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Effects of Direct Instruction Common Core Math on Students With Learning Disabilities

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Walden University
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MS, City University of New York, 2005

BS, University of Arkansas, 1995

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

U.S. students with learning disabilities' math skills acquisition has been on the decline in recent years. Studies show that teachers using traditional methods of teaching math lack knowledge of task analysis, chunking, sequencing, mass practice, modeling, and repetition of instruction. These components of direct instruction or pedagogical activities are hallmarks of special education teaching and are collectively described as cognitive support pedagogy. The study evaluated direct instruction teaching strategies to teach Common Core math to middle school students with learning disabilities, to determine if the current downward trend in math skills acquisition amongst them can be reversed. The theoretical framework of this study was based on Watson's theory of behavioral psychology as it applied to learning and teaching. The participants consisted of a convenience sample of students with learning disabilities. The study used a Solomon 4-group experimental design, in a series of two One-way ANOVAs to measure differences in math score by intervention for pretested and for non-pretested students, with one Factorial 2 X 2 ANOVA which measured for differences by interaction between pre-testing and intervention. Results of ANOVAs were significant at the α-levels of .05 (F (1,78) = 233.66 $p < .001$), indicating that significant differences existed in math scores of pre-tested students who received intervention and those who did not. The study is significant to teachers, curriculum developers, and instructional leaders because it is the first study of its kind to measure the outcomes of Common Core math using direct instruction and it points a way forward to creating positive social change by increasing students' graduation rates and promoting students' engagement in school and beyond.

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Dedication

This page is dedicated to Collette Ewere Monye, who advised that I undertake a doctoral study instead of law. To Allison: this struggle was made possible due to your wisdom and strong commitment to see that I succeed. Despite all the odds against success, our lives are intertwined. I am also grateful to my five children: Amachi Mokwuyem-Monye (California), Emeka (Virginia), Iris (Arkansas), and Echeanu (New York), and the very precocious and all-knowing Misan.

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Here is a nice place to thank the faculty, family members, and friends who have helped me reach this point in my academic career. This doctoral dissertation is in keeping with the traditions of the scholar-practitioner work ethic and good citizenship that have been inculcated in me throughout the past five years. Thanks to Walden University's APA stylist, Martha King, for formatting the procedures used here. Much appreciation goes to the following professors: Dr. Charles Nwanegwo, Dr. Phyllis LeDosquet, Dr. Linda Crawford, Dr. Wade Smith, Dr. Evelyn Johnson, Dr. Dawidowicz, Dr. Safran, Mr. Anthony Mbanaja, Dr. Barry Birnbaum, the late Dr. MaryAnne Marvil, and Dr. Eicher. Come to think of it, who ever thought I would have made it to this point, wherein half of the time I found myself broke, and the other half, I found myself encumbered with health issues? I must extend thanks to my entire dissertation members, and especially, to my previous Chairs: Dr. Robert Kefferstan and the always empathetic Dr. Joseph E. Nolan, the "real McCoy". His initial programming help and mentorship made it all possible.

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Chapter 1: Introduction to the Study

Background of the Problem

In the United States, many middle school students with learning disabilities do not perform well in school mathematics, mathematical reasoning skills and general computation competencies. U.S. students have lagged those of most other developed nations in these academic areas (Witzel, 2010). Witzel (2013) suggested that school mathematics ability is especially difficult for low performers and other students with math disabilities.

The National Assessments of Education Progress (2014) showed that for some students with mathematical learning disabilities or dyscalculia, acquiring computational and general math skills is a significant challenge, especially for middle school students, who scored below the national average. Research in special education indicate the existence of strategic and nonstrategic learners. Many middle school students with math problems seem to fall within the category of nonstrategic learners, as opposed to students who are strategic learners. Riccomini (2012) described nonstrategic learners as students with learning disabilities who exhibit problems with working memory, are unorganized, lack persistency, and are unable to focus on a given task.

Within the past several years, traditional methods of teaching math to students with learning disabilities have not yielded positive learning outcomes. According to Riccomini (2012), "many students with learning disabilities experience frustration and attribute math failure to teacher's instructional styles among other reasons" (para 8.). Riccomini stated that students with mathematical learning disabilities tend to be at risk for math failure as they graduate from the elementary through the middle school years well into high school and beyond. This creates instructional gaps and widens pre-existing learning gaps between grade levels.

The creation of the Common Core State's Standards in 2010 was intended to bridge this knowledge gap (Frenkel, 2013). According to Szucs and Goswami (2013), "many adult students possess immature mathematical abilities even though mathematical skills are increasingly important if individuals are to thrive in today's technologically oriented society…" (para. 2). These standards were designed as preliminary justification to simply address what students should understand and do in the classroom. Despite criticisms of the Common Core State Standards in the United States, a new focus has developed in mathematics learning and teaching. Therefore, the move to Common Core is relevant within this study as a standards-based school reform initiative. With this new focus on math processes by policy makers, teachers' instructional styles and delivery protocols appear to be changing as well due to new guidelines.

A gap exists in the literature regarding the most effective teaching strategies for math skills. Gersten, Russel, Chard, Jayanthi, and Baker (2006) conducted a meta-analysis of research syntheses involving effective strategies for teaching students with difficulties on the basis of effect size calculations for special education students and effect size for low achieving students. Gersten et al. included six aspects of instructional strategies in the study, finding that the average effect size was moderate at 0.50, for "Visual and graphic descriptions of problems, systematic and explicit instruction, student think-clouds, use of structured peer-assisted learning activities involving heterogeneous ability groupings, formative assessment data provided to teachers, and formative assessment data provided directly to students" (Gersten et al., 2006, as cited by NCTM, 2010).

The literature on the most effective teaching strategy in math basics, involving procedural and conceptual mathematics, remains scarce. According to Arslan (2010), the research on procedural facility in computational mathematics is limited. This gap in the literature is further exacerbated by the fact that research on how to teach math (procedural), what strands of math to teach (conceptual), and when to teach what grade levels (sequential) is limited on the effects of their relationships regarding students with a mathematical learning disability.

Special education researchers in music skills acquisition for example, have demonstrated the importance of subitizing among grade school students. Arslan (2010) stated that procedural knowledge in math should include "a type of learning involving memorization of operations without understanding of the underlying meanings" (para. 3). Furthermore, for students to have adequate grounding in mathematical skills, Arslan recommended that in "conceptual learning, students would be able to understand and interpret mathematical concepts and their relationships" (para. 6). According to Star (2002), a student may be asked to compute the sum of (1÷5+1 ÷4+ 1 ÷3), having been taught how to apply several algorithms. But in conceptual mathematics, the same student may be prompted to provide explanations first without physically providing the addendum when asked, "Is the sum of one fifth, plus one fourth, and one-third, bigger or smaller than one…? To which a teacher's response will be followed by asking, how do you know?" (Star, 2002, p. 3).

Research shows that teachers in the traditional methods of teaching math lack requisite training in cognitive support pedagogy, such as task analysis, chunking, sequencing, mass practice, structured feedback, repetition of instruction including modeling (the hallmark of special education instructional practices) and direct instruction techniques (Rosenshine, 2012). Some students exhibit problems in number substitution, where X = 5, but not 5 = X, or number transposition, where "1, 2, 3, 4" is not the same as "1, 2, 4, 3". Students with mathematical learning disabilities also experience difficulties in number reversals and number omissions. Teachers may not recognize these types of mathematical difficulties as a form of math disability. Although traditional teaching methods in math focus more on procedural aspects than on conceptual mathematics, a direct-instruction teaching technique is designed to extend the traditional teaching model to a higher level by combining both procedural and conceptual techniques in classroom delivery.

Cognitive Support Pedagogy

Garrison, Anderson, and Archer (2001) described cognitive support pedagogy as the presence of learner engagement with new skills and concepts aimed at helping the student learner progress through scaffolded instruction (i.e., enquiry-based, critical thinking, knowledge-application) in structured learning units and processes. Table 1 and 2 give examples of how to implement teaching strategies for students with learning disabilities, teaching data analysis using the mean, median, and mode.

Table 1

Cognitive Support Pedagogy: Using Direct Instruction for Structured Presentation of the Mean, Median, and Mode

Teacher (Will point and say)	Student (Will listen and do)
1. Listen: Johnny got 4 points on Monday, 7 points on Tuesday, 3 points on Wednesday and 6 points on Thursday (Write 4,7, 3, 6)	1a.) Students write 4, 7, 3, 6 as directed.
a.) We want to figure the average number of points that Johnny got each day.	
b.) What do we want to figure out?	1b.) Students write "we want to figure out the average number of points Johnny got each day."
2. Here's how we figure the average. First we add, then divide the sum by how many numbers we added. First we add, then what do we do?	2. Students say "First, we add, then we divide the sum by how many numbers we had added."

Table 2

Procedure

Teacher Direction or Question	Student Response
1. First we add. (Write the problem on the smart-board) 4 + 7+ 3+ 6 =?	
2. What is the sum of 4, 7, 3, and 6? (Pause)	Student says "20"
3. The sum is 20. We added.	
4. Now we divide by how many numbers we added. (Teacher points to 4, 7, 3, and 6 as you say.)	
5. We added 1, 2, 3, 4, numbers. We added 4 numbers. So, we must divide 4 into 20.	
6. What must we divide?	Student says "4 into 20"
7. How many times does 4 go into 20?	Student counts and says "5 times."
8. Yes, Johnny's average is 5 points each day.	
9. What is Johnny's average point each day?	Student says "5 points each day"
10. Did Johnny score exactly 5 points every day?	Student says "No, 5 points on average daily"

A teacher must repeat steps 1–10 if student's learning has stalled (see Table 2) with the following examples to determine students' level of sportsmanship and perseverance, and their understanding of the use of the mean, median, and mode in problem solving. The following math sequence is an adaptation from Stein, Silbert, and Carnine (1997):

> Donte and Tierra are 8th-grade students who are interested in competitive sports of volleyball and marathon race. They have been instructed by their teacher to explore their understandings of the mean, median, and mode to compute their interest levels on a given day in their particular sporting activity. Donte is interested in volleyball games. In one of his tournaments, he scored the following points in each game:
>
> 6, 8, 9, 5, 0, 10, 4.
>
> Tierra, Donte's arch-rival, needed to compete with him in her favorite team sports of marathon race during one week. So, she ran these numbers of miles each day:
>
> 3, 1, 1, 7, 0, 0, 4.

The classroom teacher (having appropriately matched student's skills, interests, and abilities) introduces this assignment with a brief review of concepts and procedures of previously taught lessen contents. The teacher therefore provides *scaffolding support* to students. Thus, in a comparison of two different sporting activities involving two very motivated students, the teacher asks,

> Who is the better sportsman in terms of persevering with their running, or at perseverance? How can this decision be reached using what the students have

learned about mode, mean, and median values to determine one's level of perseverance on a given day, and throughout the competitive tournament?

Assessing Critical Thinking Skills Mastery

In a Direct Instruction classroom, students are given structured worksheets to determine the criteria for critical thinking mastery. The advantage of direct instruction with cognitive support pedagogy is that the teacher easily implements the coordination of relationship data and presentation of math memorization techniques simultaneously (Stein, Silbert, & Carnine 1997).

In this way, teachers can demonstrate rigor and raise students' expectations. Teachers of mathematics in both elementary and middle schools have found that the instructional techniques that ensure special needs students receive optimized instructional services are more beneficial to the students than the instructional types that do not (Stein, Silbert, & Carnine 1997).

Additionally, because students with learning disabilities are students who are not able to learn at an optimal rate when compared with students without learning disabilities, it is necessary to explore individual students' academic needs, as indicated in their IEPs. Research shows some students appear capable of performing the assigned tasks, but at an unusually slow pace.

Although many students with IEPs have sections on goals and objectives on cognitive reasoning, data analysis, and problem solving in their IEPs, some of these students may have comprehension or articulation problems regarding the teaching and learning strategies specific to their education environment. To move forward and enable students with learning disabilities, who are often placed in special education because of their low math scores, teachers must implement a radically different teaching strategy to enable these students to have access to the general curriculum. This is the inclusion mandate of the No Child Left Behind Act of 2001, 20 U.S.C. section 6301, in which ideas were further incorporated into the 2010 Common Core State's Standards in math.

Special educators should have the ability to teach students who require varying learning and teaching techniques and approaches in the classroom. The special educator should recognize specific student's needs, as well as make the necessary environmental and instructional adaptations, based on the individual student basis. The underlying learning theory of this technique, known as direct instruction is well detailed in (Engelmann & Carnine, 1982). Stein et al. (1997) described direct instruction, as providing a comprehensive set of prescriptions for organizing instruction so that students acquire, retain, and generalize new learning in an efficient, effective manner. Students' acquisition of mathematical skills is heavily influenced by variables such as instructional designs, presentation techniques, and organization of instruction.

