Instructional Strategies for Teaching Algebra

While exploring previous research in the area of teaching math to students with disabilities, it is no surprise that the majority of studies have focused on teaching basic math computational skills to students with learning disabilities. A closer examination of mathematical research also reveals that it has typically has focused on three instructional areas. These areas include DI, peer tutoring, and self-monitoring. These areas will be discussed in further detail in the following paragraphs.

2.3.1 Direct Instruction

A seminal event leading to the development of DI curricula began in 1968 during the implementation of *Project Follow Through* (Englemann & Carnine, 1991). This project originated in the midst of President Johnson's *War on Poverty* and ended nearly a decade later in 1977. *Project Follow Through* was designed to determine effective instructional approaches for teaching students from low-income backgrounds. Approximately 100,000 students in kindergarten through third grade participated in the project (Meyer, 1984; Watkins, 1997).

DI, as well as eight other instructional methods (e.g., applied behavior analysis, Piagetian theory, and student-directed open education), were evaluated to determine their effects on three standardized measures. These measures included self-concept, basic skills, and cognitive abilities. Results indicated that students receiving DI surpassed students in comparison groups on all three measures. More specifically, students who were given at least three to four years of DI significantly outperformed all other groups in mathematics problem solving and basic math concepts (Becker & Gersten, 1982).

Another interesting aspect is that low-income students from the DI group had scores which corresponded with their same-age peers coming from middle-class backgrounds.

Subsequent to *Project Follow Through's* findings, Adams and Engelmann's (1996) meta-analysis reviewed 37 studies involving DI and its effects on both general and special education students. Of these studies, 173 independent comparisons were made between DI and non-DI approaches to teaching. Results of the meta-analysis indicated that individuals in DI groups were consistent in outperforming non-DI groups in 87 percent of the cases. Not only did students receiving DI continue to excel into middle and high school years, but at least two of the studies found that DI also improved the likelihood of students graduating and being accepted into college.

In more recent research surrounding effective instruction, Maccini and Gagnon (2000) recommended the use of DI to teach mathematics to students with cognitive disabilities. Their support for DI hails from the fact that DI concentrates on both "what" and "how" to teach. DI not only provides teachers with scripted lesson plans, but also addresses a variety of components that are beneficial to student success including (a) explicit teaching, (b) mastery learning, (c) immediate error correction, (d) decreasing teacher participation, (e) variety of examples and nonexamples, and (f) cumulative skill reviews.

Kroesbergen & Van Luit's (2003) meta-analysis reviewed 58 studies that spotlighted a variety of math interventions that focus on students with disabilities in elementary settings. Of these studies, the authors found DI and self-monitoring to be the most highly effective instructional methods. In this review, researchers noted that DI was found to be most useful in teaching simple math facts, while self-instruction (e.g., self-monitoring or cognitive prompts) resulted in the acquisition of problem solving skills.

In addition to systematic/explicit instructional methods for teaching mathematics, it is important to note other evidence-based practices that have historically worked for students in special education. Other research has revealed the use of peer tutoring as an effective strategy for teaching algebra to students with disabilities (Calhoon & Fuchs, 2003).

2.3.2 Peer Tutoring

Although there are several variations of peer tutoring (Peer-Assisted Learning Strategies, classwide peer tutoring, or cross-age tutoring), research has shown that working with peers can significantly increase student motivation and attainment of academic knowledge (Light & Littleton, 1999; Wentzel, 1999). The majority of researchers suggest that both tutors and tutees can profit socially and academically across a number of educational settings (Fuchs, Fuchs, Mathes, & Martiniez, 2002; Rohrbeck et al., 2003).

Current research, including a synthesis of fifteen studies (Baker, Russell, & Dae-Sik, 2002) which investigated a variety of mathematic interventions, produced consistent findings favoring the use of peer tutoring. When students, especially those with disabilities, have the ability to work collaboratively in small groups or with peers, incidental learning may occur. By imitating others solving algebraic problems, students with disabilities can have the same success in algebraic problem solving as their peers. Baker et al. stated, “Research shows that the use of peer tutors to provide feedback and support improves low achievers’ computational abilities and holds promise as a means to enhance problem-solving abilities. If nothing else, having a partner available to provide immediate feedback is likely to be of great benefit to a low achiever struggling with a problem" (p. 67).

Calhoon and Fuchs (2003) used an experimental design with a control to determine the effects of both peer-assisted learning strategies (PALS) and curriculum-based measurements (CBM) on the algebra performance of secondary students with LD in self-contained resource classrooms. Ninety-two students with LD from three separate public schools were randomly assigned to either the treatment condition receiving PALS/CBM or the control condition receiving instructional methods taught from a workbook and worksheets. Participants in the PALS/CBM group were first trained as tutors, then as CBM assessors. Prior to tutoring, students were taught to give step-by-step feedback, including frequent verbal/written interactions, and to also act as a tutee. The CBM intervention helped students to track their own performance by profiling and graphing skills twice weekly. The results of this study found that although there were no differences between groups on concepts or application math skills, students who received PALS/CBM had statistically significant higher scores on computation skills.

Although significant gains in the area of math research has given teachers guidance on teaching strategies, gradual fading of teacher involvement is a must when teaching students to become independent in their own problem solving. One effective strategy that allows students to assume responsibility for their own learning is called metacognitive strategies. Metacognitive strategies include an assortment of instructional methods such as self-monitoring, self-instruction, self-regulation, cognitive prompts, and cue cards.

2.3.3. Self-Monitoring

In the 1980s educators became increasingly interested in teaching students with disabilities to manage their own behavior and learning. Although not described in the literature as an area of "mathematics", instruction in self-monitoring, data collection, comparison, and graphing can provide teachers with important resources on how to teach these skills within a classroom setting (Browder, Spooner, Ahlgrim-Delzell, Harris, & Wakeman, 2008). For example, a teacher may want to have students monitor their progress on daily multiplication math drills. The teacher may have students to make predictions about their scores. Students could then be asked to graph their daily progress on a line graph. This type of data collection would not only allow students to see a visual representation of their daily progress, but would also give them an opportunity to analyze their scores, identify trends, and make changes based on their interpretations.

Several other research findings have shown that self-monitoring affects on students with mild disabilities (e.g. Attention Deficit Disorders and learning disabilities) have increased academic productivity, accuracy, fluency, and on-task behaviors (Shimabukuro, Prater, Jenkins, & Edelen-Smith, 1999). One such study investigated the effects of a behavioral self-management intervention on fourth grade students with and without disabilities. Researchers found that students (a) were able to accurately self-monitor answers to math calculation problems on daily warm-up problems, (b) had increased math fluency and engaged time, (c) were able to match or exceed the math fluency levels of their peers, and (d) made generalizations to improve fluency in solving math word problems (McDougall & Brady, 1998).

A comprehensive literature review by Miller et al. (1998), found that 6 of the 14 studies focusing on problem solving used cognitive and/or self-monitoring approaches to teach students systematic steps in solving word problems. Individual studies provided students with at least five, but no more than eight, specific steps in determining answers to given word problems. During initial instruction of these approaches, students were given time to memorize, review, and practice each step. Other successful problem-solving interventions found by this review included the use of concrete manipulatives and drawings, direct instruction of numerical facts, schematic diagrams, and systematic teaching procedures (e.g., scripted lessons). Similarities throughout these studies indicated that the majority of students were supported through the use of teacher modeling and immediate feedback.

A related study by Hutchinson (1993) investigated the effects of a self-monitoring cognitive strategy on the ability of 12 high school students with LD to complete word problems involving proportions and at least two unknown variables. Interventions took place in a resource setting. Students in a control group received typical teacher-directed instruction. Teachers participating in the study were first trained to use a cognitive strategy approach through the use of scripted lessons designed by the investigator.

This approach consisted of two phrases (problem representation and problem solution). Each phrase required students to follow a self-monitoring cue card that provided them with successive steps to solving word problems. In the first phrase, cards cued students to ask themselves questions such as, “Do I understand the problem?” and “Do I have an entire representation of the problem?” The second phrase cued students to ask, “What is the unknown?” and “What type of equation do I need to write to solve it?”

Results showed that students who received the intervention had statistically significant higher scores on posttest measures. Posttests included algebraic word problems, open-ended questions, and metacognitive interviews with think aloud problem solving. Students in the cognitive strategy group were also able to maintain and transfer the strategy up to six weeks after the intervention had ended.

Most recently, Montague (2003) created the *Solve It!* strategy to provide mathematical instruction to three students with learning disabilities in the 8th grade. The *Solve It!* strategy consists of four steps including (1) assessing students' current performances, (2) providing explicit teacher instruction, (3) teacher modeling, and (4) providing students with immediate feedback. This program teaches students how to translate mathematical problems into everyday situations, and then construct a plan for solving each situation. Students are taught the process of self-regulation and checking for accuracy by verifying answers to each solution. Results indicated that *Solve It!* instruction increased students' abilities to solve abstract mathematical problems and that students enjoyed using the strategy and would continue to use it as future reference.

2.3.4 Summary of Effective Practices

Although direct and explicit instruction has largely been established as the most effective method for teaching basic skills in mathematics to students with mild disabilities (Kroesbergen, 2003), there are several other evidence-based practices that lead to promising results. Other effective methods for teaching mathematical problem solving include the use of self-instruction (e.g., cognitive prompts, self-regulation, or self-monitoring) and peer tutoring. Self-monitoring has been found to be particularly useful for fading teacher involvement and teaching students with disabilities to work independently (Hutchinson, 1993; McDougall & Brady, 1998; Miller, et al., 1998; Shimabukuro et al., 1999; Montague, 2003), while peer tutoring can have significant effects on both student motivation and academic skills **(**Baker et al., 2002; Calhoon, & Fuchs, 2003; Fuchs et al, 2002; Rohrbeck et al., 2003**).**

CHAPTER 3: METHODS

This study is designed to compare two instructional grouping conditions on the ability of students with mild disabilities to solve one-step algebraic equations. The first condition will include Direction Instruction (DI) only, while the second condition will involve an instructional package created by the investigator. The instructional package will incorporate a combination of evidenced-based practices including DI, self-monitoring, and peer assisted learning. This chapter offers an in-depth description of the methods used to investigate previously stated research questions, along with descriptions of participants, experimental design, data collection, and analysis of data.

3.1 Participants

Forty-three middle school students with mild disabilities will participate in the study. Participants will be operationally defined as students classified with mild disabilities (e.g., learning disabilities, behavioral disorders, and ADD, as well as other mild conditions such as Asperger Syndrome) based on their individualized education program (IEP). This will include a selection of students from four algebra inclusion classes within a local school system who are currently enrolled in sixth and seventh grade math inclusion classes. The Exceptional Children's Director of a local school system will announce the study at the beginning of an Exceptional Children's teacher meeting. Teachers at the meeting who are interested in participating will receive additional information about the study (See Appendix A for Letter of Agreement). Demographic information for students can be seen in Table 1.

Table 1

Demographic Information for Participants

	Class 1	**Class 2**	**Class 3**	**Class 4**	**Total**	**Percent**
Grouping Condition						
Inst. Package	11	9	0	0	20	46.5%
DI only	0	0	10	13	23	53.5%
Grade Level						
Sixth	0	3	10	13	26	60.5%
Seventh	11	6	0	0	17	39.5%
Gender						
Male	7	4	6	6	23	53.5%
Female	4	5	4	7	20	46.5%
Ethnicity						
Caucasian	10	6	6	7	29	67.4%
African-American	1	3	3	5	12	27.9%
American Indian	0	0	0	0	0	0%
Asian	0	0	0	0	0	0%
Hispanic	0	0	1	1	2	.05%
Multi-racial	0	0	0	0	0	0%

Teachers, in whose class the study will take place, will be selected based on the following criteria: high level of interest in participating, grade level of students (sixth or seventh grade), disability identification of students (mild disabilities), the content area in which he/she teaches (pre-algebra or algebra), and the setting in which he/she teaches (inclusion math). Both regular and special education students will be invited to participate in the study. However, dependent measures, including pretests, posttests, and maintenance will be collected for students with disabilities only.

Consent forms will be sent to parents/guardians, while assent forms will be given directly to the students. The form includes a letter that details the purpose of the study and the kinds of activities in which students will participate. Parents/guardians will be asked to return the consent forms with signatures within a specified time period. A second form and letter will be sent to parents/guardians who do not return the initial form within this time period. Phone calls will be made as a follow-up with parents/ guardians who do not return the second form. Students will sign assent forms so they are aware of the purpose of the study and their right to withdraw at any time (Consent and Assent Forms are included in Appendix B).

3.2 Setting

The intervention will take place within four inclusion math classes over a period of 15 school days. Generalization and maintenance data will be collected beginning on the 15th day. The investigator will be responsible for implementing instruction in both the grouping conditions (DI and the instructional package).

The investigator will visit the school on at least five occasions before the actual instruction begins. The first visit will be to explain the study to the teachers. A brief PowerPoint presentation will be shown and teachers will be encouraged to ask questions about the study. The next visits will simply be an introduction of the investigator to students. Because the investigator will be the sole instructor throughout the investigation, it is important to build rapport with students before taking over mathematics' instruction. On the fourth visit, both assent and parental consent forms will be explained and read aloud to students. On the last visit assent and consent forms will be collected. Once the instructional phase begins, the investigator will visit each classroom on a daily basis. The purpose of visits will be to implement instruction for both groups, along with collecting data (administer pretests/posttests) and monitoring student progress.

3.3 Research Design

This study will employ a randomized block design. Students whom are currently enrolled in sixth and seventh grade inclusion math classes will be randomly assigned to experimental or comparison groups. Students will be assessed and put in blocks of two according to which grade level (sixth or seventh grade) they are currently enrolled. Students in the sixth grade are in the first block and students in the seventh grade are in the second block. Therefore, the investigator will randomly assign math classes in each of the two blocks to one of two grouping conditions.

Table 2

Blocking Conditions by Group

		Grouping Conditions	
		Instructional Package	DI
Blocking	sixth grade	N= 9	N=10
	seventh grade	N=11	N=13

Dependent Measures

Pretests and posttests will be used to measure individual student's ability to complete one-step algebraic equations independently without the use of a self-monitoring checklist. This measure will be defined as the total number of points scored on pretests and posttests involving one-step equations. One-step equations are those that contain one unknown variable and require one-step such as addition, subtraction, multiplication, or division to solve (e.g., $7 + x = 15$). Two-step equations will be given as part of pretests and posttests for the purpose of measuring generalization. This will include students' ability to generalize the instructional strategy to more complex problem solving. Two-step equations are those which contain one unknown variable, but require two different steps such as multiplication/division and addition/subtraction to solve (e.g., $3x + 6 = 12$). Pretests/Posttests measures will only be used for the purpose of data analysis. Points scored on pretests/posttests (0-45 points) will determine students' ability to independently solve equations. Dependent measures will not be used to assign grades to students in math class.

Students will be expected to show all steps involved in the problem solving process. An assessment of 15 algebraic equations will be given to students on three separate occasions: Pretest (before the instructional process begins), posttest (once instruction is completed), and maintenance (at least two weeks after instruction is completed). Copies of assessments will be given to students by the investigator. This is an important aspect of working with students with disabilities, because it avoids having students copy equations from the board. Students with disabilities often have deficits in processing information (Geary, 2004). Therefore, handing them a set of prewritten equations allows for an authentic assessment of problem solving abilities rather than copying skills. Students will simply be asked to write step-by-step procedures taken to solve each problem. Steps will include (1) bringing down the missing variable, (2) identifying the current operation, (3) choosing the correct inverse operation, (4) identifying the correct number to add, subtract, multiply, or divide, (5) correctly solving the equation, and (6) checking the equation by plugging in the solution to determine if the answer is correct.

Independence in solving one-step algebraic equations. This will be measured based on an individual student's ability to solve one-step equations independently without the use of a self-monitoring checklist. Solutions to equations will be measured using a 3-point scale. Therefore, students will receive: (a) 3 points for writing the correct answer with all work shown, (b) 2 points for correct use of the problem solving strategy with all work shown, but not receiving the correct answer due to a fact error, (c) 1 point for an attempt to solve problem with all work shown, but not using the correct strategy, and (d) 0 points for not attempting to answer or show work. Therefore, a total of 3 points can be earned for each equation answered correctly. Since each pretest/posttest will contain 15 algebraic equations, students will have the opportunity to score between zero and 45 points.

This scale was chosen to ensure that students were able to show evidence of strategy techniques needed to solve each individual equation. By establishing a "no response" category it encourages students to generate an answer rather than sitting idly while others complete the posttest. The scale is not only consistent with the NCTM (2000) assessment standards (providing evidence/argument to support answers, expressing mathematical understanding through reading/writing/talking, and applying the problem solving process to mathematics), but it also gives researchers and teachers a valuable look into the cognitive steps students are taking in the problem solving process. In addition to offering a point system (between 0 and 45) that is sufficient in distinguishing between student abilities, points allotted for individual equations (between 0 and 3) are precise enough for the researcher and inter-rater to easily reach an agreement on reliability (Taggart, Phifer, Nixon, & Wood, 1998).

Data Collection Procedures/Instrumentation

Pilot. Prior to actual data collection beginning, a draft of the algebraic problem solving instrument will be piloted to sixth and seventh grade students with disabilities. Two math inclusion classes from the approved local school system (that will not be included in the current study) will be asked to participate. Approximately 15 students will be involved in the piloting process (7 students from the sixth grade; 8 students from the seventh grade). Students will be given approximately 30 minutes to complete the entire pilot test. Students will be asked to show their work during the problem solving process.

The pilot test will not be included as part of study data nor will it be used for further data analysis. Information obtained during pilot testing will be used as part of an informal evaluation to assist the investigator with future planning. First, it will help to determine an acceptable time limit for future pretest and posttests. Next, it will give the investigator an opportunity to observe student motivation and determine if students currently possess the ability to independently solve one or two-step equations. Lastly, it will provide an assessment for content experts to review for content validity purposes.

Pretest. All participants will be given a pretest containing 15 algebraic equations. This will include 10 one-step equations (all with the same level of complexity) and 5 two-step equations (all with the same level of complexity). This test will be created by the investigator through the use of content experts (special and regular education math instructors). Students will be given exactly 30 minutes to complete the pretest. During this time students will be closely monitored by the investigator and a data collector that is blind to the study. This will determine which students, if any, are not making honest attempts of answering test problems (e.g., lack of motivation, putting head on desk, etc.). Outliers will be identified and a decision to include/exclude each individual student will be decided upon before data analysis has begun.

Posttest. Each participant will also be given a posttest measure. This test will also contain 15 algebraic equations. To ensure that both pretests and posttests have equivalent levels of complexity (without having the exact problems and solutions), the investigator will use pretest equations, but consistently add 1 to each numeral within the equation (e.g., pretest: $X + 2 = 17$, posttest: $X + 3 = 18$). This assessment will include 10 one-step equations and 5 two-step equations. Students will be given the exact amount of time to complete the posttest as was given for the pretest (30 minutes). Again, students will be closely monitored by the investigator and a data collector that is blind to the study. Outliers will be identified prior to data analysis and decisions to include/exclude will be made based on each individual case.

Maintenance. Subsequent measures of students' ability to solve one and two-step equations will be collected within the two weeks following instruction. In an attempt to control mediating factors, classroom teachers will be asked not to teach mathematics that are algebra-related for the two weeks following the intervention. This will ensure that students are not receiving additional instruction in algebraic problem solving. The investigator will use the same 15 pretest equations, but consistently add 2 to each numeral within the equation (e.g., pretest: X + 2 = 17, maintenance: X + 5 = 20). Students will be given the exact amount of time to complete maintenance testing as was given for the pretest and posttest (30 minutes).

Independent Variables

Instructional package. The first independent variable for this study will be an instructional package developed by the investigator. This package is designed to lead students through the process of an algebraic problem solving (DI, PALS, and self-monitoring). This instructional intervention will employ the use of scaffolding techniques to lead students to independence in solving one-step algebraic equations.

The intervention will take place over a period of 15 school days (10 instructional days, along with 5 days for assessment purposes). Current research suggests that it takes approximately 10 to 15 days for effective group instruction (Montague, 2003). Teachers within the study will also be given the opportunity to observe individual intervention techniques. Pre-intervention training will aim to ensure that teachers have background knowledge of evidence-based instructional strategies, while also emphasizing the importance of teaching algebra to students with disabilities. The intervention will be divided into five aspects: (1) piloting of pretest, (2) pretest/present level of student performance, (3) instructional time given to students, (4) posttest measures, and (5) maintenance measures.

Classroom assignment. The second independent variable for this study will be "classroom assignment". Although researchers are rarely faced with "random effects" based on classroom settings, one cannot assume that variables in each of the chosen classrooms will be “fixed”. Classroom variables such as years of teaching experience, years of teaching in an inclusion setting, number of students in the classroom, grade level, or educational level of classroom teacher can all have effects on dependent variables measured throughout an experimental study. Therefore, in an attempt to generalize results to students with disabilities beyond the chosen inclusive settings, the use of “classroom assignment” will be used as a sampling design variable (which of six classrooms the student is enrolled). This will allow findings to be generalized to a much larger population (considering it is based on a normal distribution).

This section is designed to give in-depth details of instructional procedures that will take place for both experimental and comparison groups. Since instruction will be led by the investigator, it is important to provide specifics by including DI lesson plans, peer assisted learning techniques, and self-monitoring checklists. Providing a list of systematic procedures will allow for future replication of this study. To also ensure the integrity of this study, it is necessary that both groups receive interventions containing evidence-based instruction.

Instructional package (experimental group). Students in this condition will receive instruction incorporating a variety of evidence-based math practices (DI, PALS, and self-monitoring) for a period 10 school days. Each lesson will be based on the three-phase instructional model of lesson planning documented in a *Report to the California State Board of Education and Addendum to Principal Report Review of High Quality Experimental Mathematics Research* (a meta-analysis of 100 research studies by Dixon, Carnine, Lee, Wallin, & Chard, 1998). Within this report, researchers noted that effective lesson plans consist of three phases (see Figure 1).

Phase 1 (Teacher Input)		
Teacher demonstrates, explains, ask questions, or conducts discussions	→	Students are actively engaged and actively responding
Phase 2 (Guided Practice)		
Teacher, peers, and/or groups help with gradual release of responsibility	→	Students receive feedback, corrections, and/or additional explanations if needed
Phase 3 (Independent Practice)		
Teachers assess students' ability to apply knowledge	→	Students demonstrate ability to independently recall knowledge, only after they have achieved success during guided practice

Figure 1. Effective phases of lesson planning.

Phase 1 (teacher input) of instruction will begin with approximately 35 minutes of teacher-led DI. The teacher input phase not only involves teaching of new skills, but also states the lessons objectives, tells students why the skills is important, and reviews previously taught skills. DI will be based on modifications of scripted lessons taken from the *Connecting Math Concepts Level F* program developed by SRA (Engelmann, Bernadette, & Carnine, 1997)**.** *Connecting Math Concepts* is "a comprehensive developmental mathematics program designed to teach students to compute, solve problems, and think mathematically" (Marchand-Martella, 1999-2005). As with all DI programs, *Connecting Math Concepts* includes (a) explicit lesson/scripts, (b) choral responses with visual signals, (c) individual turns, and (d) immediate error correction and/or affirmation procedures. A sample lesson plan can be seen in Appendix C.

Throughout the DI lesson modeling of self-monitoring will be introduced. At the end of each equation modeled, the instructor will have a laminated checklist adhered to the blackboard. The instructor will take time to model checking each step of problem solving, while also taking time to verify answers for accuracy. Modeling of each step taken will assist in individual students' own metacognitive process (Hammer, 1994; Schoenfeld, 1987**).** A sample equation with an example of the self-regulation checklist can be seen in Figure 2.

1. Box	X – 25 = 13	
2. Inverse	+ 25 = + 25	
3. Solve	13 + 25 = 38	
4. Check	Does 38 – 25 = 13?	Yes!

Figure 2. Self-regulation checklist.

After 35 minutes of teacher-led DI, Phase 2 (guided practice) of the lesson will begin. During this phase students will be paired with a peer for approximately 30 minutes to work through guided practice sessions. Since the study will take place in inclusion settings, it will be easier to pair students based on ability levels. That is, students with higher levels of mathematical achievement with will be paired with students with lower levels of math achievement. Students in each pair will take turns acting as tutor-tutee.

Tutor training procedures will be discussed in subsequent paragraphs. Throughout this phase, the instructor will give several examples of one-step equations for students to work on. Each pair of students will share a self-monitoring checklist. Both tutors and tutees will be given a list of expectations and asked to follow the step-by-step metacognitive procedures to ensure proper problem solving of equations. The instructor will simply act as a facilitator during this phase by monitoring students and offering additional explanations when needed.