According to Stein et al. (1997),

> Direct instruction, when used with immediate grade-level students at average or above average skills levels, should be characterized by a heavy emphasis on student-directed independent work. But, on the other hand, direct instruction should be used with primary-level students or with intermediate-level students, who have encountered difficulty in earlier grades, as characterized by a more structured, more teacher-directed environment. (p. 183)

Stein et al. (1997), further emphasized that:

> DISTAR (Direct Instruction System for Teaching Arithmetic and Reading); distar arithmetic as an instructional program is based on a Direct Instruction approach. The DISTAR Math program was co-authored by Siegfried Engelmann and Doug Carnine . . . which incorporates new six level basal mathematics series also based on Direct Instruction theory called, Connecting Math Concepts. (Engelmann, Carnine, Engelmann, and Kelly, 1995; p. 88).

Although commercial programs are not in themselves inefficient, teacher-made, teacher-generated, organic, or holistic approaches to teaching using direct instructional methods appear to have an effect on student learning. Daily or weekly lesson plans can be organized skillfully combining cognitive support pedagogy and direct instruction techniques to enhance students' learning. In this way, students are encouraged to participate in class without fear of failure in math. When this encouragement occurs, the teacher benchmarks the students' overall critical thinking and computational mastery skills level at 80% proficiency.

I expected that students would gain meaningful incremental successes which would boost their self-esteem. I also anticipated basic math skills to improve among students with learning disabilities when math phobia disappears?

Social Change Discussions, Summary and Conclusion

Mathematics Competency May Reduce Special Education Referrals

Usiskin (1996) stated that mathematics today in the U.S. is the province of an intellectual elite and accorded special intelligence, just as reading once was. Therefore, researchers can no longer believe that it takes a special intelligence to understand mathematics. The benefit of realizing the temporal nature of learning to acquire math skills in the classroom is that mathematics learning and teaching provide the keys to understanding current learning issues, modern day special education placement problems and how to effectively navigate and communicate in it.

In Ramsey's (2003) observation of the nature of mathematics intervention, inclusion is described as both a concept and a method of service delivery. Once a student is identified as being at risk academically or socially, remedial interventions are attempted within the general education classroom. U.S. federal legislation requires that sincere efforts should be made to help children learn in the general education classroom with other students who are not identified as being at-risk (Ramsey). School-based professionals must therefore work together to provide solutions and suggestions about curricular alternatives and instructional modifications. As a result, public school teachers use instructional modifications to accommodate the student in the general classroom setting (Ramsey, 2003).

In Rosenshine's (2012) *Principles of Instruction*, he explained that effective instruction is geared toward individual needs and recognizing the different learning modalities of the students. Modification requires task analysis of subject contents, pacing, and prompting, as well as providing extra response time and repetition of learning units until mastery of topical issues in a given domain is achieved. As students become more confident and gain greater self-esteem with improved math test scores, recommendations to a new placement in the general education setting would be a boost to students' overall well-being, contributing to a new appreciation for math and an improvement in not only math test scores, but also general readiness in other academic domains as well.

Dyscalculia is a significant issue that needs to be addressed to provide effective instruction to affected students. Kaufmann and Von-Aster (2012) described dyscalculia as a multitude of learning disabilities in the domain subject area of mathematics. Kaufmann and Von-Aster (2012) stated that “dyscalculia does not improve without treatment … and that dyscalculia is often associated with other mental disorders” (p. 2). Kaufmann and Von-Aster reported that “for students to acquire necessary skills and accomplish quantitative tasks involving arithmetical procedures, numerical reasoning and conceptual arithmetic knowledge, structured intervention will be highly dependent on teaching methods” (p. 5).

In this study, I aimed to combine procedural facility and common sense to conceptual math application by using direct instruction to teach Common Core math to students with learning disabilities. Teaching students with math disability can be challenging to teachers. Therefore, considering either the student’s math difficulty or disability in determining the most practical practices to use was significant to this research.

Brief Problem Statement and Social Change

In discussing how mathematics competency may reduce special education referrals, researchers should note that within the past fifty years, traditional methods of teaching math to students with learning disabilities have not yielded positive learning outcomes. In reviewing studies conducted on the effects of using direct instruction teaching methods on math achievements among students with learning disabilities, they revealed that many authors focused on remediation strategies for correcting ineffective or misaligned skills. By using these teacher-directed, misaligned math skills, once internalized by students, teachers may find it difficult to improve students' memory and perception skills. Additionally, students' attention skills and motivation tend to be affected and would therefore decrease their executive functions (Al-Makahleh & Abdulhameed, 2011). Decreases in students' executive functions further exacerbate their procedural facility in math.

However, many traditional teaching methods do not mitigate nor incorporate awareness of such salient mathematical issues of the effects of dyscalculia on student learning in the classrooms. Thus, some students tend to be frustrated, lacking in motivation and a loss of self-efficacy. According to Arslan and Yavuz (2012), "self-efficacy is an important part of shaping students' lives so it is essential for teachers and educators to foster positive self-efficacy in their classrooms" (p. 5625). Students may become frustrated when general education teachers in the classrooms, without specialized training, are expected to teach students with math disabilities, who in many cases suffer from retrieval, number facts, procedural, spatial, or conceptual dyscalculia.

Morin (2014) stated,

> dyscalculia is a learning disability that causes serious math difficulties… It isn't as well-known as dyslexia; however, some researchers now think it may be almost as common…. Fortunately, there are many ways you and teachers can help

your child –whether it is strengthening math skills or boosting his self-esteem. (para. 3).

In instructional periods, a teacher's assignment to teach a math class could become a major challenge, both for the teacher as well as for the student and family members.

Purpose of the Study

I designed this intervention study to investigate the efficacy of direct instruction and explore the teaching and learning issues posed by the problem statements, while calculating the main effects and interaction effects of intervention. I specifically examined the effects of using direct instruction strategies, as described by Al-Makahleh and Abdul-Hameed (2011), to teach Common Core mathematics computation skills to students with learning disabilities in middle school education. Although many traditional teaching methods in math focus mainly on procedural aspects, direct instruction teaching technique is designed to extend this traditional teaching model to a higher level, by combining both procedural and conceptual techniques incorporating cognitive support systems' mathematical pedagogy in classroom delivery.

Research shows that teachers in the traditional methods of teaching math lack requisite training in task analysis, chunking, sequencing, mass practice, structured feedback, and repetition of instruction (Arsic, Eminovic, & Ivona-Stankovic, 2011; Arslan, 2010; Morin, 2014; Riccomini, 2013; Rosenshine, 2012; Witzel, 2013). Task analysis is the focus of special education classroom practice and direct instruction teaching techniques. Researchers should note, however, that as a treatment of academic deficiency involving math and other basic computation skills within the classroom, I believe that direct instruction teaching model is best suited method for students with learning disabilities, particularly students with mild to moderate learning skills in middle school mathematics.

In many middle school learning environments, implementing effective special education teaching practices is the most viable means by which students can access the general education curriculum in the 12th grade and beyond with minimal distress. This study is needed because I explored effective special education teaching technique, direct instruction, and its effect on the student. The relevance of the problems are found in several research projects which demonstrate that elementary through high school math students with learning difficulties also suffer from math-related disability, otherwise, known as dyscalculia.

In this chapter, I investigated three null hypotheses involving middle school students, especially those in the 7th grades, with learning disabilities who have IEPs, and are at risk for math failure in the following manner:

$H_0$1: Students with learning disabilities who received direct instruction with cognitive support pedagogy in math will not differ significantly in acquisition of math skills following treatment compared to the control group.

$H_0$2: Students with learning disabilities who received direct instruction with cognitive support pedagogy in math will not differ significantly in their maintenance of math skills after one week following treatment compared to the control group.

$H_0$3: Students with learning disabilities who received direct instruction with cognitive support pedagogy in math will not differ significantly in their generalizable math skills in core areas of instruction compared to the control group.

Chapter 2: Literature Review

Introduction

This chapter briefly covers the concept of mathematical disability and mathematical difficulty as experienced by students with learning disabilities. The concept of dyscalculia is explored in relation to its etiology and instructional remedies in a literature review matrix. The review further discusses a variety of direct instruction techniques with multiple forms of support pedagogy, and shows how teachers' failure to properly implement these techniques, may have a negative effect on students' self-esteem and self-determination. In the final analysis, this presentation is followed by a matrix of the reviewed literature from the past five years.

Literature Search Strategy

I searched literature resources including, but not limited to, peer-reviewed articles and journals on mathematical learning disabilities, as well as online databases on using direct instruction to teach math, common core state's standards in mathematics, mathematical difficulties in K-12 education, and *International Electronic Journal of Elementary Education in Mathematics*. In addition, I used several other resources including the Walden University research library, *Sage Publication Manuals*, and *Academic Search Premier*. I also conducted targeted research in several specific journals: the *Journal of Child Neurology*, *Journal of Special Education*, *Journal of Learning Disability Research*, and *Journal of Math Disability*.

Theoretical Foundation

Mathematical Learning Difficulty

Several recent studies have shown that mathematical learning difficulties occur in a variety of settings. In a third-grade learning environment for example, math problems in theory seem to affect a student's learning of basic skills (Heasty, McLaughlin, Williams, & Keenan, 2012). In their study of basic math skills acquisition of middle grade students, Patton, Cronin, Bassett, and Koppel (1997) concluded that mathematics competence is a significant part of human lives, "affecting successful functioning on the job, interpersonal relationships, in school, at home, and in the community" (p. 193).

Per Patton, et al. (1997), "most students with learning disabilities are able to generalize the math skills they had acquired in school, to a wide variety of real life situations that require math applications" (p. 179). Additionally, they contended, many jobs in the modern economy demand math competence. Math skills that are important for adults include time management, the ability to count money, the ability to convert coins, basic computational math, and reading maps for directions. The importance of these skills was validated by Lloyd's (1978) data analysis of third-graders' math performance, which successfully predicted school failures in early childhood into adulthood.

This same position was articulated by Lerner and Johns (2012), who wrote that the relative importance of literacy and numeracy cannot be overemphasized. Most earlier researchers in this area (e.g., Badian, 1983; Bryant, Bryant, Gersten, Scammacca, & Chavez, 2008; Gross-Tsur, Manor, & Shalev, 1996; Kosc, 1974) agreed and indicated that, mathematical disability often occurs alongside reading and or spelling difficulties, even though mathematical disability may occur independently of any language-based disabilities. This sentiment was similarly expressed by the United States' Chief States' School Officers in 2010, according to Riccomini, (2013C).

Kosc (1974) coined the term *Practognostic dyscalculia* to describe students that have difficulties in translating their knowledge of abstract mathematical know-how into real-life problem solving. For example, I have been able to observe that many eighth graders are quite capable to conceptualize numbers, but some find it difficult to work with quantities in a practical way. In this regard, given a number line, some may still exhibit problems with order magnitude. When presented with an array of 20 numbers, such as 43, 53, 63,74, 84, 94, 15, 25, 25, 25, 25, 48, 59, 59, 81, 71, 61, 51, 41, 32, and asked to determine the mode after arranging them in their order of magnitude, the students often do poorly.

Garnett (1998) reported that while children with disorders in mathematics are specifically included under the definition of learning disabilities, seldom do math learning difficulties cause children to be referred for evaluation by instructional leaders. Garnett further stated that, "In many school systems, special education services are provided almost exclusively on the basis of children's reading disabilities" (para. 2). Students with significant math difficulties are often ignored and withdrawn from special education services. Thus, the theoretical foundation of mathematical learning difficulty derives from the fact that many middle school students with mathematical disabilities are hardly diagnosed nor provided with the appropriate instructional services.

Conceptual Framework

Several research projects carried out in the 1940s with dyscalculic students by Kaufman, Lord, Reese, & Volkmann, (1949), demonstrated the importance of mathematical subitizing. Subitizing has been described as a student's ability to immediately perceive and conceptualize numbers by identifying the number of items in a given set without having to count. It has been reported by the authors that subitizing amongst elementary school children plays an important role in the development of basic math skills and future successes in math. My classroom experience of teaching middle school students indicate that many general education teachers of mathematics may not always differentiate between *conceptual subitizing* and *perceptual subitizing* in classroom delivery.

Conceptual subitizing involves a student's awareness of number combinations in small manageable chunks. Conceptual subitizing has several implications for teaching. Many special needs students accomplish conceptual subitizing by memorizing specific number patterns, but the special education teacher must be willing and open to allowing the student extra processing time, and must be willing to explicitly teach the concept of subitizing to their students. An example of perceptual subitizing is when a student quickly perceives the difference between two apples and four apples in separate columns, identifying them as such without understanding that combining those two sets of number items can produce six apples.