Phase 3 (independent practice for approximately 20 minutes) of instruction will give students an opportunity to independently recall what they have learned throughout the daily lesson. Students' abilities will be assessed in relation to objectives stated at the beginning of each lesson. During this phase students will not be allowed to work with peers, but will be asked to use their own self-monitoring checklists. This is extremely important, because it provides the investigator with feedback on student learning and progress. Since each lesson is planned to serve students in a 90-minute block, there will be an extra 5 minutes built in for transitions from one phase to another, behavior management issues, closure of the daily lesson, etc.

Once students have received five full instructional days of DI (along with metacognitive modeling) and peer assistance, each student will be given his/her own self-monitoring checklist. Individual checklists will be laminated and taped to students' desks. Students will also be given individual vis-a-vis markers and erasers for checking lists and erasing before moving to the next equation. Students will spend the next three school days learning how to self-monitor their own metacognitive thinking by working with peers to check each step of the problem solving process.

The remaining instructional days (two days) will be used to teach students to work independently without the assistance of peer or teacher intervention. Students will be asked to solve simple one-step equations using their own self-monitoring checklists. The investigator will spend approximately 25 minutes reviewing DI procedures for solving equations. Modeling of metacognitive procedures will also be used throughout the problem solving process. Students will, then, be asked to work independently to solve a variety of one-step algebraic equations.

DI only (comparison group). Students in this condition will receive the same amount of instruction over a period of 10 school days, which also consists of the 3 phase model developed by Dixon et al., (1998). Phase 1 of instruction will begin with 35 minutes of teacher-led DI. Daily scripted lessons, along with workbook activities will be followed accurately by the investigator. Each scripted lesson will be based on a typical 6-point lesson plan including: (1) objectives, (2) a review, (3) teacher-led DI, (4) guided practice, (5) independent practice with DI checks, and (6) a closure. Lessons will be comprised of teacher scripts, along with correct student responses to each signal that teacher presents.

The differences between comparison and experimental groups lie within Phases 2 and 3 of daily instruction. Although each phase will be allotted the exact same time commitments as the experimental group, traditional methods of classroom instruction will be used. Therefore, students will not work with peers during guided practice and will not be allowed to use self-monitoring methods during independent practice. Lessons will be given to participating teachers in both experimental and control groups at the end of the investigation. This will allow for future replication.

Peer tutor training. Training will take place as a class-wide activity. On the first day of instruction, the investigator will take approximately 30 minutes to train all students on the responsibilities of tutoring others. The importance of working in teams will be stressed, along with the use of appropriate feedback. The class will be asked to list benefits of helping others. They will also be asked to come up with a list of positive feedback to share with their tutee (“yes, that’s right”, “let’s try again”, “you’ve got it”, etc.). The investigator will take time to show examples of inappropriate feedback as well (e.g., “no”, “that’s not right”, “you are wrong”, etc.). Students will not be asked to share inappropriate examples to ensure the training remains in a positive direction.

Once peer work has begun, the investigator will simply act as a facilitator. This will be done by providing students with clear instructions to complete individual tasks, while also monitoring students closely to guarantee that they are working towards completing each task. Students will be given a list of expectations to follow throughout the PALS process. Steps include taking turns acting as tutor/tutee, providing immediate feedback, providing additional explanations/answering questions, sharing self-monitoring checklist, checking off each step of self-monitoring checklist, showing all work, and completing all guided practice problems.

Pairing of tutors/tutees. To maintain the integrity of peer assisted learning techniques, students will be placed in peer dyads based on the following procedures: (1) teachers will be asked to rank students based on math performances (including class grades and the previous school year’s end-of-grade test scores), (2) this list will be split in half (with the top half of the list representing stronger students and the bottom half representing weaker students), (3) names from each list will be placed in two separate containers (a container with top list names and a container for bottom list names), (4) students will, then, be randomly assigned by drawing names from each container and placing them in student pairs, and (5) classroom teachers will be asked to review each dyad to determine on appropriate peer matches based on abilities and personalities.

Data Analysis Procedures

Data from pretests and posttests will be analyzed using descriptive and inferential statistics. Sample sizes, means, and standard deviations for pretest and posttest measures will be reported. Outliers will be identified prior to initial data analysis. A discussion of each outlier will be provided and a final determination to include/exclude individual cases will be decided upon at this time.

Two-way analysis of variances (ANOVAs) containing repeated measures and an analysis of covariance (ANCOVA) will be conducted to examine the effects of grouping conditions across two measures. These measures will include a posttest involving *one and two-step algebraic problem solving* collected at the beginning and end of each instructional session. There are two independent variables with two between-subjects factor (grouping conditions and class assignment) and one within-subjects factor (three measures of the dependent variable, *solving one and two-step equations*). It is hypothesized that there will be a significant interaction because of differential effects between the grouping conditions and class assignments. Finally, effect sizes will be reported on each outcome measure.

Reliability

Procedural reliability will be measured at least three times during the intervention phase (through the use of lesson plan checklists and a list of peer tutoring expectations) to ensure that the investigator is teaching the entire lesson in the appropriate order (see Appendices D and E) and that peer tutors are following lesson expectations (see Appendix F). Lessons are designed to follow a certain format, so the checklist will match accordingly. Two separate data collectors that are blind to the study will observe three or more lessons, for both experimental and control groups, on a variety of occasions to confirm that each of them is being delivered as planned.

Inter-rater measures will also be used to check for reliability. One hundred percent of pretests/posttests will be scored independently by a second rater. This will make certain that both pretests and posttests are scored correctly. Agreement percentages will be calculated and reported (agreements should equal 90% or higher).

Validity

Content validity will be measured through the use of an expert panel. This panel will be made up of (a) a special education instructor that concentrates in teaching math to students with disabilities, (b) a regular education instructor that specializes in math instruction, and (c) a statistics instructor that is well-experienced in group design. This panel will be responsible for reviewing all materials including instructional lesson plans for both experimental and comparison groups, pretests, and posttests. The panel will meet on three separate occasions throughout the research experiment to determine if instructional materials, along with assessments, are aligned to NC Standard Course of Study for algebraic problem solving, including both one- and two-step equations.

Quality Indicators

Because of much debate involving quality educational research (Gersten, Baker, & Lloyd, 2000; Levin & O'Donnell, 1999; Mosteller & Boruch, 2002; Shavelson &

Towne, 2002), the consideration of quality indicators are just as critical as the method itself. According to Gersten et al. (2005), each study must maintain a proper set of standards that lend to more credible research. These standards are designed not only to increase the integrity of experimental research, but also to ensure proper assessment of findings. Therefore, Tables 3, 4, 5, and 6 were created to address individual quality indicators that were carefully regarded throughout the conceptualization and development of this study.

Table 3 describes steps that have been taken to ensure that this study meets standards for a “high quality” research proposal. To meet this standard, each of the following indicators must be met: (a) a conceptual framework of why the study is important, (b) sufficient information in describing students’ disabilities, (c) intervention for both experimental and control groups are appropriate and described in detail, (d) outcomes measures are aligned with intervention, (e) appropriate use of statistical analysis, and (f) other desirable indicators (e.g., blind study conditions, maintenance and generalization, interrater reliability, and content validity).

Table 4, on the other hand, provides quality indicators that warrant completion of a “high quality” research study. Although many of the indicators appear to be consistent with indicators in Table 3, Table 4 provides readers with a means of evaluating practices used throughout the study. Careful consideration of each indicator can potentially lead to a study which provides researchers with innovative and promising new instructional practices.

Table 3

Quality Indicators for Group Experimental Research Proposals

Indicator	*How will this be addressed?*
Conceptualization Underlying the Study	▪ Review of theoretical and empirical research literature surrounding all areas of visual map (teaching algebra to students with disabilities, self-monitoring, DI, PALS, and inclusion) ▪ Research questions will be reviewed by content experts in the field of mathematics and special education
Participants/Sampling	▪ To ensure salient characteristics across participants, all participants will be selected based on the following criteria: o grade level (sixth or seventh grade) o disability identification of students (mild disabilities) o setting (inclusion math class) o IQ scores ▪ An investigator trained specifically to use the algebra instructional interventions will deliver instruction to both experimental and comparison groups
Implementation of Intervention/Nature of Comparison Group	▪ Procedural fidelity checklist to ensure that intervention is followed correctly ▪ Comparison group will receive DI provided by the investigator
Outcome Measures	▪ A repeated measures ANOVA will be used to provide descriptive differences between two grouping conditions ▪ An ANCOVA will be used to determine variances between treatment conditions and classroom assignments
Data Analysis	▪ A repeated measures ANOVA will be used to determine variances between experimental and comparison groups ▪ Effect sizes will be specified in results section ▪ A power analysis will also be provided
Desirable Quality Indicators	▪ Data collectors/scorers will be blind to study conditions ▪ Maintenance and generalization measures will be gathered for more complex algebraic equations ▪ Interrater reliability will be measured on 20% of data ▪ Pretest/posttest will be measured for content validity (through the use of content experts)

Table 4

Quality Indicators for Group Experimental Research Articles and Reports

Indicator	*How will this be addressed?*
Describing Participants	▪ Participants will be chosen based on IEP classifications (Mild Disabilities) ▪ To confirm that all participants demonstrate learning/social difficulties the following characteristics will be given o grade level (sixth or seventh grade) o disability identification of students (mild disabilities) o setting (inclusion math class) o IQ scores
Implementation of Intervention/Description of Comparison Group	▪ Training of experimental group will be described in detail throughout Method section ▪ Procedural fidelity checklist will be used to ensure proper training and intervention techniques
Outcome Measures	▪ A repeated measures ANOVA will be used to determine variances between experimental and comparison groups ▪ Phases include: pretest, posttests (teacher directed instruction, peer instruction, self-monitoring, and generalization)
Data Analysis	▪ Statistical results will be reported for each dependent measure ▪ Effect sizes will be reported
Desirable Quality Indicators	▪ Attrition rates will be reported in results section ▪ Data collectors/scorers will be blind to study conditions ▪ Maintenance and generalization measures will be reported for more complex algebraic equations ▪ Interrater reliability will be collected on 20% of data ▪ Pretests/posttests will be measured for content validity (through the use of content experts)

Tables 5 and 6 address the researcher’s attempts to control for both internal and external validity. For example, in an attempt to control for internal threats to validity (history, maturation, selection, mortality, compensatory rivalry, resentful demoralization, testing, and experimenter bias) the researcher will use a comparison group with a large number of participants, along with collecting data over a short period of time. Pretests and posttests will be checked for content validity, equal instructional time will be given to each grouping condition, and raters will be blind to the intervention. In an attempt to control for external validity (generalization to different groups, other settings, and past/future situations), participants will be described in detail, students will receive the intervention with their typical math class, and generalization measures using more complex two-step equations will be collected.

Table 5

Controls for Internal Threats to Validity

Internal Threat	*How will it be controlled?*
History	▪ Comparison group will be used ▪ Intervention will not extend over a long period of time
Selection	▪ Random assignment to treatment by classroom
Mortality	▪ Larger number of participants will be used in the beginning of the study
Compensatory rivalry	▪ Confidentiality agreement ▪ Control group will be trained to use the instructional package after the data has been collected
Resentful demoralization	▪ Equal attention will be given to both experimental and comparison group
Testing/instrumentation	▪ Tests will be checked for content validity through the use of content experts ▪ Retests will be changed using random algebraic equations of equal complexity
Experimenter Bias	▪ Study simply compares two grouping conditions ▪ No expectations of experimental or comparison groups being more successful than the other ▪ Two separate investigators that are blind to the study will observe three or more lessons (for both experimental and control groups) to confirm that each lesson is being delivered as planned

Table 6

Controls for External Threats to Validity

External Threat	*How will it be controlled?*
Generalization to different groups	▪ Other algebra interventions with varying populations will be reported, along with suggestions for future research ▪ Each group of participants will be described in detail to help readers generalize o Grade level o disability identification of students (mild disabilities) o average IQ scores
Generalization to other settings	▪ Students will receive intervention where they generally receive math instruction (math class)
Generalization to past/future situations	▪ Generalization measures will be collected and reported using more complex algebraic equations

In summary, the purpose of this study is to compare two instructional grouping conditions on the ability of students with mild disabilities to solve one-step algebraic equations. Conditions consist of two groups (1) DI only and (2) an instructional package involving three evidence-based practices (DI, PALS, and self-monitoring). By offering an in-depth look at procedures and structuring of this study, it possible to maintain both reliability and validity, while also minimizing internal (history, selection, mortality, compensatory rivalry, resentful demoralization, testing, and experimenter bias) and external (generalization to different groups, other settings, and past/future situations) threats.

CHAPTER 4: RESULTS

The purpose of this study was to investigate the use of an algebra instructional package that combines a set of strategies (DI, PALS, and self-monitoring) to teach one-step algebraic equations to middle school students with mild disabilities in inclusive settings. There were four steps in this study: (1) pretest or present level of student performance before instruction begins, (2) instructional intervention with students, (3) posttest measures taken at the end of the instructional phase, and (4) maintenance measures taken two weeks after instructional intervention ended.

Student performance in both experimental and comparison groups was compared to explore individual research questions. Forty-three middle school students with disabilities were asked to participate in the study. All students that were invited to participate agreed by signing assent forms and having parents sign consent forms. The experimental group received the instructional package that allowed for fading of prompts to teach algebraic equations. The comparison group received DI only. Independent variables for this study were the grouping condition in which students were assigned (experimental vs. comparison) and classroom assignment. Dependent measures collected throughout this study included student's ability to complete one and two-step algebraic equations independently without the use of a self-monitoring checklist. Data was collected based on students' ability to correctly solve simple equations using a step-by-step problem solving strategy.

This chapter will present results of the data analyses. First, evidence of procedural reliability, including measures of reliability, and content validity will be reported. Next, participating classroom demographics will be provided, along with characteristics of students which participated in the study. Lastly, the results of repeated-measures ANOVAs and ANCOVA will be reported to reveal effects of each grouping condition on student performances.

4.1 Procedural Reliability/Content Validity

Procedural reliability was determined three times during the duration of the intervention phase. The researcher took time to train two separate observers that were blind to the study (unaware of dependent and independent measures). Observers included two students from the Special Education Graduate Program at the University of North Carolina at Charlotte. Observers were instructed to place a "check" on the procedural checklist if the researcher accurately presented the lesson as intended and to place and "X" if the item was left out or presented inaccurately. Observers were also asked to write notes in the column next to the checklist to ensure that the researcher could resolve any problems that may arise during the presentation of lessons.

The first measure was to ensure that the investigator was teaching algebra lessons as planned. Lessons were observed by the two observers and rated independently. Data collectors visited each of the four classrooms on three separate occasions for a total of 12 visits. While in the classroom, they were given a lesson plan checklist (see Appendix D) to confirm that both experimental and comparison groups were as described in Chapter 3. Procedural fidelity checklists determined 100 percent accuracy (*102 Agreements/102 Total*) of delivery across each of the four classes taught.

Secondly, observers were given a checklist of peer tutoring expectations (see Appendix E) to observe throughout lessons reserved for the two classrooms in experimental group only. This list helped the investigator determine if peer tutors/tutees were following appropriate tutoring techniques (that had previously been taught to them). Data from the checklists indicated that peer tutors were following expectations at an accuracy rate of 98 percent (*53 Agreements/54 Total*).

The third measure of reliability was collected to confirm scoring agreements for pretests and posttests. Trained observers were asked to score pretests and posttests of participants to ensure reliability of scoring techniques. Observers were instructed to score students based on the following scale: (a) 3 points for writing the correct answer with all work shown, (b) 2 points for correct use of the problem solving strategy with all work shown, but not receiving the correct answer due to a fact error, (c) 1 point for an attempt to solve problem with all work shown, but not using the correct strategy, and (d) 0 points for not attempting to answer or show work. A random selection of approximately 33% of pretests and posttests were scored and agreement percentages were calculated. Inter-rater reliability agreement was found to be 92 percent.

An expert panel comprised of (a) a special education instructor that concentrates in teaching math to students with disabilities, (b) a regular education instructor that specializes in math instruction, and (c) a statistics instructor that is well-experienced in group design met on three separate occasions throughout the research experiment. Materials including pretest, posttest, and lesson plans created by the investigator were reviewed by the panel to determine the degree to which the materials were representative of the content area. The panel found that all materials were aligned to the NC Standard

Course of Study for algebraic problem solving, including both one- and two-step equations.

4.2 Description of Class Assignments

The following paragraphs describe each of the four classes participating in the study. Each description includes the number of students pre-tested and post-tested. Given that the intervention process lasted for a short period of time (15 days) attrition rates for both experimental and comparison groups was equal to 0%. Classroom characteristics will be provided, including teacher demographics, students within each setting, and length of instructional sessions. Classes within this school were based on 90 minutes of block scheduling, therefore, instructional sessions will be described for each participating class.

Class One. This class was assigned to the experimental group. It was a 7th grade inclusion math class with 18 regular education students and 11 special education students (for a total of 29 students). Pretests and posttests were administered to all 11 special education students. Students were taught using the instructional package involving the use of DI, peer tutors, and self-monitoring. This class received approximately 35 minutes of teacher-led DI, then 30 minutes of peer-assisted guided practice followed by 20 minutes of self-monitoring independence.

Class Two. This class was a 6th grade inclusion class with 21 regular education students and 9 special education students (for a total of 30 students). Pretests and posttests were given to each of the 9 students with disabilities. Students in the group were also instructed using the experimental instructional package. Therefore, students received

35 minutes of teacher-led DI, 30 minutes of peer-assisted guided practice, and 20 minutes of independent work involving the self-monitoring checklist.

Class Three. This class was a 6th grade inclusion class with 18 regular education students and 10 special education students (for a total of 28 students). Students classified as having a disability were pre-tested and post-tested ($n = 10$). This setting was part of the comparison group which received DI only. Therefore, scheduled lessons included 35 minutes of teacher-led DI, 30 minutes of DI guided practice, and finally 20 minutes of independent practice.

Class Four. This class was a 7th grade inclusion class with 17 regular education students and 13 special education students (for a total of 30 students). All 13 special education students were given pretests and posttests. This group was also a part of the comparison instructional methods which received 35 minutes of teacher-led DI, 30 minutes of DI guided practice, and finally 20 minutes of independent practice without the use of self-monitoring checklists.

4.2 Descriptive Statistics

Before performing data analyses, it was important to scan the pretest data for normality, outliers, and missing data. This helps to identify outliers and homogeneity of students within the study. Results indicated there were no missing values. After examining the descriptive statistics, along with a visual scan of boxplots, only one outlier was identified. Dependent measures ranged from 0 to 45, with one participant in the experimental group scoring close to the maximum score of 45 (a score of 34). Since this score was not unusually far from other pretest scores, it was decided to include the outlier in data analysis. Once considerable outliers were identified, tests for normality indicated that all skewness and kurtosis levels were less than the absolute value of 1.0. Therefore, no serious departures for normality were revealed. Levene's test for homogeneity indicated that group variance was nonsignificant (*p*= .919). The assumption of equality of covariance was satisfied for all analyses. Otherwise, group sizes are fairly equal (experimental *n* = 20 and comparison *n* = 23), *F* is robust against any violation of assumptions (Stevens, 1999).

4.3 Research Questions

Question number 1. Is there a difference between experimental (instructional package including DI, PALS, and self-monitoring) and comparison groups' (DI only) of middle school students' (with mild disabilities) abilities to independently solve one-step algebraic equations?

A two-way analysis of variance (ANOVA) containing repeated measures was conducted to examine the effects of grouping conditions across two measures. These measures included pretests and posttests involving *one and two-step algebraic problem solving* collected at the beginning and end of the 10 day instructional session. There are two independent variables with two between-subjects factors (grouping conditions and class assignment) and one within-subjects factor (two measures of the dependent variable, *# of correct one and two-step equations*). It was hypothesized that there would be a significant interaction due to differential effects between the grouping conditions and class assignments. The means and standard deviations for the two measures of algebraic problem solving by grouping conditions are reported in Table 7.

Table 7

Means (Maximum Score of 45), Standard Deviations, and Sample Sizes for Measures of Algebraic Problem Solving by Grouping Conditions

	Group	M	SD	N
Pretest	Instructional Package	17.15	9.762	20
	DI Only	17.70	9.537	23
	Total	17.44	9.530	43
Posttest	Instructional Package	39.15	4.891	20
	DI Only	39.39	6.081	23
	Total	39.28	5.496	43

The assumption of homogeneity of covariance matrixes was found to be tenable (Box's *M*=5.137, *p*=.182). There was a statistically significant within subject effect [$F(1, 41) = 579.6$, $p<.001$, $\eta^2=.934$], but there was no significant interaction reported [$F(1, 41) = .028$, $p= .868$, $\eta^2=.001$]. In addition, results suggested that there was not a statistically significant between subjects effect, $F(1,41) = .031$, $p=.861$, $\eta^2=.001$]. The results suggest that students in both experimental and comparison groups had similar growth pertaining to pretest and posttest results; however, students in both groups made significant gains in the ability to solve one and two-step equations after receiving 10 days of either the instructional package or DI.

Question number 2. Is there an interaction between "grade level" and treatment conditions on students' ability to independently solve one-step algebraic equations after controlling for pretest scores?

Classroom assignment includes variables which may have mediating effects on students' performances (grade level, years of teaching experience, years of teaching in an inclusion setting, number of students in the classroom, and educational level of classroom teacher). Since students from both 6^{th} and 7^{th} grades, along with 4 different teachers participated in the study it was important to not to make assumptions based on each student's classroom assignment.

Although a test of homogeneity suggested that students in both grade levels were performing on comparable ability levels, we must also take a closer look at the students' grade level. Dependent measures, such as pretest and posttest scores, could possibly be affected due to predetermined factors that are often out of a researcher's control; therefore, grade level was a factor that was covaried based on pretest scores of students. The following table shows a list of classroom demographics that were considered for purposes of collecting accurate data throughout the study.

Table 8

Class Assignment Demographics

Class	Grade Level	Total # of Students	# of Sped. Students	# of Reg. Ed. Students	Teacher's Education Level	Years of Teaching Experience	Years of Inclusion Experience
Class 1 (Experimental)	7th	29	11	18	Master's Special Education	6	4
Class 2 (Experimental)	6th	30	9	21	B. S. Special Education	15	3
Class 3 (Comparison)	6th	28	10	18	Master's Special Education	9	2
Class 4 (Comparison)	7th	30	13	17	B. S. Special Education	4	4

As stated in the above paragraphs, it was hypothesized that there would be a significant interaction due to differential effects between the grouping conditions and class assignments. An analysis of covariance (ANCOVA) was used to examine differences between treatment conditions and grade level on students' ability to solve one-step algebraic equations after controlling for students' pretest scores before instruction had begun. As stated previously, the data were screened for outliers and normality. Independent variables were type of treatment condition (instructional package or DI only) and grade level (6^{th} or 7^{th}), the dependent variable was *ability to independently solve algebraic equations* after 10 days of instruction. The covariant was pretest scores on 15 algebraic equations. The means, adjusted means, and standard deviations for posttest scores by treatment conditions and grade level are reported in Table 9. The correlation coefficient between the pretest and posttest was .718, which suggests an adequate relationship for using pretest scores as a covariate. The means, adjusted means, standard deviations, and sample sizes for the algebraic problem solving by grouping condition and grade level are reported below.

Table 9

Means, Adjusted Means, Standard Deviations, and Sample Sizes for Measures of Algebraic Problem Solving by Treatment Condition and Grade Level

Treatment	Grade	M	Adj. M	SD	N
Experimental	6th	38.78	38.83	5.59	9
	7th	39.45	39.67	4.50	11
	Total	39.15		4.89	20
Comparison	6th	38.50	37.74	6.62	10
	7th	40.08	40.44	5.81	13
	Total	39.39		6.08	23

The assumption of homogeneity of regression lines was examined and found to be tenable, $F_{(1,39)}$ =.1.275, p=.266. The results of the ANCOVA are reported in Table 10. There was not a significant difference between treatment conditions or grade level on the adjusted posttest for solving algebraic equations, $F_{(1, 38)}$ =.969, p=.331.

Table 10

ANCOVA Results

Source	*Df*	Mean Square	*F*	Sig.
Corrected Model	4	227.86	24.24	<.001
Intercept	1	8990.39	956.36	<.001
Pretest	1	894.48	95.15	<.001
Group	1	.26	.03	.868
Grade level	1	32.88	3.50	.069
Group*Grade Level	1	9.11	.97	.331
Error	38	9.40		
Total	43			
Corrected Total	42			

These results suggest that there were no differences between treatment conditions or grade levels on the ability to independently solve algebraic equations. Results also suggest that both grade levels had similar growth pertaining to posttest results; however, students in the 7^{th} grade had slightly higher posttest scores (approximately by 1 point or less) after 10 days of instruction.

Question number 3. Is there a difference between experimental or comparison groups' ability to maintain the effects of multi-step strategy for at least two weeks after instruction has ended, leading to independence in solving one-step algebraic equations?

Measures based on maintenance of the dependent variable were collected approximately two weeks after total completion of both experimental and comparison instructional methods had ended. Maintenance of results are not only important to this study, but are considered to be a quality indicator that ensures reliable findings within experimental research (Gersten et al., 2005). Therefore, maintenance measures, including means and standard deviations for the two measures of algebraic problem solving by grouping condition are reported below.