Properly teaching number sense is important, but quite challenging. Gersten and Chard (1999) described the concept of number sense as " analogous to mathematics learning as phonemic awareness has been to the reading research field" (p. 18). Thus, If a student has both reading and mathematical disabilities, this can be additionally challenging for mathematics teachers as they attempt to differentiate their instruction in the classroom.

Dirks, Spyer, Van Lieshout, and Sonneville (2008) investigated comorbidity of reading and arithmetic disabilities among participant fourth and fifth grade students (N = 799) in Holland using standardized school achievement test results. Dirks et al. identified the cooccurrence of word recognition through reading comprehension and spelling deficits, as well as explored the gaps in the literature regarding arithmetic learning disabilities. Although they accepted the research findings of other researchers (Badian, 1999; Shafrir and Siegel, 1994), Dirks et al. argued that previous research studies demonstrated that children with "combined reading and arithmetic disabilities do have more generalized verbal and nonverbal problems; which appear to have the most impairments when compared to groups of reading-only or arithmetic-only disability groups" (p. 466). In this way, co-morbidity tended to present in students, its own peculiar challenges for learning and teaching.

Prevalence of Combined Reading and Arithmetic Disabilities

Dirks et al. (2008) stated that arithmetic fact retrieval is a skill that is wholly based on counting, which would involve number words and competencies in numeracy. Because many of the students did not perform well in math as expected, Dirks et al. suggested that "counting skills are associated with long term memory of problems and answers which are represented at least, in part, by the same phonetic and semantic memory support systems" (p. 463). The Dutch student samples in Dirks et al.'s study appeared to be deficient in both reading and arithmetic skills' instruction, but the students appeared to differ in their disability categories which may have affected their learning rates.

U.S. researchers should use caution in interpreting results cross-culturally because, according to Badian, (1999), although "word recognition and reading comprehension skills are both reading processes," operationalizing them within the American educational context of number knowledge and numeracy components may require different cognitive interpretive skills, even though they both have similar linguistic structures. *Numeracy* or number knowledge is the "mastery of some of the basic symbols and processes of arithmetic". Some aspects of numeracy skills that a student must have include *number recitation* and the ability to manipulate the symbols of addition, subtraction, multiplication, and division. Students may also be able to manipulate weights and measures, count money, tell time, and draw geometrical shapes and objects as directed or taught through competent instruction (Gersten et al., 2006).

According to Lerner and Johns (2012), a teacher must recognize some potentially disabling symptoms of a disability to effectively teach math to students with these learning disabilities. These symptoms may include (a) student's confusion arising from difficulties with planning and budgeting their time, (b) confusion with number identifications and one-to-one number correspondence issues, and (c) difficulties arising from problems using mathematical symbols (e.g., +, /, -, x). A potential problem could also arise for a student with dysgraphia. According to Dirks et al. (2008), dysgraphia is the “impairment of the ability to write as a result of brain injury or brain damage”. In the DSM-V, researchers have described dysgraphia as “a severe difficulty with writing and other problems associated with fine motor-skills.”

In addition, research conducted by the Organization for Learning Disability shows that a student with dysgraphia can often be associated with information processing deficits in the brain, which often affect both visual and auditory sequencing (Horowitz, 2011). It is assumed that the student knows the number when presented and is taught to him or her to the extent that they sees it and understands it, but only to find out that they could not write out the numbers properly, even when prompted. For example, if a student is given a task with numeracy problems and prompted to write “one” and “three” or 13, but instead writes 31, or if a student is directed to write “two” in the one’s column and “one” in the ten’s column, and writes 21 instead of 12, it is known as *number reversals* or *number transpositions*.

Teachers may also encounter communication problems while teaching students with dysgraphia, as with teaching students with dyscalculia, because of poor organizational skills development. A student’s inability to make correct changes, for example, at a grocery store given the appropriate amount and proper instructions on what to do, may constitute life-affirming examples of dysgraphia. Certainly, such presenting conditions can be corrected by using response to intervention mechanisms with students in middle and elementary school environments. The situation can be challenging among college-ready and career-bound students, as well as high school students.

Research shows that a well-validated teaching method, such as direct instruction, is well suited to teaching math skills to students with learning disabilities, especially those with difficulties comprehending basic math skills. Direct instruction appears to be an effective method for teaching basic common core knowledge and skills as well. According to Kellough and Jarolimek (2008), the benefit of direct instruction is significant when accompanied by cognitive support pedagogy or motivational units. Because the sources of students' motivations are mostly extrinsic, "student's achievement of specific academic content is therefore predictable and manageable" (p. 209), when direct instruction protocols are effectively used in the classroom.

Literature Review Related to Key Variables and Concepts

The Direct Instruction Literature

Many researchers in the area of learning disabilities movement have criticized the amount of research work in the area of instruction, even though no consensus exists regarding the best way to move forward. In search of a perfect curriculum, Woodward (2004) estimated that as with the 1950s and 1960s, "several methods at teaching math were being implemented in the United States throughout the 1970s and the 1980s…" (p. 22). Woodward (2004) explained that teachers began to experience failures in their implementation of the new math curriculum, wherein the need therefore developed for a broad-based professional development for the K-12 grade teachers" of mathematics (p. 26).

The teachers' attention was focused on revamping the abstract nature of the reform movement in mathematics starting at the elementary school level. In this way, both rote and passive learning strategies gave strength to active learning. It was within this tradition that direct instruction was developed as a teacher-directed instructional package. As would be expected, direct instruction and other "follow-up and go through" initiatives became popular school reform efforts. Adams and Engelmann's (1996) study describes "project follow-through as an effective school reform, behaviorally-oriented practice based on direct instruction (DI), or explicit training model…. Direct instruction (upper case), utilizes a tightly controlled instructional methodology followed by highly structured teaching materials" (p. 1).

According to Adams and Engelmann (1996), direct instruction aims to "accelerate academic skills among students with disabilities with, or without the natural environment of a school setting" (p. 17). Adams and Siegfried's (1996) analysis of project follow-through and beyond was an "experimental evaluation research where teacher participants were presented with specific questions to use in eliciting verbal responses from their students" (p. 9). In this regard, an analysis of project follow-through and beyond shows that "proper responses were considered accurate, and therefore reinforced, but inaccurate answers were immediately corrected according to specified procedures" (p. 11). By design, questions, answers, and correction procedures were all contained in the direct instruction system in arithmetic, as well as in reading.

This was the concept behind DISTAR materials as published by the Science Research Associates' Organization. DISTAR is a scripted curriculum. Noncurricular subjects were introduced after mastery of basic fact skills. Accordingly, Adams and Engelmann (1996) stated that "direct instruction steps for teachers are structured to allow teachers to have greater flexibility and become proficient practitioners of their DISTAR's techniques" (p. 17). I did not use DISTAR curriculum in this study, but instead used direct instruction with cognitive supports, also known as the teacher effectiveness variety, because it is different from the much criticized original formulation of direct instruction practice, which has not been fully understood nor has DISTAR been fully appreciated in most American K-12 learning circles.

Several other validated instructional strategies that fall within this category of direct instruction are what putatively have been classified by Rosenshine (2008) as the "teacher-effectiveness" variety. The teacher-effectiveness varieties constitute the direct instruction teaching methods. According to Rosenshine, these varieties would have included teaching methods and packages such as Common Core Math, Cognitive Strategy Instruction, Cooperative Learning, Peer-Assisted Learning, Brains Are Fun-Success with Math, Open Court, Explicit Instruction, Strategy-Only Instruction, Constructivist Instruction, Saxon Math, Core Knowledge, Success for All-SFA, and others. Each of these teaching methods exemplifies aspects of the direct instruction variety with cognitive support systems.

The core of direct instruction is in its "logical hierarchies," wherein contradictions are routinely found in the presentation of instructional examples that not only exemplify *sameness* in a variety of ways, but also exposes object differences. For example, in explaining the concept of *stimulus discrimination*, a teacher may show a picture of an equilateral triangle in a row of objects, but then teaches an isosceles triangle within the same context, while also assessing each student's responses to check for understanding.

This process may constitute a violation of hierarchical order. Direct instruction adheres to logical hierarchies of information presentation.

This object discrimination process is a characteristic of direct instruction, and enables a child's cognitive development. A teacher might consider this logical hierarchical presentation of objects as leading toward discovery learning. If the teacher's goals were specific enough, and presented in rapid succession with clear, understandable communication, then the learner will increase their engagement time, and will learn at an accelerated rate.

Although dated, Engelmann and Carnine (1982) validated research findings in this area noting that, "If we choose to present written tasks that require following directions at an 'accelerated rate', we must teach the learner to decode before we present the tasks" (p. 378). In this way, students would be expected to learn cumulative tasks better and faster. According to Taylor and Parsons (2011), researchers should anticipate that students' engaged time would be improved. Successfully accomplishing math tasks using direct instruction within a learning disability environment are not because of a student's developmental frames of reference, nor is the learning that takes place a matter of the students' gender classification, age, and social economic statuses. Learning takes place when a clear communication links learner and teacher. Learning is enhanced in this way, because of both teacher and learner characteristics.

A well-structured instructional package could be helpful, but so too is the student's ability to muster courage, willingness, and self-determination skills. Usually, clear communication is followed by the teacher's presentation of an appropriate instruction, with an academically desirable curriculum that is scripted without ambiguity, as the learner becomes the prime focus of instruction. In this way, every student's self-esteem is enhanced in the process of learning and teaching as anticipated.

Self-Determination Skills and Child Outcomes

In a 2009 opinion page *Impact of Self-Determination on Math Skills*, some staff writers at the National Center for Learning Disabilities concluded that, "as math learning continues in subsequent years, school-age children with language processing disabilities may have difficulties solving basic math problems" (para. 6). Students' problems may be compounded as they use mathematical symbols of addition, multiplication, subtraction, and division (+, x, -, /). The literature on acquiring basic math skills increasingly demonstrates difficulties experienced in acquiring math skills as elementary school children graduate to upper grades.

While targeting interventions for children with math difficulties, Dowker and Sigley (2010) showed that these difficulties negatively affect students' self-esteem and confidence in school settings. Math failure was attributed to students' low self-esteem and unsustainable math anxiety. Some researchers in the field of self-determination (e.g., Geary, 2006; Wehmeyer & Schwartz, 1997) have lamented the extant nature and scanty research connecting these self-esteem links between mathematical anxiety, socio-emotional development, and self-determination skills.

Although these researchers are aware of the role of anxiety in math competences, not much is known about how much of a student's anxiety with mathematics can actually cause a student to make errors in computation and reasoning skills from preschool, through grade school, and into adulthood. It would be difficult, for example, for a third or fourth grader, who would in another ten years become a young adult, to be taught how to do grocery shopping, or hold down a job in their teenage years in the absence of planned or programed remediation. Although establishing the links may be fuzzy at best, for many lower grade students with learning disabilities, inappropriate instruction in basic math skills and other learning processes may tend to dampen their self-determination skills, their self-image, and their self-esteem during their secondary school years and beyond.

Although not much research has been done to establish cause and effect links between lack of self-determination skills among students in elementary or secondary school settings and negative adult outcomes, the links might have already been present, but not formally acknowledged by educators and school officials. According to Garrett, Mazzocco, and Baker (2006), a self-determination link relationship exists between metacognition and math ability among school children (> 11years old) participants in a longitudinal study. Although this study involves disparate students' age groups, it is quite relevant here, nonetheless. Knowing what you think you know (metacognition) tend to improve your self-determination and self-esteem skills in areas of daily living.

According to Mazzocco and Baker (2006), "metacognition refers to knowledge about one's own cognition" (para. 3). Metacognition can seem refreshing to a student with math anxiety, especially where incremental successes are observed and independently verified. At any rate, an individual who feels good about their accomplishment in any area of human engagement, especially in math competency, is a welcoming idea.

Taylor and Parsons (2011) wrote about the necessity of improving student engagement and the teacher's role in facilitating such improvements. Researchers and teachers are hard pressed for valuable information regarding the lacking cognitive demand for what works instructionally in middle school settings. By suggesting what special educators need in *Learning Disability Resources and Essential Information,* Horowitz (2011), goes a bit further to show 'what teachers must know and be able to do' to underscore the relevance of a clearly defined knowledge base and improve their students' engagement. Table 3 consists of a literature review matrix of relevant research done within the past five years.

Table 3

Relevant Literature Review Matrix Within the Past Five Years

Author/ Date	Theoretical/ Conceptual Framework	Basis of Research Question(s)/ Hypotheses	Methodology	Analysis & Results
Al-Makahleh & Abdul-Hameed (2011)	Direct Instruction on fourth and fifth graders with learning disabilities	Can direct instructional package enhance students' achievement in math?	Direct Instruction plus Cognitive Supports to students with learning difficulties	Math achievement gains were reported among 4th, and 5th graders with learning disabilities
Arslan, C. (2010)	Teaching math literacy: Procedural & Conceptual Knowledge	Examination of working memory in students with LD	Explicit instruction. Impact of conceptual and procedural knowledge on working memory	Program reports achievement gains in math literacy
Dowker & Sigley (2010)	Targeted Interventions for children with arithmetical difficulties	Comorbidity of learning disabilities and their effects on instruction	Strategy Instruction	Main effect gains are reported when intervention is targeted
Kaufmann & Von Aster (2012)	Diagnostic / Intervention	Diagnostic and Management of Dyscalculia	Effective instructional components	Targeted intervention shows program promise overtime
Riccomini, P. (2013)	Common-Core State's Standards (CCSS)-framework in instructional scaffolding	How to: Writing and teaching vocabulary of math words	Instructional Scaffolding together with cognitive support pedagogy	Positive effect gains are reported among students with a history of low performance
Szucs & Goswami (2013)	Neuro-science and origins of Dyscalculia	Developmental Dyscalculia: Trends in education and neuro-science	Exploratory analysis	Positive gains detected following treatment

Table 3 continued.

Author/ Date	Theoretical/ Conceptual Framework	Basis of Research Question(s)/ Hypotheses	Methodology	Analysis & Results
Riccomini (2013)	Case Studies in Elementary mathematics	How to implement Interdisciplinary teaming	Response to intervention (RTI)	Implementation to sustainability
Arsic, Eminovic, & Ivona-Stankovic (2011).	Conceptual Monitoring	Quality of Working memory	Explorative: Working memory of Children with Calculation difficulties	Instruction types enhances memory skills
Ayo, Kelechi, & Abiodun (2013)	Manifestations of Dyslexia & Dyscalculia	Effects on Students with special needs education	A Correlational Study/Investigative/ Explorative studies of Elementary / Secondary school children in Nigeria	"Persons with academic deficits in English language and mathematics should be screened for either dyslexia or dyscalculia, even both. They should be taught according to a carefully developed Individualized Education Plan" (p. 1).
Berch & Mazzocco (2014)	Etiological foundations of mathematical learning disabilities	Origins of math difficulties in some children	Explorative / Data analysis / Scientific data & Archival information	Explanations for why math is so hard for some children and not others
Garcia & Pacheco (2013)	An Exploratory case study using computer simulations in mathematics problem solving.	How to use computational platform to enhance students' learning in mathematical problem solving.	Constructivist pedagogy provides alternative to traditional math instruction in Mexico	Integration of computational tools into conventional teaching methods to improve students' motivation and self-efficacy.
Powell, Fuchs, & Fuchs (2013)	Addressing Common Core Standards in Math	Teaching Students with learning disabilities in Math	Cognitive instruction / Response to intervention (RTI)	Report shows achievement gains in both intervention settings

Table 3 continued.

Author/ Date	Theoretical/ Conceptual Framework	Basis of Research Question(s)/ Hypotheses	Methodology	Analysis & Results
Woodward et al. (2012).	Mathematical Problem Solving Processes	Guess and Check vs. Schema-Based Instruction	Process Monitoring in Schema-based instruction	Results show achievement gains
VanDerHeyden, Amanda, McLaughlin, Tara, Algina, James, Snyder, & Patricia (2012).	Mathematics intervention for fourth and fifth grade English-speaking students	Fluency building for math computations and procedures	An Evaluation study	"Intervention effects were detected at both grade levels-but not on all outcome measures" (p. 328), following multi-level linear modeling
Flores, Hinton, & Strozier (2014).	Using Concrete-Representational-Abstract (CRA) sequence and Strategic Instruction Model (SIM)	Using effective teaching protocol to teach conceptual understanding in mathematics	Replication study to investigate the effects of CRA and SIM to teach subtraction and multiplication with re-grouping	Students demonstrated achievement gains across all regrouping tasks.
Swain, Kristine, Bertini, Tamara, Coffey, & Dara (2010)	Effectiveness of a specific direct instruction method-"folding in"	Folding in intervention on Elementary school students' math computation skills	Curriculum-based measurement of basic math facts	Continuous progress monitoring
Stockard, (2010).	Effects of Direct Instruction	Assessing direct instruction on the Elementary-level math achievement of First-graders	Comparative Longitudinal study of math achievement in a large urban school district from 1998 - 2003	Positive outcome measures for students in direct instruction class when compared to others.
Smith, John P., III; Males, Lorraine, Dietiker, Leslie, Lee, KoSze, Mosier, & Aaron (2013).	Cognition and Strategic Instruction	Assessing written 'Elementary mathematics curricula as contributing to the problem of learning length measurement'	Teaching direct access to conceptual mathematical principles of length measurement to grades K-3 students with learning disabilities	Program demonstrated a shared focus on procedures-leading to substantial attention of conventional knowledge by the 3rd grade students

Table 3 continued.

Author/ Date	Theoretical/ Conceptual Framework	Basis of Research Question(s)/ Hypotheses	Methodology	Analysis & Results
Witzel (2013).	This is common core math and how to teach it	Strategies for teaching common core math to students with a history of low performance who have LD	Direct instruction strategy plus cognitive support pedagogy were used to teach basic algebra	Effect gains were indicated among middle and high school students with learning disabilities
Misquitta, (2011).	A review of current instructional practices for teaching fractions to struggling students.	Establishing directions for future research in effective instructional packages	Assessing teaching methods involving strategy instruction, explicit instruction, direct instruction, and graduate-sequence instruction.	Review "highlighted the paucity of research in this critical mathematical content areas" (p. 33).
Kay, (2013).	Evaluating web-based learning tools as pedagogical design	Impact of instructional architectures on middle and high school students' attitudes toward learning & engagement; and students' performance in remembering, & understanding.	Comparing direct instruction vs. constructivist instruction	"Direct instruction may be better suited than constructivist instruction for younger students who are learning basic-level tasks and concepts" (p. 116).
Grady, Watkins, & Montalvo, (2012).	Constructivist mathematics on achievement in three rural school districts	Evaluation of three mathematics curriculum and pedagogy	Comparing K-6 Everyday math with Traditional instruction (Chalk & Talk), and Traditional instruction supplemented with Mountain math	Results of the "study show constructivist K-6 elementary math curriculum did not lead to higher levels in math achievement when compared to traditional methods of instruction" (103).

Table 3 continued.

Author/ Date	Theoretical/ Conceptual Framework	Basis of Research Question(s)/ Hypotheses	Methodology	Analysis & Results
Celik, Semiha; Vuran, Sezgin (2014).	Direct instruction and Simultaneous Prompting Procedure on Teaching Concepts to individuals with intellectual disability	Comparative study using parallel treatment designs in a special education center	Comparing the efficiency, effectiveness, maintenance effects and social validity of two instructional methods	“Results show both direct instruction and simultaneous prompting procedure were effective. (2) Simultaneous prompting procedure was found more efficient than direct instruction procedure in terms of the number of trials and incorrect responses (3) Participants maintained concepts at the first, third, and the fifth weeks following intervention

Summary and Conclusions

The major themes of the literature review included direct instruction teaching methods, educational setting, and learning and teaching in middle school educational environment regarding direct instruction with cognitive support pedagogy, as well as an exploration of students’ self-determination skills and mathematical awareness. According to Garrett et al. (2006), data and information about learning disabilities should be made available and should inform teachers on the practices of early identification, intervention, and instructional modifications for children with persistent difficulty in mathematics. This is expected to provide special education teachers and instructional leaders with the opportunity to use data to arrive at informed decisions for classroom teaching.

In Chapter 3, I explore the research methods segment applied in this study and considers the above literature review matrix showing work done within the past five years.

Chapter 3: Research Method

Introduction

The purpose of this quantitative research was to investigate the extent to which the direct instruction teaching methods involving cognitive support pedagogy can affect math scores for grade level students with mathematical learning disabilities. I used a Solomon four-experimental group design, with a math achievement pretest administered to two groups, and an intervention with one of those groups; as well as a pair of groups with no math achievement pretest, and one of the two were subjected to the intervention (see Figure 1). I used analysis to pare out the direct effect of intervention on the student experimental groups.

In this chapter, I also explain the data collection process, operationalization of research variables, and the analyses used in data examination. Additionally, threats to validity and ethical considerations are defined, and procedures to remedy any such difficulties are outlined. My operationalization of the type of direct instruction used in this study focuses on a specific area of math, data analysis. As I answered questions that were developed from about 50 years of evidence based practice demonstrating its effectiveness in meeting the needs of students with learning disabilities, I also placed emphasis on how the present study contributes to the existing knowledge base.

Research Design and Rationale

I used a quantitative methodological design. Because I examined the statistically significant effects of an intervention on quantifiable (i.e., numerically measurable) concepts, this was the most appropriate method (Howell, 2010). The focus of this research was to investigate the effects of an intervention on math test scores. This investigation was accomplished through data collection and analysis of four mutually exclusive groups, to whom either direct instruction were provided (i.e., the intervention groups), or traditional teaching techniques were continued (i.e., the control groups). One of the groups that were administered the pretest also received the intervention, and one of the groups that were not administered a pretest received the intervention. In assessing differences in math achievement, I gathered numerical, quantifiable representations of each student's math achievement level through test scores.

As this research focused on the assessment of differences in these numerical values, a quantitative design was appropriate to assess students' reasoning and computation skills. For this study, I used a Solomon four-experimental group intervention design. This design allowed me to compare the effect of the pretest and the effect of the direct instruction intervention separately to rule out the effects of repeated testing. The concept of a repeated testing effect is that exposure to a test instrument, especially an achievement or skill test, primes participants to higher scores in the second exposure to the test (Pagano, 2009). The Solomon four-experimental group intervention design allows inspection of both experimental and control groups who were or were not exposed to the pretest (see Figure 1). This analysis is robust against the effects of the confounding factor of repeated testing (Gall, Gall, & Borg, 2003). The use of a Solomon four-experiment allows a researcher to avoid effects of instrumentation on program outcomes via careful comparison.

I assessed differences in math scores for seventh grade students with learning disabilities who were either provided direct instruction intervention or were not. Learning disabilities were assumed to be present in students with an IEP. The effect of this intervention was compared to the effect of receiving a pretest assessment, as these two distinct treatments affect posttest scores. This comparison provided a level of statistical control for the effect of pretesting to determine the main effect of direct instruction to alter math achievement (McGahee & Tingen, 2009).

I specifically employed a quasi-experimental design with two treatment groups and two control groups. In a quasi-experimental design, all aspects of an experimental design are preserved, excluding the random assignment into either a treatment or control group. I followed this procedures because teachers were contacted with students already assigned to their class, whereby random assignment was not a possibility within the scope of this research. However, teachers may be randomly assigned to either administer a treatment or control. Additional groups in a Solomon four-group design may be used to determine the effect of both the treatment, and of the pretest on the posttest scores (Gall, Gall, & Borg, 2003). This design allowed for the use of smaller groups, while maintaining the statistical significance of a large group design (McGahee & Tingen, 2009)

In the Solomon four-group design, subjects are assigned to one of four groups (McGahee & Tingen, 2009). Two groups receive intervention and two do not (McGahee & Tingen, 2009). All four groups receive a posttest, but only two groups receive the pretest. Those who receive the pretest include one group that is subjected to the intervention, and one group that is not subjected to the intervention (McGahee & Tingen, 2009). A diagram of this procedure can be found in Figure 1.

This design allowed me to test the main effect of the pretest, as well as the interaction of the pretest administration and the intervention (McGahee & Tingen, 2009). This design requires that the treatment be introduced simultaneously to both treatment groups. I was not able to introduce the interventions simultaneously, but introduced the interventions to the classes within a narrow time frame to reduce bias in the delivery of the intervention, as suggested by McGahee and Tingen (2009).

By using this design, the bias of the pretest influencing the outcome of the study can be evaluated and dismissed by comparing it to the intervention that did not have a pretest included (McGahee & Tingen, 2009). The conclusions of the study can be compared across the four test settings. These settings include (a) students who are given a pretest, intervention, and posttest; (b) students who are given a pretest and posttest; (c) students who are given the intervention and a posttest; and (d) students who are given a posttest only. This design also allowed for comparison of the current teaching methods with the outcomes of the two intervention groups (direct instruction methods).