Table 11

Means (Maximum Score of 45), Standard Deviations, and Sample Sizes for Pretest, Posttest, and Maintenance Measures by Grouping Condition

	Group	M	SD	N
Pretest	Experimental	17.15	9.762	20
	Comparison	17.70	9.537	23
	Total	17.44	9.530	43
Posttest	Experimental	39.15	4.891	20
	Comparison	39.39	6.081	23
	Total	39.28	5.496	43
Maintenance	Experimental	40.95	4.371	20
	Comparison	34.04	6.011	23
	Total	37.26	6.302	43

A two-way analysis of variance (ANOVA) containing repeated measures was conducted to examine the effects of grouping conditions across pretests, posttests, and maintenance (collected two weeks after all instructional sessions had ended) tests scores involving *one and two-step algebraic problem solving*. There was one independent variable with two between-subjects factor (grouping conditions) and one within-subjects factor (three measures of the dependent variable, *solving one and two-step equations*). The assumption of homogeneity of covariance matrixes was not violated (Box's

M=7.402, *p*=.339). There was a statistically significant within subject effect [$F(2, 82) = 334.2$, $p<.001$, $\eta^2 = .891$], and there was also a significant interaction reported [$F(2, 82) = 10.09$, $p<.001$, $\eta^2=.198$]. In addition, there was not a statistically significant between subjects effect, $F(1, 41) = 1.17$, $p=.286$, $\eta^2=.028$].

A graph of the interaction can be seen in *Figure 3*. The results of this interaction imply that although students in both groups scored similar measures on pretests and posttests, students in experimental groups continued to score comparable points (approximately one point higher than posttest) for up to two weeks after math instruction had ended. Furthermore, students in comparison groups had lower test scores (approximately five points lower) than previously collected during posttest measures, therefore, suggesting that students that were taught using the instructional package (DI, PALS, and self-monitoring) were more likely to retain problem solving strategies than students whom only receive DI.

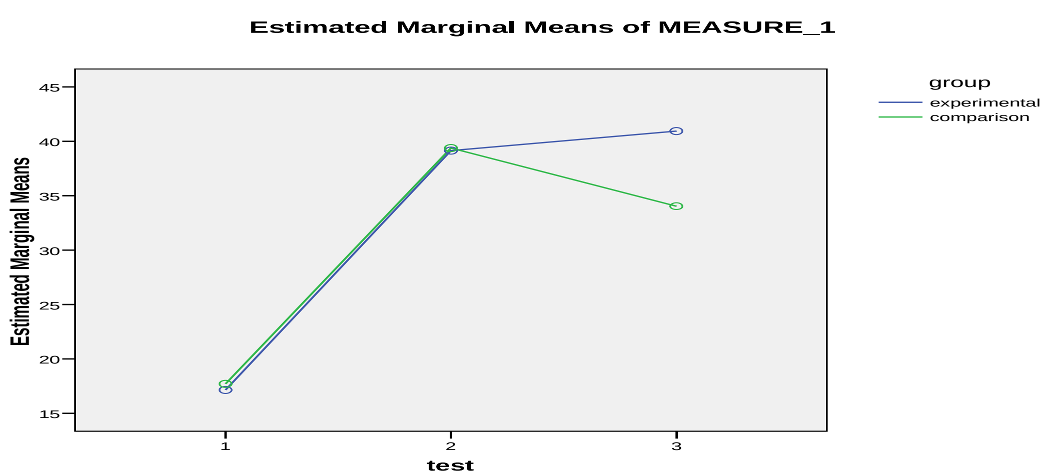

Figure 3. An illustration of the interaction between grouping conditions and pretest, posttest, and maintenance test scores.

Question number 4. Is there a difference between experimental or comparison groups' ability to generalize the effects of multi-step strategy, leading to strategy use with more complex two-step algebraic equations?

According to Alberto & Troutman (1999, p. 495), generalization refers to the "expansion of student's capability of performance beyond those conditions set for initial acquisition". To determine if students were able to perform skills beyond what was taught during the 10 days of instruction, generalization measures were collected. Two-step equations (five of the 15 equations) were given as part of pretests and posttests for the purpose of measuring complex problem solving. Two-step equations are those which contain one unknown variable, but require two different steps such as multiplication/ division and addition/subtraction to solve (e.g., 3x + 6 = 12). Measures of generalization from both pretests and posttests, including means and standard deviations for the two-step problem solving by grouping condition are reported below.

Table 12

Means (Maximum Score of 15), Standard Deviations, and Sample Sizes for Pretest and Posttest Generalization Measures by Grouping Condition

	Group	M	SD	N
Pre-Generalization	Experimental	.65	.988	20
	Comparison	.78	.998	23
	Total	.72	.984	43
Post-Generalization	Experimental	9.15	4.891	20
	Comparison	9.43	6.006	23
	Total	9.30	5.453	43

A two-way analysis of variance (ANOVA) containing repeated measures was conducted to examine the effects of grouping conditions on students' ability to generalize instructional strategies *to more complex two-step algebraic equations*. The assumption of homogeneity of covariance was found to be tenable (Box's M= 2.422, p=.514). Although there was not a significant interaction reported [$F(1, 41) = .011$, $p= .919$, $\eta^2<.001$], there was a statistically significant within subject effect [$F(1, 41) = 133.55$, $p<.001$, $\eta^2=.765$]. In addition, there was not a statistically significant between subjects effect, $F(1, 41) = .047$, $p=.829$, $\eta^2=.001$]. Results suggest that there were no statistically significant differences in groups' ability to generalize strategies to more complex problem solving. Students in both groups were found to receive higher scores (approximately 8 points higher) on posttest measures for solving two-step algebraic equations.

Summary

The current study compared two grouping conditions (DI only and an instructional package) on 6th and 7th grade students' (with mild disabilities) ability to solve algebraic equations in inclusive settings. Results concluded that there were no differences between experimental for comparison groups based on students' abilities to independently solve one-step equations. In addition to these results, it was also suggested that students in both 6th and 7th grade levels had similar growth on posttests after 10 days of instruction (with 7th graders scoring a mere 1 point higher).

Further results indicated that students in experimental groups had higher retention rates than students in comparison groups for up to two weeks after instruction had ended. Finally, results suggested that there were no statistically significant differences in groups' ability to generalize strategies to more complex problem solving. Students in both treatment groups scored approximately 8 points higher on posttest measures for solving two-step algebraic equations.

CHAPTER 5: SUMMARY AND DISCUSSION

The purpose of this study was to investigate the use of an algebra instructional package that combines a set of strategies (DI, PALS, and self-monitoring) to teach one-step algebraic equations to middle school students with mild disabilities in inclusive settings. The ultimate goal of this study was to promote student independence in solving algebraic equations (without the use of prompts expressed by teachers or peers).

Classrooms were initially selected based on the following criteria: (a) students must be classified as having a mild disability (e.g., learning disabilities, behavioral disorders, and ADHD, as well as other mild conditions such as Asperger Syndrome) based on their individualized lesson plan (IEP), (b) the classroom in which the student currently recieved math instruction must have been an inclusion setting, and (c) the grade level in which the students were currently enrolled must have been sixth or seventh grade. Therefore, four classrooms from one particular school was chosen to participate.

Prior to data collection, students were assigned to peer tutors based on the following procedures: (1) teachers were asked to rank students based on math performances, (2) this list was then divided into two lists (stronger and weaker students), (3) names from each list were placed in two separate containers, (4) students were, then, randomly assigned by drawing names and creating student pairs, and (5) classroom teachers were asked to review each dyad to determine appropriate peer matches based on abilities and personalities.

Once data collection began, dependent measures included pretests and posttests based on individual student's ability to solve one-step equations independently without the use of a self-monitoring checklist. Solutions to equations were measured using a 3-point scale. Students received: (a) 3 points for writing the correct answer with all work shown, (b) 2 points for correct use of the problem solving strategy with all work shown, but not receiving the correct answer due to a fact error, (c) 1 point for an attempt to solve problem with all work shown, but not using the correct strategy, and (d) 0 points for not attempting to answer or show work. Therefore, a total of 3 points could be earned for each equation answered correctly. Since each pretest/posttest contained 15 algebraic equations, students had the opportunity to score between zero and 45 points.

During instructional sessions, the researcher acted as the instructor for both experimental and comparison groups. Students in experimental groups received an instructional package (PALS, DI, and self-monitoring checklist) and students in comparison groups received DI only. Dependent variables were analyzed using two-way ANOVAs with repeated measures including two between-subjects factors and one within-subjects factor. All other data were analyzed using ANCOVA (pretest measures determined as covariate).

A randomized block design with pretest and posttest was used for this study. Students were assigned to experimental or comparison groups using a randomized block design. Students in the sixth grade were placed in the first block and students in the seventh grade were placed in the second block. Therefore, individual classrooms from each block were randomly assigned to one of two grouping conditions (Experimental: instructional package or Comparison: DI only).

5.1 Discussion

Discussion of results from this study will be presented in a manner related to specific research questions. Recommendations for future research and implications for practice will be presented to provide educators with effective techniques for teaching students to work independently to solve a variety of skills related to math problem solving.

Question number 1. Is there a difference between experimental (instructional package including DI, PALS, and self-monitoring) and comparison groups' (DI only) of middle school students' (with mild disabilities) abilities to independently solve one-step algebraic equations?

The researcher found that when middle school students with mild disabilities are taught using either DI or an instructional package containing DI, PALS, and self-monitoring they were able to solve one and two-step algebraic equations independently. Findings from this particular study parallel that of previous research, which indicates that direct and explicit instruction has largely been established as the most effective method for teaching basic mathematic skills to students with mild disabilities (Kroesbergen, 2003).

Although students in both experimental and comparison groups made substantial gains in algebraic problem solving, the current study broadened special education literature by combining three effective research-based practices and presenting them in a strictly controlled environment. As stated at the beginning of this study, the majority of algebra studies involving students with disabilities simply focus on the use of one particular strategy to teach algebraic word problems (e.g., concrete manipulatives, mnemonics, self-regulation, cue cards, peer tutoring, or videodiscs). Prior studies have also neglected to teach students with disabilities to work independently without the use of teacher/peer prompting or computer-assisted instruction leading them step-by-step through the problem solving process.

The instructional package (an independent variable) for this study was designed to lead students through the process of algebraic problem solving (teacher instruction, peer assisted instruction, self-monitoring, and independence). Participants within the study were not only exposed to teacher modeling of step-by-step problem solving, but also learned to implement their own self-monitoring strategies through the use of cognitive prompts. Therefore, the ultimate goal of students' independently solving one and two-step algebraic equations was accomplished.

As mentioned in Chapter 2, Calhoon and Fuchs (2003) used the PALS method of teaching algebra to students with learning disabilities. Similar to previous studies, this study focused on the use of one instructional method, PALS, where students with disabilities were tutoring other students with disabilities in self-contained resource classrooms. The current study made use of the PALS method of teaching but, ultimately chose peers without disabilities to alternate roles (acting as tutor/tutee) with students with disabilities in general education inclusion classrooms. This allowed students in the experimental group to discuss solutions to problems and provide support to one another when errors occurred. Since the majority of PALS research suggest that both tutors and tutees can profit socially and academically (Fuchs et al., 2002; Rohrbeck et al., 2003), it is safe to say that when students with disabilities are given the opportunity to share tutoring responsibilities they can be successful in solving algebraic equations.

Question number 2. Is there a difference between the six individual "classroom assignments" and their students' abilities to independently solve one-step algebraic equations?

Although students in both 6th and 7th grade participated in the study, results suggest that there were no differences between experimental or comparison treatment conditions or grade levels on the ability to independently solve algebraic equations. In addition, both grade levels received almost equivalent scores on posttests, with students in the 7th grade scoring less than 1 point higher. With this in mind, we can now conclude that both treatment conditions had comparable effects on student achievement in both grade levels.

This finding is interesting, because the typical educator would assume that 7th grade students would score higher than 6th grade students on any given academic measure. What must also be taken into consideration are mediating factors that may have an effect on student performance. With this in mind, all classroom factors were accounted for and pretests were used as covariates. Results indicated that regardless of treatment condition, grade level, teacher experience, or teacher education, students were able to make significant strides (approximately 22 points higher than pretest scores) in the ability to solve one and two-step equations independently.

Question number 3. Is there a difference between experimental or comparison groups' ability to maintain the effects of multi-step strategy for at least two weeks after instruction has ended, leading to independence in solving one-step algebraic equations?