This effect was evaluated as differences in math assessment scores between seventh grade students with a learning disability who received traditional teaching methods and those of seventh grade students with a learning disability who received the direct instruction teaching methods that were given in the intervention. This research method is modeled in Figure 1.

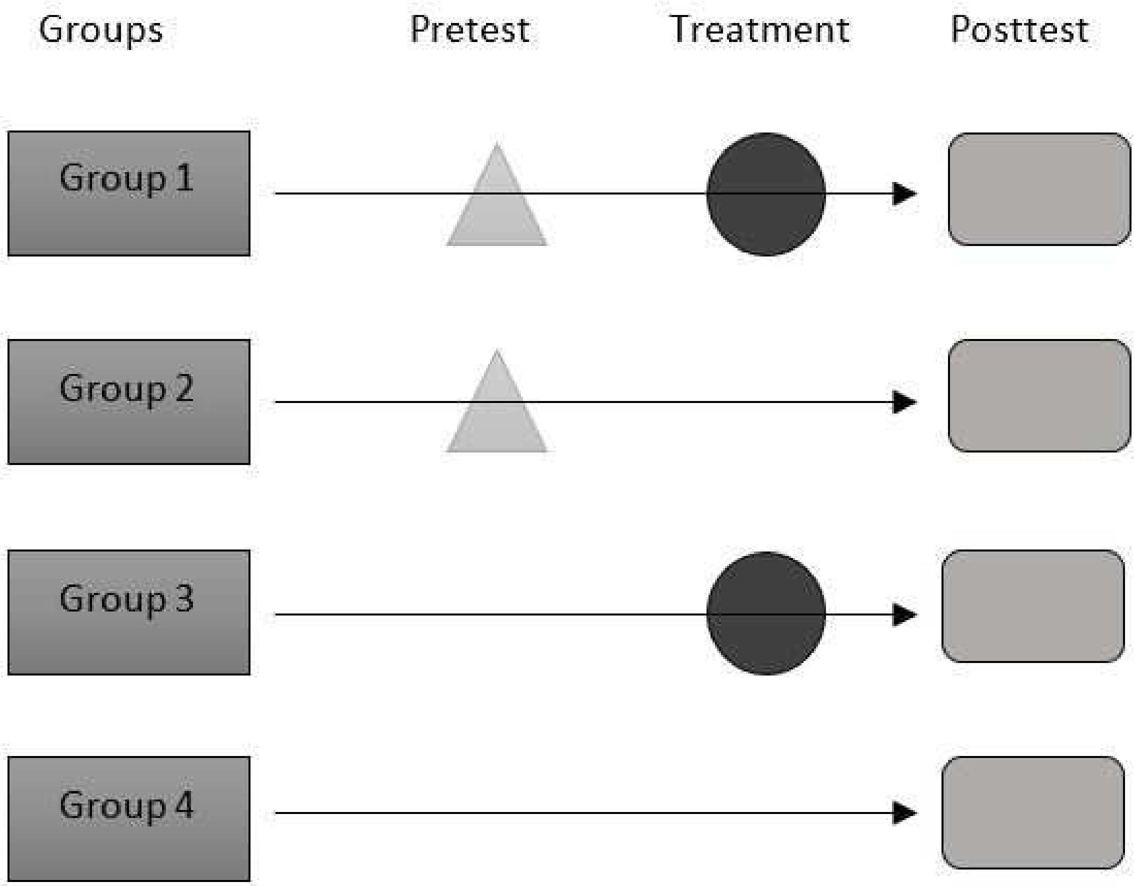

Figure 1. Solomon four-group research design

Methodology

Population

The population of this study consisted of seventh grade school students with a learning disability who reside in the United States. This population encompassed ethnically diverse students from the seventh grade with many demographic differences and socioeconomic backgrounds. This population includes students who are actively engaged in a nonhome schooling program and have a school-determined learning disability. Determination of a learning disability was based on the student's qualification for an IEP. Those students who had an IEP were considered learning disabled for the purposes of this study and were deemed suitable for inclusion in the study population.

Sampling and Sampling Procedures

To assemble a treatment and control group, teachers were contacted from several grade schools of interest. To contact these individuals, I initiated communication through a gatekeeper. A gatekeeper is an individual who acts as an intermediary for a group or organization. It was important for me to build rapport with the gatekeeper and any points of contact that may assist in data collection to facilitate communication. Using school gatekeepers to solicit participation is a form of nonprobability sampling, wherein participation is sought using a group of individuals who are readily available, and without random selection. The gatekeepers solicited participations from teachers, who then gathered informed consent from the guardians of students with an IEP.

This sampling procedure was a purposive, nonprobability design, which is in line with convenience sampling, as schools were not chosen at random, and only those teachers who responded that they would like to take part in the study were used as vehicles for the intervention. A student’s inclusion in the treatment or control group depended on the student’s teacher and was assigned to each teacher at random. Parents were informed of the method of instruction that was used in the treatment group of participating classrooms, but were blind to their student’s placement in a treatment or control classroom. Participating students were not informed by myself nor by their teachers regarding the method of instruction used in their classrooms.

A nonprobability sampling design was chosen because, in special education research, the issues and problems discussed by researchers are usually directed at specific populations. In the case of the present research, the specific population of interest consisted of learning disabled students, and these students represented a minority within the school system. With a restricted population, it was difficult for my volunteer teachers to gather truly random samples because of the diminished population size from which to elicit participation. In addition, I surmised that my questions, hypotheses, variables of interest, and stringent analysis would have rendered this sampling procedure's potential a discredit to validity both negligible and worthwhile.

Procedures for Recruitment, Participation, and Data Collection

School gatekeepers were emailed and informed of the study's purpose, procedures, ethical considerations, and societal benefit. This email was sent with an informed consent form and guidelines for direct instruction attached so that all parties were fully aware of the procedures prior to providing consent to participate. The gatekeeper was asked to forward this information, my contact information, and the consent form to the school's math teachers. Teachers that indicated that they wanted to participate in the study were given a comprehensive guideline for direct instruction procedures to follow. This guide was in the form of a checklist and was returned to me upon data collection to ensure that the indicated procedures were followed.

Once the participating teachers provided informed consent, they were asked to forward consent forms to student guardians. Because the students were not subjected to harm or trauma, and were not in contact with me at any point, minimal risk was expected.

Student guardians were reminded that minimal to no risk existed for students involved in the study, and that their children's identities were maintained as anonymous. Parents were also informed of the study's potential benefit to education.

Sample Size Requirement

The analyses included two one-way ANOVAs and one factorial (2x2) ANOVA, where time was the factor. Of the two types of analyses, the factorial (2x2) ANOVA required the most stringent sample size and provided a baseline sample size requirement to the study. G*Power was used to determine the appropriate sample size to achieve empirical validity (Faul, Erdfelder, Buchner, & Lang, 2013). For a 2x2 ANOVA with three degrees of freedom and two groups with two levels, I expected a medium effect size of difference ($f = .25$), an alpha of .05, and a power of .80; the recommended sample size is 212 participants. This sample size indicates that 106 participants should receive the treatment and 106 should be assigned to the control group. Additionally, 106 participants should take the pretest and 106 should not.

Instrumentation and Operationalization of Constructs

Instruments pertinent to the study included the Test of Early Mathematics Ability, Third Edition (TEMA-3). One assessment (posttest) was administered to two groups, and a pretest and posttest were administered to another two groups. These tests were standardized for the population of interest, and included mathematics questions of similar difficulty for both the pretest and posttest. The testing materials included a kit that had (a) an examiner's manual, (b) picture books for Form-A and Form-B, (c) 25 copies of examiner's record booklets—Form-A, (d) 25 copies of examiner's record booklets—

Form-B, (e) 25 students' worksheets—Form-A, (f) 25 students' worksheets—Form-B, (g) assorted assessment probes with 5 in. x 8 in. instructional activity cards, (h) 20 math blocks, (i) 20 tokens, and (j) a mesh bag. I generated students' report for examination and follow-up studies.

> The student report is a straight-forward listing of the student's mastery status on each objective with indications of performance on each item. A class list will be used to list each student in the class, with a summary of individual performance-showing the number of students and objectives mastered. (p. 5).

The TEMA-3 assessment is a well-established and standardized tool to measure achievement in mathematics. Assessments were graded as a ratio of correctly answered questions out of a total number of questions. A percentage was calculated for each student's assessment. This calculation resulted in ratio level data, which is continuous in nature, and appropriate for use as the dependent variable in a study of mean differences. This test is both grade and age appropriate when basal and ceiling levels of competencies are closely examined.

The following test review materials were accessed from the Buros Institute of Mental Measurements website. The TEMA-3 has been extensively reviewed by Crehan, (2010) and Monsaas (2011). Crehan (2010), wrote that although

> the test is individually administered with a starting point determined by the child's age, testing is continued until the child passes five consecutive items (basal), and misses five consecutive items (ceiling), with an average testing time estimated to be between 45 and 60 minutes. (para. 2).

All test items are ordered according to their levels of difficulty. So, if items are administered below the basal levels, they are marked as correct. However, when items are not administered above the ceiling level, they will also be regarded as incorrect. Thus, test appears to be both age and grade-level appropriate.

Monsaas (2011) indicated that the TEMA-3 has two forms, wherein "results of item analyses for the norm sample was reported by age level and test form" (para. 4). According to Monsaas (2011), "the year-to-year median item difficulties range from .03 for the form B, 3-year old sample to .87 of the form B, 8-year old sample. This presents an irregularity between forms by age mean raw scores" (para. 6). Therefore, conflict exists in the reported changes among difficulties in median test forms and age-level analysis. The problems of test score irregularities and test forms were resolved by the authors of these testing instruments as they conducted several correlation measures.

According to Monsaas, (2011), "evidence of correlation with other measures of mathematics is reported for seven mathematics subtests selected from the Key Math-R/NU, Woodcock-Johnson III-ACH, Diagnostic Achievement Battery-3, and Young Children's Achievement Test which provided further showing of construct-identification validity" (para. 8). Evidence exists of concurrent and predictive validity, although not explicitly stated by the authors. All tests that were used are ranked high and acceptable on their reliability and validity scales. "The standardization sample is composed of 1, 219 children. Test results are reported as standard scores, percentile ranks, as well as age and grade equivalents" (para. 27).

Evidence of reliability and validity. The testing instrument was individually administered, although, it can also be administered in groups. Authors report that the internal consistency reliabilities are above .92. Additionally, many of the validity studies described on this instrument included both immediate and delayed alternative form reliability scales in the .80s and .90s. According to the publishers of TEMA-3,

> The Test of Early Mathematics Ability (TEMA) was originally developed as a means for identification of learning difficulties or the likelihood of developing learning difficulties for children in Kindergarten through the third grade and higher…; the test was also intended to provide useful information on the strengths and weaknesses of children without learning difficulties.

Intervention

The main independent variable in this study is direct instruction. Direct instruction was used as a teaching strategy to improve students' math skills as provided for and available in the testing materials. To determine the effect of direct instruction teaching methods on student achievement, teachers definitively used the method. To assign teachers who used the method, I used a random number generator (RNG). Several of these RNGs exist for the purpose of grouping participants into a treatment or control group. For the teachers who were selected to use direct instruction, a checklist—a tier 3 or corrective math observation checklist—was provided to assure that all aspects of the method were being used to an equal degree for all intervention teachers. These teachers were allowed to continue with their normal curriculum in every other regard.

Teachers did not use the direct instruction method were also provided a checklist, so that they did not mistakenly administer the treatment. In this way, the intervention may be conducted or controlled similarly within each treatment or control group. Participating teachers were asked to provide test scores from the students with learning disabilities only, but were not asked to provide identifying factors, so that the students' anonymity is maintained, and their disabilities are not disclosed at any time to any party.

In addition to the checklist, both participating and nonparticipating teachers' classroom interactions were video recorded for the entire duration of intervention. Computation and data analysis lessons taught were recorded for daily lesson progress. The video data were used only to assure that lessons were taught correctly, and will remain stored in a locked file cabinet and in a password protected file when not in use.

Data Analysis Plan

Data were entered into SPSS version 22.0 for Windows for analysis. I examined descriptive statistics to describe the characteristics of the population sample, calculating frequencies and percentages for categorical data, such as the proportion of students in each group. I also calculated means and standard deviations to describe the spread and central tendency of continuous data, such as mathematics assessment scores in alignment with similar other analysis provided by Howell (2010).