Because classroom teachers agreed not to provide instruction or review related to algebraic problem solving, it is fair to say that students receiving the instructional package were more likely to maintain the ability to independently solve algebraic equations. Furthermore, students in comparison groups had lower test scores (approximately five points lower) than previously collected during posttest measures, therefore, suggesting that students that received the instructional package were more likely to retain problem solving strategies than students whom only receive DI.

The importance of this finding focuses specifically on the ability of students to work independently once teachers have stopped teaching simple equations and move on to more complex problem solving. The majority of regular education teachers plan their lessons based on a curriculum pacing guide, thus, moving students along from one grade level objective to the next. Special education teachers are no exception to this rule. For this reason, many students with disabilities are often “left behind” still trying to master skills that were taught earlier in the year. The instructional package not only teaches students to feel comfortable asking peers for assistance, but also gives them a self-monitoring technique that can be used for the simplest algebraic objective (solving one-step equations) to the most complex equation (those with several missing variables).

DI lessons, alone, rarely take time to teach students how to monitor their own learning. For this reason, students with disabilities are often confused when left alone to work independently. The process of allowing students to work with peers, while also using their own self-monitoring techniques, gives them a strategy for solving equations without ongoing teacher assistance. Consequently, when students are left alone to solve algebraic equations they are equipped with the tools needed to successfully complete their assignments without relying on prompts given by teachers or peers.

Question number 4. Is there a difference between experimental or comparison groups' ability to generalize the effects of multi-step strategy, leading to strategy use with more complex two-step algebraic equations?

Generalization measures were collected to determine if students were able to utilize problem solving techniques taught during the 10 days of algebraic instruction for skills needed to solve more complex equations. Although students were able to generalize effects of this multi-step strategy (leading to strategy use with two-step equations), results indicated that there were no statistically significant differences between experimental and comparison groups. Students in both groups scored approximately 8 points higher on posttest measures than previously measured pretest scores. As a result of this finding, one could consider the use of DI or the instructional package as being a successful instructional method for teaching math strategies to students with mild disabilities.

In 2000, Maccini and Hughes stated that their research was limited, because it only focused on one specific type of problem within algebra (solving equations involving integers). Researchers recommended that future mathematics' research should explore the effects of instructional strategies on the many facets surrounding the concept of algebra. The current study was able to address this issue by combining a variety of effective instructional practices into a 90 minute lesson plan which addressed abstract concepts (solving for more than one unknown variable) along with collecting generalization data surrounding more complex equations.

5.2 Limitations and Recommendations for Future Research

Although this study found that combined instructional strategies can account for possible solutions in teaching algebra to students with disabilities, there were several limitations suggesting that continued research is still needed. Limitations include length of study, focusing solely on quantitative data, and not allowing typical classroom teachers to deliver instruction. Recommendations for future studies include longitudinal data collection, true randomization of treatment conditions, collecting qualitative research measures, and allowing typical classroom teachers to deliver instruction for the purpose of collecting standardized data. Further details of limitations and recommended areas of math research are provided in the following paragraphs.

First and foremost, the length of the intervention was not considered ideal for optimal learning effects. Due to time restraints, this study involved shortened instructional periods with even less time to assess students to determine whether the interventions contributed for more positive classroom environments. Future research, using a longitudinal study with true randomization would help to address several of these concerns. It would be advantageous for researchers to begin instructional interventions prior to pre-algebra courses. This would allow for students with disabilities to prepare for algebra at an early age (e.g., sixth or seventh grade).

True randomization could easily occur at this phase. Researchers could randomly place students in either treatment condition prior to entering middle school. Since DI, PALS, and self-monitoring are all considered effective research-based practices, no students would be at risk of receiving improper instructional techniques. Researchers could, then, continue the study by following students throughout their entire educational career.

In addition, this study only focuses on quantitative data collected based on one component of algebraic problem solving (solving equations); therefore, it is essential that future research explore the effects of this strategy on the many facets surrounding the concept of algebra. The instructional package could easily be implemented as a teaching mechanism for a variety of abstract concepts of algebra, such as solving for unknown variables found in word problems, organizing and solving proportions, or visually graphing equations.

By collecting quantitative data, we are only beginning to scratch the surface when it comes to teaching algebra to students with disabilities. Data collected for future research should not only focus on quantitative measures of students' abilities, but also look into teacher, student (both special and regular education) and parent perceptions of treatment conditions, including peer tutoring and self-monitoring techniques. This can be done by collecting qualitative measures, for example, social validity data, surveys, or one-on-one interviews at the beginning and end of the instructional process. It is also possible to delve into social consequences that the instructional package may have on self-esteem, student behavior, motivation, etc.

A separate limitation of this study is that it did not include a comparison group that received instruction from their typical classroom teacher. In an attempt to control for teaching and classroom effects, both intervention and comparison groups were taught by the researcher (a trained professional in the area of DI, PALS, and self-monitoring) in a tightly controlled setting. Consequently, we do not know what effect students' usual classroom teachers would have on the performance of posttest measures.

Additional areas of research may include training special education teachers to develop their own instructional packages. Classroom teachers generally know their students better than anyone. By allowing teachers to develop their own instructional packages (combining a set of given research-based practices), researchers could learn to listen to teacher instincts rather than their own. Once teachers have decided on an instructional package, group or single subject comparisons could be investigated on the basis of each individual classroom.

Since the majority researchers do not have time to teach an entire semester or year-long course, collecting data for a larger population of individual classrooms could be a challenge. Researchers who are interested in the effects of combining effective practices into instructional packages could simply monitor classroom teachers for procedural reliability on a weekly basis. Hence, standardized data could be collected by looking at end-of-grade or end-of course math scores of teachers participating in the study.

5.3 Implications for Practice

These results are not only important to researchers, but they can also be helpful in assisting special and general educators with current instructional approaches needed for students that struggle with abstract mathematical concepts. This study, along with previous research has revealed the use of peer tutoring as an effective strategy for teaching algebra to students with disabilities (Calhoon & Fuchs, 2003). Since traditional teacher-directed instruction does not always lend itself to the motivation of student learning, it is important to note that student motivation can often be increased when students have the opportunity to work with peers. When students, especially those with disabilities, have the ability to work collaboratively in small groups or with peers, incidental learning may occur. By imitating others solving algebraic problems, students with disabilities can have the same success in problem solving as their peers that do not have disabilities.

It is no surprise that students with mild disabilities often lack cognitive abilities, such as memory, attention, and self-monitoring that can have a detrimental effect on mathematical learning (Montague, 2007). With this in mind, researchers suggest that self-monitoring is a strategy that must be taught to students through explicit and systematic instruction (Geary, 2004; Montague, 2007; Jerman & Swanson, 2006). Examples from previous research include individualized checklists created for students based on the kind of errors each student was making in the problem solving process (Dunlap & Dunlap, 1989), using audiotapes recorded by students to walk themselves through the steps of math computations (Carran, Rosenberg, & Wood, 1993), and teaching students to select their own self-monitoring goals (on task behavior, fluency, and accuracy) as well as recording their own results (DiGangi, Maag, & Reid, 1993).

Although researchers tend to have alternating views surrounding the concept of self-monitoring/self-regulation, one thing remains constant; researchers agree that self-monitoring creates opportunities for students to be actively engaged in their own learning. Boekaerts and Corno (2005) suggested that teaching students well-defined self-monitoring strategies instills a sense of good work ethic. When students learn to work effectively they are less reluctant to letting obstacles, such as learning and emotional disabilities, get in their way and more likely to focus on their own efforts to get them through a variety of academic dilemmas.

In order to proceed with the use of these findings, it is important to educate teachers, students, and parents about benefits of the instructional package, including DI, PALS, and self-monitoring. This should be done through support given by school systems. Many school systems are currently training teachers to use DI methods for teaching a variety of academic areas. Training teachers may seem like a simple solution to improving education for students with disabilities, but teachers alone cannot be held accountable for such an important undertaking. Parents and students must also take on the role of responsibility.

Teachers and parents must be taught how to provide students with opportunities to learn and work independently. This can be accomplished through teacher/parent trainings or conferences. Teachers must first understand the importance of the instructional package. The idea of allowing students to work with peers, then monitor their own instruction rather than depending primarily on teacher or parents' step by step instructions is essential to teaching and raising socially productive adults.

This instructional package has the potential to not only benefit students academically, but also socially. By allowing students to empower themselves, instead of always relying on teacher and/or parental input, students can take ownership in their abilities. DI lessons are typically scripted and rely on teacher-directed instruction without the use of peer tutoring or self-direction; therefore, at-risk students are often unable to complete assessments or homework independently without DI signaling or structured feedback. This is not only concerning for teachers, but also for parents when trying to assist their child with homework assignments.

The second recommendation from this study is the use of the instructional package in a variety of academic areas (e.g., reading, writing, and other areas of mathematics). Previous studies have indicated a variety of effective practices for students with disabilities, with this study being no exception. The fundamental goal of education is to teach students to become self-sufficient adults. Though researchers often establish techniques that are practical in the classroom, they are not always suitable in the outside world. For example, DI is considered one of the most effective strategies for teaching students with disabilities (Kroesbergen et al., 2003), but when students leave the classroom they have to depend on their own abilities to survive in the real world. Eventually, these same students will become adults and begin their own careers. When left to rely on their own strategies for discovering and maintaining information, they can simply turn to peer assistance and self-monitoring. The instructional package teaches students to ask for help from their peers and to monitor there own learning, which is essential to being successful in all of life's challenges.

Conclusion

This study revealed that middle school students with disabilities in math inclusion settings made significant gains in the ability to independently solve algebraic equations. Findings concluded that there were no differences between groups which received DI only or groups that received a combination of DI, PALS, and self-monitoring on posttest scores. In addition to these results, students in both grade levels made considerable gains in algebraic problem solving. Maintenance procedures indicated that students in experimental groups had higher retention rates than students in comparison groups for up to two weeks after instruction had ended. Finally, results suggested that students in both treatment conditions were able to generalize problem solving strategies to more complex two-step equations.

DI is often used in classroom throughout the United States. Although DI enables students to be successful in a variety of academic areas (Kroesbergen et al., 2003), the combination of DI, along with peer assisted learning and self-monitoring allows for continued maintenance of skills attained. Not only does this combination of learning techniques promote the preservation of learning, but also improve students' abilities to generalize strategy use with more complex problem solving.

REFERENCES

Adams, G. L., & Engelmann, S. (1996). *Research on Direct Instruction: 25 years beyond DISTAR*. Seattle, WA: Educational Achievement Systems.

Alberto, P., & Troutman, A. C. (1999). *Applied behavior analysis for teachers* (5th ed.). Upper Saddle River, N.J.: Merrill.

Baker, S., Russell, G., & Dae-Sik, L. (2002). A synthesis of empirical research on teaching mathematics to low-achieving students. *Elementary School Journal*, *10*, 51–73.

Becker, W. C., & Gersten, R. (1982). Follow up on follow through: Behavior-theory-based programs come out on top. *Education and Urban Society*, *10*, 231-458.

Boekaerts, M., & Corno, L. (2005). Self-regulation in the classroom: A perspective on assessment and intervention. *International Association for Applied Psychology*, *52*(2), 199-231.

Bottge, B. (1999). Effects of contextualized math instruction on problem solving of average and below-average achieving students. *Journal of Special Education*, *33*, 81-96.

Browder, D. M., Spooner, F., Ahlgrim-Delzell, L., Harris, A. A., & Wakeman, S. (2008). A meta-analysis on teaching mathematics to students with significant disabilities. *Exceptional Children*, *74*(4), 407-432.

Bryant, D. P. (2005). Commentary on early identification and intervention for students with mathematics difficulties. *Journal of Learning Disabilities, 38,* 340-345.

Bryant, D. P., Bryant, B. R., & Hammill, D. D. (2000). Characteristic behaviors of students with LD who have teacher-identified math weaknesses. *Journal of Learning Disabilities*, *33*, 168-177.

Bucalos, A. B, & Lingo, A. S. (2005). Filling the potholes in the road to inclusion: Successful research-based strategies for intermediate and middle-school students with mild disabilities. *TEACHING Exceptional Children Plus*, *1*(4), Article 1. Retrieved June 5, 2007 from http://escholarship.bc.edu/techplus/vol1/iss4/1

Butler, F. M., Miller, S. P., Lee, K., & Pierce, T. (2001). Teaching mathematics to students with mild-to-moderate mental retardation: A review of literature. *Mental Retardation*, *39*, 20-31.

Calhoon, M. B., & Fuchs, L. S. (2003). The effects of peer-assisted learning strategies and curriculum-based measurement on the mathematics performance of secondary students with disabilities. *Remedial and Special Education*, *24*, 235-245.

Carnine, D. (1997). Instructional design in mathematics for students with learning disabilities. *Journal of Learning Disabilities, 30*, 130-141.

Carran, D. T., Rosenberg, M. S. & Wood, D. A. (1993). The effects of tape-recorded self-instruction cues on the mathematics performance of students with learning disabilities. *Journal of Learning Disabilities*, *26*(4), 250-258.

Center for the Study of Mathematics Curriculum [CSMC]. (2007). *An Agenda for Action Report*. Columbia, MO: Author. Retrieved October 2, 2007, from http://www.mathcurriculumcenter.org/PDFS/CCM/summaries/agenda4action_summary.pdf

Crockett, J. B., & Kauffman, J. M. (1998). Taking inclusion back to its roots. *Educational Leadership*, *56*, 74-77.

DiGangi, S. A., Maag, J. W., & Reid, R. (1993). Differential effects of self-monitoring attention, accuracy, and productivity. *Journal of Applied Behavior Analysis*, *26*(3), 329-344.

Dixon, R., Carnine, D., Lee, D., Wallin, J. & Chard, D. (1998). *Report to the California State Board of Education and Addendum to Principal Report Review of High Quality Experimental Mathematics Research.* Eugene, OR: National Center to Improve the Tools of Educators.

Dunlap, G., & Dunlap, L. K. (1989). A self-monitoring package for teaching subtraction with regrouping to students with learning disabilities. *Journal of Applied Behavior Analysis*, *22*(3), 309-314.

Engelmann, S., Bernadette, K., & Carnine, D. (1997). *Connecting math concepts: Level F*. Worthington, OH: McGraw-Hill.

Englemann, S., & Carnine, D. (1991). *Theory of instruction: Principles and applications*. Eugene, OR: ADI Press.

Farlow, L. (February, 1996). A quartet of success stories: How to make inclusion work. *Educational Leadership*, *53*(5), 51-55.

Fuchs, D., & Fuchs, L. S., (1994). Inclusive schools movement and the radicalization of special education reform. *Exceptional Children*, *60*, 294-310.

Fuchs, D., Fuchs, L.S., Mathes, P.G. & Martinez, E.A. (2002). Preliminary evidence on the social standing of students with learning disabilities in PALS and No-PALS classrooms. *Learning Disabilities Research & Practice*, *17*(4), 205-215.

Fuchs, D., Fuchs, L. S., Mathes, P. G., & Simmons, D. C. (1997). Peer assisted learning strategies: Making classrooms more responsive to diversity. *American Education Research Journal*, *34*, 174-206.

Geary, D. C. (2004). Mathematics and learning disabilities. *Journal of Learning Disabilities, 37*, 4-15.

Gersten, R., Baker, S., & Lloyd, J. W. (2000). Designing high-quality research in special education: group experimental design. *The Journal of Special Education, 34*(1), 2-18.

Gersten, R., Coyne, M., Compton, D., Fuchs, L.S., Greenwood, C., & Innocenti, M.S. (2005). Quality indicators for group experimental and quasi-experimental research in special education. *Exceptional Children*, *71*, 149-164.

Hallahan, D. P., Lloyd, J. W. Kauffman, J. M., Weiss, M. & Martinez, E. A. (2005). *Learning disabilities: Foundations, characteristics, and effective teaching*. Boston: Allyn and Bacon.

Hammer, D. (1994). Epistemological beliefs in introductory physics; Cognition and Instruction, (12) 2. *Cognition and Instruction*, *12*(2), 151-183.

Hasselbring, T. S. (1994, June). *Anchored instruction-Why are we here?* Presentation conducted at the Advanced Institute on Anchored Multimedia for Enhancing Teacher Education, Nashville, TN.

Hastings, R. P., & Oakford, S. (2003). Student teachers' attitudes towards the inclusion of children with special needs. *Educational Psychology, 23,* 87-94.

Hines, R.A., and Johnston, J.H. (1996). Inclusive classrooms: The principal's role in promoting achievement, *Schools In The Middle, 5*(3), 6-10.

Hofmeister, A. M. (2004). Education reform in mathematics: A history ignored? *Journal of Direct Instruction*, *14* (4), 337-343.

Hutchinson, N. L. (1993). Effects of cognitive strategy instruction on algebra problem solving of adolescents with learning disabilities. *Learning Disability Quarterly*, *16*, 34-63.

Individuals with Disabilities Education Improvement Act of 2004, 20 U. S. C. 1400, H. R. 1350.

Jerman, O., & Swanson, H., L. (2006). Math disabilities: A selective meta-analysis of the literature. *Review of Educational Research, 76*(2), 249-274.

Jordan, N., Hanich, L., & Kaplan, D. (2003). A longitudinal study of mathematical competencies in children with specific mathematics difficulties versus children with comorbid mathematics and reading difficulties. *Child Development, 74*(3), 834-850.

Kauffman, J. M. (1994). Two perspectives on inclusion: One size does not fit all. *Beyond Behavior*, *5*(3), 11-14.

Kauffman, J. M., Bantz, J., & McCullough, J. (2002). Separate and better: A special public school class for students with emotional and behavioral disorders. *EXCEPTIONALITY*, *10*, 149-170.

Kauffman, J. M., McGee, K., & Brigham, M. (2004). Enabling or disabling? Observations on changes in special education. *Phi Delta Kappan*, 613-620.

Kauffman, J. M., & Pullen, P. L. (1996). Eight myths about special education. *Focus on Exceptional Children*, *28*, 1-12.

Kitz, W. R., & Thorpe, H. W. (1995). A comparison of the effectiveness of videodisc and traditional algebra instruction for college-age students with learning disabilities. *Remedial and Special Education*, *16*, 295-306

Kroesbergen, E. H. (2003). Mathematics interventions for children with special educational needs. *Remedial and Special Education, 24*, 97-115.

Kroesbergen, E. H., & Van Luit, J. E. (2003). Mathematics interventions for children with special educational needs. *Remedial and Special Education, 24*(2), 97-115.

Levin, J. R., & O'Donnell, A. M. (1999). What to do about educational research's credibility gaps? *Issues in Education, 5*(2), 177-230.

Light, P.L., & Littleton, K. (1999). *Social processes in children's learning* (pp. 91-100). Cambridge, England: Cambridge University Press.

Logan, K. R., Diaz, E., Piperno, M., Rankin, D., MacFarland, A. D., & Borganian, K., (1995). How inclusion builds a community of learners. *Educational Leadership*, *52*(4), 42-44.

Maccini, P., & Gagnon, J. C. (2000). Best practices for teaching mathematics to secondary students with special needs: Implications from teacher perceptions and a review of the literature. *Focus on Exceptional Children*, *32*, 1-22.

Maccini, P., & Hughes, C. A. (2000). Effects of a problem-solving strategy on the introductory algebra performance of secondary students with learning disabilities. *Learning Disabilities Research and Practice, 15*, 10-21.

Maccini, P., McNaughton, D., & Ruhl, K. L. (1999). Algebra instruction for students with learning disabilities: Implications from a research review. *Learning Disability Quarterly*, *22*, 113-126.

Marchand-Martella, N. (1999-2005). Direct instruction: Math. Retrieved June 26, 2007 from www.specialconnections.ku.edu

McBrien, J. L., & Brandt, R. S. (1997). *The language of learning: A guide to educational terms*. Alexandria, VA; Association for Supervision and Curriculum Development
McDougall, D., & Brady, M. P. (1998). Initiating and fading self-management interventions to increase math fluency in general education classes. *Exceptional Children, 64,* 151-166.

Mcleskey, J., Henry, D., & Axelrod, M. I. (1999). Inclusion of students with learning disabilities: An examination of data from reports to congress. *Exceptional* Children, *66*, 55-66.

Meyer, L.A. (1984). Long-term academic effects of the Direct Instruction project follow through. *Elementary School Journal*, *84,* 380-304.

Middleton, J. A., & Goepfert, P. (1996). In B. McCombs & S. McNeely (Series Eds.) *Inventive strategies for teaching mathematics: Implementing standards for reform* (pp. 1-163). Washington, DC: American Psychological Association.

Miles, D. D., & Forcht, J. R. (1995). Mathematics strategies for secondary students with learning disabilities or mathematics deficiencies: A cognitive approach. *Intervention in School and Clinic, 31*, 91-96.

Miller, S. P., Butler, F. M., & Lee, K. (1998). Validated practices for teaching mathematics to students with learning disabilities: A review of the literature. *Focus on Exceptional Children, 34,* 1-24.

Montague, (2003). *Solve It!: A mathematical problem-solving instructional program*. Reston, VA: Exceptional Innovations.

Montague, M., & Applegate, B. (1993). Mathematical problem-solving characteristics of middle school students with learning disabilities. *The Journal of Special Education*. *27,* 175-201.

Montague, M., Warger, C., & Morgan, T. H. (2000). Solve it! Strategy instruction to improve mathematical problem solving. *Learning Disabilities Research & Practice*, *12*(2), 110-116.

Moses, R. "Algebra, The New Civil Right." In *The Algebra Initiative Colloquium,* Vol. II. Carol Lacampagne, *et al*., Editors. Washington, DC: U. S. Department of Education, Office of Educational Research and Improvement, 1995, pp. 53-67.

Mosteller, F., & Boruch, R. (Eds.). (2002). *Evidence matters: Randomized trials in education research.* Washington, DC: The Brookings Institute.

National Council of Teachers of Mathematics [NCTM], Commission on Standards for School Mathematics. (1989). *Curriculum and evaluation standards for school mathematics*, Reston, VA: The Council.

NCEE. (1983). *A nation at risk: The imperative for educational reform.* A report to the nation and the Secretary of Education United States Department of Education by the National Commission on Excellence in Education.

No Child Left Behind Act of 2001, Pub. L. No. 107-110, 115 Stat. 1425 (2002).

Rohrbeck, C.A. et al. (2003). Peer-assisted learning interventions with elementary school students: a meta-analytic review. *Journal of Educational Psychology, 95*(2), 240-257.

Schattman, R., & Benay, J. (1992). Inclusive practices transform special education in the 1990's. *The School Administrator*, *49*(2), 8-12.

Schoenfeld, A. H. (1987). What's All the Fuss About Metacognition? In

Schoenfeld, A. H. (ed.), *Cognitive Science and Mathematics Education*, chapter 8, 189-215. Lawrence Erlbaum Associates.

Scruggs, T. E., & Mastropieri, M. A. (1997). Can computers teach problem-solving strategies to students with mild mental retardation? *Remedial and Special Education*, *18*, 157-165.

Shimabukuro, S. M., Prater, Jenkins, M. A., & Edelen-Smith, P. (1999). The effects of self-monitoring of academic performance on students with learning disabilities and ADD/ADHD. *Education and Treatment of Children, 22*(4), 397-414.

Shavelson, R. J., & Towne, L. (Eds.). (2002). *Scientific research in education.* Washington, DC: National Research Council, National Academy Press.

Slavin, R. E. (1995). *Cooperative learning: Theory, research, and practice* (2^{nd} ed.). Boston: Allyn & Bacon.

Snell, M. E. (1991). Schools are for all kids: The importance of integration for students with severe disabilities and their peers. In J. W. Lloyd, A. C. Repp, & N. N. Singh (Eds.), *The Regular Education Initiative: Alternative perspectives on concepts, issues, and models* (pp. 133-148). Sycamore, IL: Sycamore.

Special Education Programs (Department of Education/Office of Special Education and Rehabilitative Services), Washington, DC. (1996). *Inclusion: A right, not a privilege.* [Brochure]. Connecticut University Health Center, Farmington: Author.

Stainback, S. & Stainback, W. (1992). *Curriculum considerations in inclusive classrooms: Facilitation learning for all students*. Baltimore: Paul Brookes.

Staub, D., & Peck, C., (1995). What are the outcomes for non-disabled students? *Educational Leadership*, *52*(4), 36-41.

Steele, M. M., & Steele, J. W. (2003). Teaching algebra to students with learning disabilities. *Mathematics Teacher*, *96*, 622-624.

System Impact, Inc. (1989). Mastering equations, roots and exponents: Signed numbers to operations. Gaithersburg, MD: Author.

Taggart, G.L., Phifer, S.J., Nixon, J., and Wood, M. (Eds.). (1998). *Rubrics: A Handbook for Construction and Use*. Lancaster, PA: Technomic Publishing.

Tomlinson, C. A. (1999). *The differentiated classroom: Responding to the needs of all learners*. Alexandria, VA: Association for Supervision and Curriculum Development.

Vaughn, S., Gersten, R., & Chard, D. J. (2000). The underlying message in learning-disability research: Findings from research synthesis. *Exceptional Children*, *67*, 99-114.