I screened data for missing cases and univariate outliers. I assessed univariate outliers on the continuous variable of interest via standardized values, or z scores. Standardized values represent the number of standard deviations a participant's score falls from the average; outliers are defined as standardized values below -3.29 or above

3.29 (Tabachnick & Fidell, 2012). I removed all outliers found in the data prior to analysis. I then conducted hypothesis testing in line with the following nondirectional (i.e., two-tailed) hypotheses:

- **$H_0$1**: There is no significant difference in math scores between the treatment group and the pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.
- **H_a1**: There is a significant difference in math scores between the treatment group and the pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.
- **$H_0$2**: There is no significant difference in math scores between the no treatment group and the pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.
- **H_a2**: There is a significant difference in math scores between the no treatment group and the pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.
- **$H_0$3**: There is no significant difference in math scores between the treatment group and the no pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.
- **H_a3**: There is a significant difference in math scores between the treatment group and the no pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.

- **$H_0$4**: There is no significant difference in math scores between the no treatment group and the no pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.
- **H_a4**: There is a significant difference in math scores between the no pretest group and the no treatment group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.

Hypothesis testing. To assess hypothesis one, and to determine if math achievement changed following exposure to a direct instruction teaching method, I conducted three ANOVAs. The first ANOVA was a one-way ANOVA that assessed differences in TEMA-3 math scores between treatment and intervention groups of students who were pretested (group 1 vs. group 2). The second ANOVA was a one-way ANOVA that assessed differences in math scores between treatment and intervention groups of students who were not pretested (group 3 vs. group 4). The one-way ANOVA is the appropriate analysis when the goal of research is to determine if differences exist in a single continuous dependent variable by two or more groups (Pallant, 2010). The third ANOVA was a factorial (2x2) ANOVA that assessed differences in the posttest scores by two grouping variables, each with two categorical levels. Those variables were used to group participants based on who took the pretest vs. did not, as well as those who received treatment vs. control. The factorial ANOVA is the appropriate analysis when the goal of research is to determine if differences exist in a single continuous dependent variable by two or more discrete grouping variables with multiple levels, as is illustrated in Figure 2 (Howell, 2010).

I analyzed the one-way ANOVA conducted to assess differences in TEMA-3 posttest scores by group (Group 1 vs. Group 2) first. The dependent variable in the analysis was mathematics posttest scores, as measured by the TEMA-3. The independent variable in the analysis was group (Group 1 vs. Group 2). Group 1 and Group 2 consisted of participants who took the pretest. Group 1 received the treatment and Group 2 did not. This analysis assessed the effect of the treatment for those who took the pretest. An alpha of .05 was used. Prior to analysis, the assumptions of the analysis were examined.

I then analyzed the one-way ANOVA conducted to assess differences in TEMA-3 math posttest scores by group (Group 3 vs. Group 4). The dependent variable in the analysis was mathematics posttest scores, as measured by the TEMA-3. The independent variable in the analysis was group (Group 3 vs. Group 4). Group 3 and Group 4 consisted of participants who did not take the pretest. Group 3 received the treatment and Group 4 did not. This analysis assessed the effect of the treatment for those who did not take the pretest. An alpha of .05 was used. Prior to analysis, the assumptions of the analysis were examined.

The factorial 2x2 ANOVA was conducted to assess differences in TEMA-3 math posttest scores by the two grouping variables simultaneously, providing the opportunity to examine the interaction of pretesting sensitivity and intervention. Spector (1981) and Braver (1988) showed the benefits of the factorial (2x2) ANOVA, in that this analysis was able to specifically target the interaction of pretesting and intervention, as its own distinct variable, to determine if potential confounding issues existed. The dependent variable in the analysis was mathematics posttest scores, as measured by the TEMA-3.

There were two independent variables by which participants were grouped. The first independent (or grouping) variable grouped participants based on those who took the pretest vs. those who did not. The second independent variable grouped participants based on treatment vs. control. These grouping variables were not mutually exclusive, as one pretested group received intervention, and one did not. Simultaneously, one of the non-pretested groups received intervention, and one did not. Main effects describe the direct effect of placement by one grouping variable as examined independent of the other group. Interaction effects describe the combined effect on math scores depending on placement into either a treatment or control group, and administration of a pretest.

Both main effects and interaction effects were closely examined. If the interaction term is found to be significant, post hoc analyses would be conducted to determine where the significant differences lie. This interaction term would indicate if a significant interaction exists between repeated testing effects and the intervention itself. Nonsignificant interaction effects suggest that the pretest did not confound the results of the intervention's effectiveness. An alpha of .05 was used as a benchmark to interpret significance; and this ensured 95% confidence that any significant findings were not due to random chance alone. A visual representation of group placement for both groups simultaneously is presented in Table 4.

Table 4

Group placement based on two dichotomous grouping variables

Testing groups	Intervention groups	
	Intervention	No intervention
Pretested group	Group 1	Group 2
Non- pretested group	Group 3	Group 4

I examined the assumptions of each ANOVA prior to conducting the analysis. Using either the one-way or factorial 2x2 ANOVA, I assumed that data is normalized and variance between the two groups are nearly equal. These assumptions are known respectively as normality and homogeneity of variance. Normality is the assumption that the sampled math scores are normally distributed (i.e., bell-shaped); I assessed this with the Kolmogorov Smirnov test (Stevens, 2009). Homogeneity of variance is the assumption that both groups have equal error variances and was assessed using Levene's test.

In many cases, researchers consider the F test to be a robust statistic in which assumptions may be violated without contributing relatively major effects to the test's validity (Howell, 2010). Stevens (2009) further stated that, because of the central limit theorem, data typically approach a normal distribution as *N* exceeds 30. Violations of either assumption were noted so that they may be considered in the interpretation of results.

Threats to Validity

Internal validity. Potential threats to internal validity address alternative explanations of the results (Creswell, 2003). One such threat is the inability of a researcher to randomly assign students to either a treatment or control group. This is because I contacted schools in which students are already assigned to teachers, and I only had the ability to implement the intervention on a class-wide basis.

In many quasi-experimental designs, it is difficult to discern the effects of a treatment from several other confounding factors. However, the Solomon four-group analysis takes several effects into account. For example, the effect of having taken a pretest may be examined in comparison to those who did not take a pretest. In addition, the larger number of groups assists the research in controlling for random fluctuations that may be amplified when only two groups are examined (Tabachnick & Fidell, 2012). Therefore, I attempted to control for many of the limiting factors of quasi-experimental research.

External validity. External threats of validity refer to issues regarding the generalization of findings (Creswell, 2003). One such threat to validity was the method of participant selection: the participants selected to participate for the study may not have accurately represented the population of interest. Sampling from a larger pool of schools and participants would have limited the extent of this threat by representing a wider variety of students (Pallant, 2009).

Ethical Procedures

Ethical procedures were undertaken to ensure that the proposed study was conducted in a respectful and ethically advised manner. Research participants were made aware of the study's goal and the details of their participation (i.e., the study is completely voluntary, participants may withdraw at any time, etc.). I omitted all names of participants from any study documents that were used to analyze data. This procedure was used to ensure that participation was entirely anonymous, and to assure participants of this. In addition to these measures, all of the assessment scores and demographic data will remain in a secure, password-protected e-file until such time as they will be destroyed after a period of no less than five years. This method of data retention and destruction are used to avoid any disclosures of data and ensure the right to privacy.

In this document, I present the results in a fair and honest manner, with no manipulation of the data or the outcomes. Institutional Review Board (IRB) approval was obtained prior to any data collection, along with congruence to school policy and any federal regulations. Assurances were made to ensure the ethical and safe completion of the present study. I obtained IRB approval by completing an IRB application form with full disclosure of the study procedures and ethical safeguards. Walden University IRB approval number for this study is: 12-09- 15-0047745. I then worked closely with the IRB to assure that the study was conducted with the utmost ethical care.

Teacher Participant Training

I identified interested teachers who were willing and able to participate in a short training exercise that implemented. The selected teachers were trained in special education practices of direct instruction with cognitive support systems. (See appendix C).

Procedure, Day 1: Introduction to intervention in special education teaching practices. First, participating teachers were taught to regard intervention records valuable as they were to be held confidential and safeguarded by encrypted technology. Second, teachers were informed that training protocol was to last for 2 consecutive days, including 15 minutes' break periods, session reviews, and constructive feedback. Each training session lasted for 45 minutes in duration and was organized into nine short lessons to include a program fidelity checklist (Cognitive Support Pedagogy) and a tier-3 corrective math teacher observation sheet. Data collection of school record was carried out using RNG software in which a Gaussian generator enabled random numbers to accurately fit a normal distribution. I reviewed the participating school website for Partnership for Assessment of Readiness for College and Careers (PARCC) results for grade levels in Math 7 and Math 8. Data from the suppressed PARCC results for fiscal years 2014 and 2015 were used as the basis for the research control group and teacher training purposes of participating teachers on how to implement direct instruction techniques involving cognitive support pedagogy.

Procedure, Day 2: Conversion of raw data. According to the editors of the Common Core State's Standards (2010), conversion of raw scores to age and grade equivalencies in special education research is appropriate because in a common core learning environment, PARCC assessments often focus on grade levels 3–8 to effectuate data collection effort for use on transition and career decisions down the road in post-secondary education. I used the partner site "School-Stat" dataset from the PARCC secondary data source and merged it with current students' composite de-identified data for teacher training purposes. The partner site agreed to redact identifiers, such as students' names, age, and other information associated with students' grades and disability statuses.

At no time during the research process was I in direct contact with participating students. This data use agreement was memorialized in the following manner:

> The purpose of this agreement is to provide data recipient with access to a limited data set (LDS) for use in research in accord with laws and regulations of the governing bodies associated with the data provider, data recipient, and data recipient's educational program. In the case of a discrepancy among laws, the agreement shall follow whichever law is stricter. (Walden University, n.d.)

The partner site agreed to supervise and assume responsibility for instructional activities within the scope of their regular school operations. Neither parental consent, nor child assent to do research were needed to conduct this research because the teachers were involved in activities that were ordinarily germane to the students' normal school work under normal school supervision.

Summary

In this study, I examined if the effect of direct instruction teaching technique can quantifiably be said to affect math achievement of students with learning disabilities. This quantitative intervention study used a Solomon four-experimental group design to assess differences in the levels of math achievement for seventh grade students who did and did not receive direct instruction, while also controlling for several weaknesses of an inherently embedded quasi-experimental approach.

This chapter provided a detailed explanation of the procedures that were used in this research study. These procedures were outlined in depth to detail the research design, methodology, data and participant collection procedures, and finally the action plan regarding data analysis. The issues of ethics, researcher's role, and issues of trustworthiness were also addressed with special consideration to potential methods which may remedy these difficulties or harms. I adhered strictly to these procedures in gathering and analyzing data to cleanly and efficiently address the research question and assess the effect of direct instruction on math achievement.

Chapter 4: Results

Introduction

Within the past several years, traditional methods of teaching math to students with learning disabilities have not yielded positive learning outcomes (Szucs & Goswami, 2013). For more than half of the students with learning disabilities, acquiring computational and general math skills is a challenge at all levels—especially for middle school students (National Assessment of Educational Progress, 2012). Riccomini (2012) described students with learning disabilities as *nonstrategic learners*, pointing out that this category of students exhibits problems with working memories, being unorganized and lacking in persistence, and not being able to focus on a given task. Given that some teachers lack the necessary skills to teach students with learning disabilities, an ineffective combination of both teacher and student characteristics can pose unimaginable learning problems within the classroom setting. Hunt, Valentine, Bryant, Pfannenstiel and Bryant (2016) elaborated that "teacher's perspectives are a function of the idiosyncratic needs and present understandings of their students along with their own characteristics 'sic', such as teacher's preparation, backgrounds, and beliefs regarding mathematics and intervention for special populations" (p. 86).

Hunt et al. (2016) wrote that "When using supplemental mathematics programs, which are designed for tier 2 intervention- 'remediation', special education teachers likely should intensify intervention to support their students' learning" (p. 86). In this way, teachers were encouraged to alter instructional materials with a focus on pedagogy, tasks, lesson delivery methods and materials. In a majority of cases with classroom experiences, teachers are not always welcomed to improvise, and therefore cannot be spontaneous or innovative in their service delivery methods.

As per Hunt, et., al, because of this lack of flexibility in teaching method, many students with learning disabilities tended to be at risk for math failure, as they experienced frustration and attribute math failure to their teachers' instructional styles (NAEP, 2012). Past research studies have focused mainly on remediation strategies aimed at correcting ineffective or misaligned skills. These misaligned math skills are difficult to improve once students internalize them, so an early intervention is usually necessary.