Vaughn, S., & Schumm, J. S. (1995). Responsible inclusion for students with learning disabilities. *Journal of Learning Disabilities*, *28*, 264- 273.

Watkins, C. L. (1997). *Project Follow Through: A case study of the contingencies influencing instructional practices of the educational establishment.* (Monograph). Concord, MA: Cambridge Center for Behavioral Studies.

Wentzel, K.R. (1999). Social-motivational processes and interpersonal relationships: Implications for understanding motivation at school. *Journal of Educational Psychology*, *91*, 76-97.

White, L., Swift, H., & Harmon, D. J. (1992). *Collaborative teaching model in the elementary classroom*. Westerville, OH: Author. Retrieved October 2, 2007, from http://www.nmsa.org/portals/0/pdf/research/Research_Summaries/Impact_of_Inclusion.pdf

Witzel, B. S., Mercer, C. D., & Miller, M. D. (2003). Teaching algebra to students with learning difficulties: An investigation of an explicit instruction model. *Learning Disabilities Research and Practice*, *18*, 121-31.

Witzel, B., Smith, S. W., & Brownell, M. T. (2001). How can I help students with learning disabilities in algebra? *Intervention in School and Clinic*, *37*, 101-104.

Wright, E. B. (1999). Full inclusion of children with disabilities in the regular classroom: Is it the only answer? *Social Work in Education*, *21*, 11-23.

APPENDIX A: LETTER OF AGREEMENT

Rowan-Salisbury School System
Maximizing Learning for Maximized Success

Exceptional Children's Department
Irene Meier, Director
PO Box 2349
Salisbury, NC 28145
Phone: 704-639-3064
Fax: 704-639-3072

October 1, 2007

To Whom It May Concern:

I am writing this letter to offer district level support for the UNC Charlotte research investigation entitled "Comparing Effects of Two Grouping Conditions to Teach Algebraic Problem-Solving to Students with Disabilities in Inclusive Settings." The Rowan-Salisbury schools seek to collaborate with institutes of higher education and doctoral students on research investigations designed to improve student achievement for students with disabilities particularly in the area of mathematics.

I have discussed this proposed investigation with Mrs. Amber Harris, doctoral student, and the school site has been identified. Mr. Skip Kraft, principal at Southeast Middle School, has expressed his support for this investigation and will provide Mrs. Harris with access to the identified 50 middle school participants and classrooms. We have a middle school coteaching model which will offer the investigator access to students in inclusive settings as outlined in the prospectus.

Our district looks forward to collaborating with UNC Charlotte and Mrs. Harris on this important research investigation. Please do not hesitate to contact me at 704-639-3064 if you have any questions.

Sincerely,

Irene Meier
Director of Exceptional Children's Programs

APPENDIX B: PARENTAL CONSENT AND STUDENT ASSENT FORMS

Informed Consent for Algebra Study
Parent

Educators and students are increasingly being faced with the impact of high stakes testing. Along with these demands, the state of North Carolina is now requiring the completion of algebra courses, along with algebra tests, as a requirement for high school graduation. Therefore, this study is designed to deliver carefully chosen instruction to teach students to solve simple algebra problems. First, overall strategies will be used to help promote student independence in problem solving. Secondly, student responses to instruction will be observed to note any changes in math skills. Third, a simple quiz will be given to determine if students are able to solve 15 algebra problems independently (without the help of peers or teacher guidance).

Investigators

Amber Harris, Doctoral Student, UNC-Charlotte
David Pugalee, Ph.D. Curriculum & Instruction, UNC-Charlotte

Eligibility

Your child's teacher has volunteered to learn new and exciting strategies in teaching algebraic equations to middle school students. As a student in this teacher's classroom, your child is being invited to participate in this study.

Overall Description of Participation

You child will participate in math lessons during their regularly scheduled math classes. In addition, your child may be asked to work with peers acting as both peer tutors and tutees. A test of math skills, including 15 simple equations, will be administered the week before the lessons begin and again when they have completed 10 days of instruction. This test will only be used for the purpose of this study. Your child will not be assigned a grade for this test, nor will it be used to assign grades to students in math class.

Length of Participation

This study will take 10 days of participation during your child's regularly scheduled math block (lasting 90 minutes).

Risks and Benefits of Participation

There are no foreseeable risks associated with this study. However, it is possible that unforeseeable risks do exist. Possible benefits include improved educational outcomes for your child. The results of this study will also be used to improve services for other middle school students in the area of algebra.

Confidentiality

Any information collected during the study (including teacher/student names or details), will remain confidential. Once data has been collected, all of its contents including pretests, posttests, and scoring rubrics will be placed in a locked filing cabinet.

Volunteer Statement

Your child is a volunteer. The decision to agree to your child's participation in this study is completely voluntary. If you decide to have your child participate in the study, you may stop his/her participation at any time. You and your child will not be treated any differently should you decide not to have him/her participate or if you decide to stop his/her participation in the study once it has started.

Alternatives to Study Participation

If you choose not to have your child participate in the study your decision will not affect your relationship with your child's teacher/school or your child's math grade now or in the future. Students not participating in the study will receive standard classroom instruction from their everyday classroom teacher(s).

Questions

If you have any questions about this study, please feel free to contact Amber Harris at 704-701-9837 or David Pugalee at 704-687-8887. Thank you for considering this request.

UNC Charlotte wants to make sure that you are treated in a fair and respectful manner. Contact the University's Research Compliance Office (704-687-3309) if you have any questions about how you are treated as a study participant.

Name of Child

____
Name of Parent or Legal Guardian

____ ______________
Signature of Parent or Legal Guardian Date

SIGNATURE OF INVESTIGATOR OR DESIGNEE

In my judgment the subject is voluntarily and knowingly giving permission for his/her child to participate in this research study.

____
Name of Investigator or Designee

_______________________________________ ____________________
Signature of Investigator or Designee Date

***This form was approved for use on August, 1, 2008 for a period of one (1) year

Student Assent
Algebra

You are being asked to join an algebra project. In the beginning, you will be asked to complete a 10 problem algebra quiz. Then, Mrs. Harris will begin teaching your class for the next 10 days. In the end, you will also be given a separate 15 problem algebra quiz. We hope that this project will help you to work independently in solving algebra problems.

You do not have to be in the study. Your grades will not be changed if you do not join the project. You can leave the project at any time. No one will become upset if you decide to leave. You can ask questions about the project at any time. If you choose not to participate in the project you will stay with your regular classroom teacher(s) for math instruction.

An adult has read this to me. My choice is:

Yes	**No**

____

Student Name Date

____

Investigator Date

APPENDIX C: SAMPLE LESSON PLAN

Direct Instruction Sample Lesson

Objectives

- Write and solve equations that have one missing variable
- Write equations using pictures to show the Equality Principle

Review

Script:

- Look at the following problems I have written on the overhead.

1. 5 + X = 8	4. X + 10 = 19	7. 10 + X = 10
2. 6 + X = 16	5. 8 + X = 14	8. 4 + X = 11
3. X + 2 = 9	6. 30 + X = 35	9. 7 + X = 12

- What does each of these problems have in common? (take student answers)
- Yes. All of them have an equal sign and all of them have a missing variable.
- An equal sign means that we must use the Equality Rule for each equation.
- Remembering the Equality Rule, let's recite it as a group. Ready. (Signal): "You must end up with the same number on this side and the other side of the equation."
- Write the following problem from the board.

5 + X = 8

- Let's read it aloud. Remember we want to end with the same number on both sides.
- Ready. (Signal): "Five plus X equals eight."
- How many on this side now? (point to 5 + ….)   Signal: "5"
- How many do we need to end up with on this side? (point to ….= 8) Signal: "8"
- (Teacher will go through each of the overhead examples, asking the following:) Is the equation equal on both sides? What do we need to end up with on this side to make them equal?

Teacher Input

Script:

- Each of these equations is a new type of problem. They each have a missing variable. Therefore, they do not give us the number we need, so we must figure it out ourselves.
- We use the Equality Rule to help us. The Equality Rule says we must end with the same number on both sides.
- Let's get started. What variable are we solving for? (Signal) "X"
- Draw a box around it.

5 + $\boxed{X}$ = 8

- Touch the problem. Read the problem aloud. (Signal) “5 + how many = 8”
- First we determine the side that gives us the total we should end up with. Which side gives us our total? (Signal) “8”
- This is the side we start counting on. Touch the side you start counting on.
- This side tells me to draw a total of 8 lines. Ready. You count and clap as I draw. (Signal) “1, 2, 3, 4 ,5 ,6 ,7 ,8”
- Remember, we want to end up with the same number on both sides.
- What number do we have on the other side? (Signal) “5”
- How many do we need? (Signal) “8”
- You count as I start drawing lines. Tell me when to stop. (Signal)

Ex. 5 + ☐ = 8

l l l l l + [l l l] = l l l l l l l l

- Now, both sides are equal. Are going to write an 8 in the box? No.
- What number goes into the box and replaces the variable? (Signal) “3”
- Repeat above steps with problems 2 and 3.

Guided Practice

Script:

- We are going to work problems 4, 5, and 6 the fast way. Let’s get started.

- We draw lines **<u>only</u>** for the variable that is missing.
- For example, here we need a total of 19, but only have 10. We need to add more until we get a total of 19.
- Let’s start counting with the number we already have. That is 10.

4. X + 10 = 19

l l l l l l l l l

- You count and I will draw the lines. Ready, starting with 10 held in our heads (Signal). “11, 12, 13, 14, 15, 16, 17, 18, 19. Stop”
- How many lines did I draw? (Signal) “9”
- So what number replaces the missing variable? (Signal) “9”
- Read the entire equation aloud. (Signal) “9 + 10 = 10”
- Is this correct? Does 9 plus 10 equal 19? “yes”
- Repeat above steps with problems 5 and 6.

Independent Practice

Script:

- Now, you are going to work problems 7, 8, and 9 independently.
- I will walk around to ensure that you are working them correctly.
- Please be sure to ask if you have any questions.

After approximately 5 minutes check student work aloud as a group:

- Let's check your work.
- Look at equation 7. Let's read it aloud. (Signal) "10 + 0 = 10"
- Look at equation 8. Let's read it aloud. (Signal) "4 + 7 = 11"
- Look at equation 9. Let's read it aloud. (Signal) "7 + 5 = 12"

Closure

Script:

- Today, we have reviewed the Rule of Equality and determined if an equation is equal on both sides.
- You have also learned how to find missing variables by using the slow method of solving equations.
- Tomorrow, I will teach you a much quicker method of solving simple one-step equations. Begin thinking of a see-saw and how each side of it must possess the same amount of weight to remain balanced.
- This is how we will begin to balance each side of an equation in tomorrow's lesson.

APPENDIX D: PROCEDURAL FIDELITY CHECKLIST (EXPERIMENTAL GROUP)

Experimental Group Procedural Fidelity Checklist
(Instructional Package)

_______ Approximately 35 minutes of daily teacher-led DI

(scripted lessons, choral responses with visual signal, individual turns, immediate error correction/affirmation)

____ Statement of objectives & why skill is important

____ Review of previously learned skills

_______ Approximately 30 minutes of guided practice

____ Students paired with peers for PALS

____ Tutors/tutees share self-monitoring checklist

_______ Approximately 20 minutes of independent practice

____Assessment of student knowledge

_______ Approximately 5 minutes for closure of lesson (review of what students learned)

APPENDIX E: PROCEDURAL FIDELITY CHECKLIST (COMPARISON GROUP)

Comparison Group Procedural Fidelity Checklist
(Direct Instruction Only)

_______ Approximately 35 minutes of daily teacher-led DI

(scripted lessons, choral responses with visual signal, individual turns, immediate error correction/affirmation)

____ Statement of objectives & why skill is important

____ Review of previously learned skills

_______ Approximately 30 minutes of guided practice

____ Students work independently

_______ Approximately 20 minutes of independent practice

____ Students work independently

_______ Approximately 5 minutes for closure of lesson (review of what students learned)

APPENDIX F: PROCEDURAL FIDELITY CHECKLIST
(PEER TUTORING EXPECTATIONS)

Peer Tutoring Expectations
Procedural Fidelity Checklist

_____ Tutors provide immediate feedback

_____ Students take turns acting as tutor/tutee

    ___ student 1 tutors for 1st half of equations

    ___ student 2 tutors for 2nd half of equations

_____ Tutors provide additional explanations/answering tutee questions

_____ Tutors/tutees share self-monitoring checklist

_____ Tutees check off each step of self-monitoring checklist

_____ Students show all work

_____ Students complete all guided practice problems