Purpose

The purpose of this study was to address the efficacy of a direct instruction teaching method, and to explore the teaching and learning outcomes associated with student achievement in math, while calculating the main effects and interaction effects of intervention and pretesting. This chapter contains an examination of the effects of using direct instruction strategy, as described by Al-Makahleh and Abdul-Hameed (2011), to teach Common Core mathematics computation skills to students with learning disabilities in middle school education. The math focus was both data analysis and computation in combination with associated skills from conceptual and procedural mathematics.

To meet the goals of this research, the analysis followed a Solomon four-group experimental design. I used the Solomon four-group design method to determine the likelihood of pretest sensitization effects. Pretest sensitization effect would have been established if a student scored better because of completing the pretest a few days before taking the posttest. The student may have scored better because they had completed the pretest. The student might have decided to consult with their math computation textbook for clarity and familiarity with forgotten techniques about the test and scored better during posttest in comparison to how they would have scored without the pretest. Pretest sensitization often occurs in educational settings. Sensitization effects are dependent on the length of elapsed time between pretest measures and the posttest.

In using this design, subjects were assigned to one of four groups (McGahee & Tingen, 2009). Per McGahee and Tingen's (2009) guidelines for this design, two groups received intervention and two did not. All four groups received a posttest, but only two groups receive the pretest. Those who received the pretest included one group that was subjected to the intervention, and one group that was not subjected to the intervention, as suggested by McGahee and Tingen (2009). This design allowed me to test the main effect of the pretest, as well as test the interaction of the pretest administration and the intervention, in alignment with McGahee and Tingen (2009).

Descriptive Statistics

A total of 166 students' data were drawn from school archives, with a near equal number in each of the four groups designated by the Solomon four-group experimental design. Math achievement scores were assessed for outliers, and none of the students' scores surpassed the standardized value of 3.29 that Tabachnick and Fidell (2012) identified as indicative of an outlier. The sample consisted of a majority of males (99, 60%), with 67 females accounting for 40%. Students within the sample were aged between 12 and 15 years, with an average age of 13.45 (*SD* = 0.61). All participants had math scores between 8.30% and 100%, and this aggregated group had a 64.03% mean (*SD* = 31.42). This descriptive information is presented in Table 5 and 6. The data presented in Table 5 and 6 were not disaggregated by groups.

Table 5

Frequencies and Percentages for Group Placement and Gender

Demographic	*n*	%
Group placement		
Group 1 No pretest, with intervention	39	24
Group 2 No pretest, no intervention	41	25
Group 3 Pretest and intervention	44	27
Group 4 Pretest and no intervention	42	25
Gender		
Female	67.3	40
Male	99.1	60

Note. Due to rounding, some percentages may not sum to 100%.

Table 6

Means and Standard Deviations for Age and Math Achievement

Variable	Min.	Max.	*M*	*SD*
Age	12	15	13.45	0.61
Math achievement	8.30%	100.00%	64.03%	31.42%

Hypothesis Testing

All groups were post tested, but results were calculated based on four main hypotheses:

- **$H_0$1**: There is no significant difference in math scores between the treatment group and the pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.

- **H_a1**: There is a significant difference in math scores between the treatment group and the pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.
- **$H_0$2**: There is no significant difference in math scores between the no treatment group and the pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.
- **H_a2**: There is a significant difference in math scores between the no treatment group and the pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.
- **$H_0$3**: There is no significant difference in math scores between the treatment group and the no pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.
- **H_a3**: There is a significant difference in math scores between the treatment group and the no pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.
- **$H_0$4**: There is no significant difference in math scores between the no treatment group and the no pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.
- **H_a4**: There is a significant difference in math scores between the no pretest group and the no treatment group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.

These hypotheses were aimed at assessing changes in math scores after receiving an intervention. However, in line with the Solomon four-group experimental design, the groups were assessed for differences based on the intervention, and were tested using a series of three ANOVAs. The first two ANOVAs were conducted to assess either group of students, including (a) those who received a pretest, and (b) those who did not.

ANOVA for pretested students. The first ANOVA was conducted to assess differences between those who did and did not receive the intervention who were in the group that received a pretest. Prior to analysis, the assumptions of normality and equal variances were assessed. To test the normality of the dependent variable, I conducted a Kolmogorov Smirnov test on the data from students who were pretested. Results indicated that the distribution of math scores was significantly different from normal ($p < .001$). However, because 86 observations occurred in this subsample (i.e., students who were pretested), normality was assumed. Stevens (2009) asserted that when a sample exceeds 30, the central limit theorem dictates that data approach normality to the necessary extent for parametric testing. I tested equality of variance by using Levene's test, and this analysis indicated that group variances were significantly different ($p < .001$). Howell (2010) indicated that when this assumption is violated, a more stringent alpha should be used, and suggested the use of an alpha modified using the formula $\alpha/2$. Because the α was originally set at a value of .05, the new value used as a benchmark for significance was .025.

Results of the ANOVA were significant at the modified .025 α level ($F(1, 84) = 402.37$, $p < .001$) indicating that there were significant differences in the math scores of pretested students who received the intervention and those who did not. Examination of group means confirmed that students who took part in the intervention received an average math score of 97.33 (SD = 3.76), while those who did not received an average math score of 42.23 (SD = 17.82), indicating that those who received the intervention had significantly higher scores. The partial $\eta 2$, which indicated the effect size, showed a large statistical difference between the intervention and control groups (partial $\eta 2$ = .83). These results are presented in Table 7.

Table 7

ANOVA for Differences in Math Score by Intervention for Pretested Students

Source	SS	MS	$F(1, 85)$	p	Partial η^2
Intervention	65246.60	65246.60	402.37	< .001	.83
Error	13621.16	162.16	-	-	-

ANOVA for non-pretested students. I conducted the second ANOVA to assess differences between those who did and did not receive the intervention, and were in the group that did not receive a pretest. Prior to analysis, the assumptions of normality and equal variances were assessed. To test the normality of the dependent variable, I conducted a Kolmogorov Smirnov test on these data for students who were not pretested. Results indicated that the distribution of math scores was significantly different from normal (p < .001). However, because 80 observations occurred in this subsample, normality was assumed. I tested equality of variance by using Levene's test, and this analysis indicated that group variances were statistically similar (p = .355). Based on these findings, the analysis continued as planned.

Results of the ANOVA were significant at the α level of .05 ($F(1, 78) = 233.66$, $p < .001$) indicating that significant differences existed in the math scores of pretested students who received the intervention, and those who did not. Examination of group means confirmed that students who took part in the intervention received significantly higher math score ($M = 84.67$, $SD = 12.94$) than those who did not ($M = 31.01$, $SD = 17.92$). The partial $\eta 2$ showed a large statistical difference between the intervention and control groups (partial $\eta 2 = .75$). These results are presented in Table 8.

Table 8

ANOVA for Differences in Math Score by Intervention for Non-pretested Students

Source	*SS*	*MS*	*F*(1, 78)	*p*	Partial η^2
Intervention	57552.89	57552.89	233.66	< .001	.75
Error	19212.29	246.31	-	-	-

Factorial ANOVA for interaction between pretesting and intervention. I conducted the third and final ANOVA as a factorial 2x2 ANOVA, meaning that there were two independent variables, and these variables held two groups each. Because both variables (i.e., intervention and pretest) had to vary, I used the entire sample in this analysis. By examining the interaction between the pretest and the intervention, a conclusion was drawn regarding whether the pretest assisted the students to achieve a higher math score, or if differences were because of the intervention alone.

Prior to analysis, the assumptions of normality and equal variances were assessed a final time for the full sample, including both the pretest and non-pretested students. Results of this final Kolmogorov Smirnov test indicated that the distribution of math scores was significantly different from normal ($p < .001$), though this was expected based on the nonnormal distribution of either subgroup. However, because 166 observations occurred in this overall sample, normality was assumed. Results of a Levene's test on the full sample indicated that group variances were significantly different based on the grouping of both independent variables ($p < .001$). Though Stevens (2009) posited that the *F* test is robust to violations such as this, particularly when group sizes exceed 30, a modified alpha was used for this analysis to be confident that significant findings are because of group placement and not an inflated instance of Type I error. Based on Howell's (2010) suggestion to use half of the originally determined α, a modified alpha of .025 was used as a benchmark for significance.

Results of the ANOVA were significant at the modified α level of .025 for both the effect of the pretest – $F(1, 162) = 29.14$, $p < .001$ – and the intervention – $F(1, 162) = 604.41$, $p < .001$. These findings indicated that the effect of the pretest introduced an influential factor to the students' math achievement that was separate from the intervention's effect. Similarly, the intervention influenced student math achievement in a way that was independent of the pretest's effect. Examination of the interaction term did not indicate that the interaction between the pretest and intervention had a significant effect on students' math achievement – $F(1, 162) = 0.11$, $p = .745$. This finding indicated that there was no evidence that the pretest had primed students to perform better in a way that interfered with interpretation of the intervention's effect.

Examination of the effect sizes for each variable's influence on math scores showed that the effect of being pretest was weak (partial $\eta 2 = .15$). In comparison, the effect of the intervention was very strong (partial $\eta 2$ = .79), even after controlling for the influence of being pretested. I calculated marginal means for each group's average math score after controlling for the effect of either variable. First, I examined average math scores for pretested and non-pretested students, after controlling for differences based on whether students in either group received the intervention. Pretested students (*MM* = 69.78) only scored slightly higher than students who did not receive the pretest (*MM* = 57.84). Examining marginal means for students who received the intervention (*MM* = 91.00) showed a much greater difference in the average math scores for these students versus those who did not receive the intervention (*MM* = 36.62). These results are presented in Tables 9 and 10, and visually represented in Figure 2.

Table 9

ANOVA for Differences in Math Score by Intervention and Pretest for All Students

Source	*SS*	*MS*	*F*(1, 162)	*p*	Partial η^2
Pretest	5906.38	5906.38	29.14	< .001	.15
Intervention	122499.52	122499.52	604.41	< .001	.79
Pretest*Intervention	21.56	21.56	0.11	.745	.00
Error	32833.45	202.68	-	-	-

Table 10

Estimated Marginal Means for Each Group's Placement in Factorial Model

Group	*MM*	*SE*
Pretested	**69.78**	**1.54**
Without intervention	42.23	2.20
With intervention	97.33	2.15
Not pretested	**57.84**	**1.59**
Without intervention	31.01	2.22
With intervention	84.67	2.28
Intervention	**91.00**	**1.57**
With pretest	97.33	2.15
Without pretest	84.67	2.28
No intervention	**36.62**	**1.56**
With pretest	42.23	2.20
Without pretest	31.01	2.22

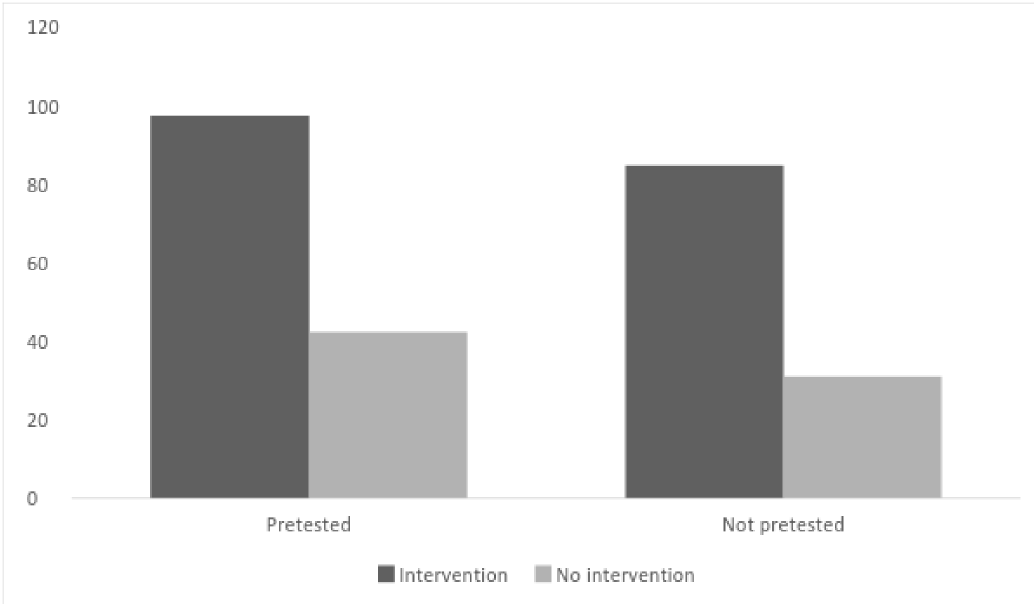

Figure 2 Bar graph of estimated marginal means for each group.

Summary of Null Hypotheses Tested

I rejected the $H_0$1: There is no significant difference in math scores between the treatment group and the pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.

I rejected $H_0$2: There is no significant difference in math scores between the no treatment group and the pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.

I rejected $H_0$3: There is no significant difference in math scores between the treatment group and the no pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.

I failed to reject H_04: There is no significant difference in math scores between the no treatment group and the no pretest group of students with learning disabilities when using direct instruction teaching methods involving cognitive support pedagogy.

Chapter Summary

This chapter began with a restatement of the purpose of the research, and a description of the Solomon four-group experimental design used to fulfill this purpose. A description of the study's final sample followed this explanation of the design, and detailed the representation of each subgroup's size, as well as the sample's representation of gender, age, and average math scores overall. Following this explanation of the sample were details of the three ANOVAs conducted in line with the Solomon four-group experimental design, with a presentation of each analysis's findings for ease of interpretation and data extraction. In Chapter 5, I discuss these results relating to the extant literature and will assess the results for their significance to the field. Chapter 5 will also include a discussion of the strengths and limitations of the study, with recommendations for social change and future research based on these determinations.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this dissertation was threefold: (a) to explore whether or not students with learning disabilities who received direct instruction with cognitive support pedagogy would differ in their acquisition of math skills, (b) to investigate whether students with learning disabilities who received direct instruction with cognitive support pedagogy differed in their math skills maintenance, and (c) to conduct a factorial 2x2 ANOVAs to measure whether students with learning disabilities in the sample who received direct instruction with cognitive support pedagogy differed significantly in their generalizable math skills when compared to the control group. The results from data indicated a rejection of H_01, a rejection of H_02, a rejection of H_03, and a failure to reject H_04.

I used confirmatory analysis to examine group means, confirming that students who took part in the intervention, following pretesting received an average math score of 97.33 (*SD* = 3.76), while those who did not received an average math score of 42.23 (*SD* = 17.82), indicating that those who received the intervention had significantly higher scores. In addition, it appears from an analysis of the resulting data that a rise of the mean scores from 57.84 to 69.78 (+ 11.94) indicating an approximately 17% increase, supporting my assertion that every student with a learning disability in the intervention should have the opportunity to be pretested.

Hodnett (2016), studies of math interventions have indicated that interventions actually help struggling students with or without learning disabilities, even though there exist gaps in specialized math instruction at the grade school levels. The present study, using direct instruction with cognitive support pedagogy, may help bridge those gaps. This is because direct instruction with cognitive support systems, as applied throughout in this research, was data-driven, required immediate feedback, was based on task analysis, and relied on scaffolding of instruction at the learner's pace. Instructional chunking of learning units was also necessary, in which students were encouraged to draw upon previously learned materials while new skills were being taught. In this way, direct instruction with cognitive support pedagogy can be described as both a multimodal and multisensory approach when effectively applied as an intervention tool.

Discussions of Strengths and Limitations of the Study

The data were not disaggregated by groups. In educational research, disaggregation of data occurs when numeric or nonnumeric information is transcribed and broken down into manageable units of understanding, for statistical clarity. Biased reporting in education research appears to be common: Several researchers in the field of special education have presented biased reporting of achievement outcomes. An example of this conclusion appeared in Schulte and Stevens' (2015) statewide longitudinal study of mathematics achievement gaps and growth in students with and or without learning disabilities. Schulte and Stevens examined the effect of the different methods of determining disability group membership; and reported that the "present way of identifying the subgroup of students with disabilities in reporting achievement outcomes may be biased and that even students who exited special education may still continue to be at risk for lower mathematics achievement" (p. 370).

The current dataset was aggregated only by age and math achievement. This was done because, according to Rumrill (2009), it is considered unethical to sort out students into groups of ethnic and racial minority, gender classifications, immigrant statuses, limited English proficiencies, or disability for the purposes of instruction or research. In addition, the focus of this study was to experiment on an instructional method and the teaching techniques used by teachers in such a way that I was not necessarily focused on the learning capacities of students with learning disabilities, but rather on the effects of a particular teaching method on students' math scores.

Data collection for this dissertation effort relied partly on archival school records using a RNG, in which I used data from disaggregated PARCC results for fiscal years 2014 and 2015 as the basis for the research control group without modification. Power and sample size calculations using SPSS, and not the G*Power software program, were sufficient in conducting this research. However, I was mindful of the fact that larger sample sizes increased statistical power. Even when a research study presents statistically significant findings, it does not necessarily indicate that the results were meaningful. (Rumrill, 2009). Significance may have been reported because the sample size was sufficiently large as to note minor differences or deviations among groups being tested. This was one of the reasons that conducting a power analysis prior to beginning a quantitative research was beneficial to me as I tried to avoid an increased chance of obtaining a Type I or even a Type II error. The results obtained in the current research are meaningful because the application of direct instruction teaching methods with cognitive support systems to teach math revealed the achievement growth over time of students with learning disabilities.

Just as the statistical testing helped me to determine the likelihood that an experimental result will differ from results that can be attributable to chance, so was the effect size measurement. Effect size calculations allowed the experimenter to compare the magnitude of experimental effect from one treatment condition to another. An analysis of this study demonstrated that effect sizes for each variable's influence on math scored as strong, but showed that the effect of being pretested was weak (partial $\eta 2 = .15$). In comparison, the effect of the intervention was strong (partial $\eta 2 = .79$), even after controlling for the influence of being pretested. The sample size for this study was appropriate, resulting in a finding of a modest effect size.

Conclusions

Frenkel (2013) stated that although the "Common Core State Standards in Mathematics (CCSSM) have been adopted by 45 states and the District of Columbia, … controversy around these standards and their implementation continued unabated-alas, for all the wrong reasons" (para. 2). Frenkel (2013), believed that three critical issues must be addressed for the Common Core State Standards in Mathematics (CCSSM) to succeed: These issues were, (a) providing properly aligned math textbooks to teachers, (b) implementing appropriate assessment protocols for students, other than the Partnership for Assessments of Readiness for College and Careers (PAARC), and (c) adequate teacher preparation through in-service training and professional developments in math.

The present research study addressed the issue of teacher preparedness and classroom instructional techniques, and did not address the deficiencies and gaps found within the “de facto national curriculum,” nor the ill-structured assessment protocols, before the implementation of PARRC. According to Frenkel (2013) the problem is that “We still have no viable textbooks to use for teaching mathematics according to the CCSSM!” (para. 4). A possible solution to this problem is to give teachers textbooks that are aligned with the common core standards and provide teachers with the means to acquire content knowledge for effective instructional practice.

Social Change Discussions

Through this study, I aimed to construct a theoretical framework for writing a research study using direct instruction as a theory on behaviorism in students’ learning and how teachers should teach. Direct instruction as a teaching method, has long been out of trend in the American K-12 educational arena. I attempted to revive direct instruction in this study. The framework for this endeavor was based on a particular aspect of theory formulation popular in the social sciences—the axiomatic theory. Axioms are generally statements that are assumed to be true, but in need of explanation and proof. In a way, axioms are like theorems on which propositions are deduced from but are subjected to verification. In addition to streamlining this theoretical framework, I had to use the *Formulating a Research Problem and Question Format* procedures (Jacobs, 2013).

In the present study, my phenomenon of interest was in finding out the effects of using direct instruction with cognitive support teaching methods to teach middle-grade level (i.e., Grade 6–8) students within the elementary and secondary school systems in the United States, but who have been diagnosed with learning disabilities.

Recommendations

In the present study, I conducted a theory-then-research-driven strategy, described by Jacobs (2013) as “a research plan beginning with the development of ideas and followed by an ‘sic’ attempt to confirm or refute those ideas through empirical research” (p. 41). I recommend that future research in special education research in direct instruction common core math follow the outline of the procedures in the next section.

Rosenshine (2012) wrote that “research-based principles of instruction for classroom practice come from three sources of ‘teaching and learning’ enquiries involving (a) research in cognitive science (b) research on master teachers, and (c) research on cognitive support systems” (p. 12). For example, using research in cognitive science, a special education teacher might ask “How can using direct instruction teaching methods improve the learning and retention capacity of students with learning disabilities?” But, research questions on master teachers on the other hand, might be, “How does a master teacher present new materials or new learning units to students with learning disabilities?” Or, in the alternative, “Do master teacher’s students’ achievement data differ substantially from those of other teachers?” Finally, research on cognitive support systems, such as implementing scaffolding of instruction, modeling, guided practice, and task analysis may compel a special education teacher to ask “How does cognitive support pedagogy help students with learning disabilities?” This line of questioning borders on academic speculation, however introspective.

Note, that the above researchable situations as contemplated, can offer the investigator and special educators the means to access several different research questions and a possible null hypothesis as stated below.

Research Questions

RQ1: Can the use of direct instruction teaching strategy on students with learning disabilities improve their learning rates in math?

RQ2: What is the relationship between Direct Instruction teaching methods- involving cognitive support pedagogy and students' math scores?

References Which Support Expected Outcome of Research

Several references in the literature support the expected outcome of this research. Al-Makahleh and Abdulhameed-Aufan (2011) found that "results from the statistical analysis indicated a perceived effect of the direct instruction teaching strategy on basic math skills achievement of fourth and fifth grade students with learning difficulties…" (para. 2). Additionally, students' attitudes toward math instruction improved, attendance and graduation rates increased, and the dropout rate decreased. In the current study, intervention was also found to have been effective.

Summary and Conclusion

When it comes to graduation and students' readiness for careers and college preparation, nothing could be more important than quality of teachers' instruction. Meeting the needs of individual teachers may be as important as meeting the needs of individual students. This social change may be realized in many areas of human intellectual activities from a formulation of research questions which would help students to analyze and structure problem statements, and eventually to conduct research and implementation toward whole school improvement.

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Reference Permission Request #T3501 Mr. Joseph Monye, Walden University 726 E. 37 Street, Baltimore, MD 21218 USA. For permission to use Form B of the Test of Early Mathematical Ability–Third Edition (TEMA-3) by Ginsburg, Baroody, Austin: PRO-ED. Protocol 10880. Number of copies: N/A. USAGE: Research for Master Thesis or Dissertation: I am a doctoral student at Walden University and I am applying for permission to use the following test kits for my dissertation: Test of Early Mathematics Ability (TEMA-3) and the Diagnostic Achievement Battery -4 (DAB-4). Please note that upon request from my dissertation committee members to "show and tell", I plan to reproduce actual test material and my student's test scores on DAB-4 subsections 7, pages MR.3, MR, 8, MR.9 and subsection 8, pages 5,6 and 7 as well as actual TEMA-3 test items, pages B53 and student worksheet Form B in the appendix section of my dissertation. Note also, that I plan to only discuss and defend my research analysis, summary statistics, and the results to faculty and my Walden University dissertation committee. LIMITATIONS: Permission is granted to utilize Subtest 8, pages 5, 6, and 7 in this dissertation, as well as questions #62, #66, #69 and #71 from the Student Worksheet B. No alterations or modifications will be made to the test items. PAYMENT: No fee will be assessed. Total Paid: $0.

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Appendix C: Fidelity Observation Form: Cognitive Support Pedagogy

In using this fidelity observation form, teacher understands that he or she must do whatever is legally possible and permissible to secure student's cooperation in the classroom. Good classroom management practices must first and foremost solicit students' cooperation to be Teacher observer, CIRCLES -Yes- or -No- on all targeted performance objectives:

Teachers must model success in the classroom if students are to succeed and be on task

-- x—Has teacher asked and received students' cooperation before any classroom instruction?

_x_ Has teacher modelled the math problems and given away the answers first, if any before commencement of cognitive support instruction?

List #2: Circle Performance Objectives-Yes or No

Teachers' Classroom Preparations and Conclusions

_x___ Has provided for input-- reading, TV or film viewing, observation, etc.-- prior to __x__ Lets students know what will be expected of them in terms of participation-Yes No

_x___ Involves students in deciding what issues to discuss-Yes No

__x__ Draws together contributions of various members of the group-Yes No

_x___ Summarizes and draws new conceptualizations at end-Yes No

__x__ Uses questions to stimulate discussion-Yes No

_x___ Prevents or terminates discussion monopolies-Yes No

_x___ Seeks to involve individuals who are not participating-Yes No

__x__ Recognizes potential contributor and makes an opening for that person-Yes No

_x___ Reinforces infrequent contributors in positive ways-Yes No

__x__ Assists a quiet student in class &quote; saying what he means; -Yes No __x__ Accepts silence without criticism-Yes No

__x__ Reminds students to listen to one another-Yes No

_x__ When discussion is not going well, stops to deal directly with group processes-Yes No

__x__ Helps student to accept correction or appropriate criticism-Yes No

_x___ Encourages students to acknowledge comments of others by summarizing them-Yes No

__x__ Allows time for evaluation of the discussion itself-Yes No

__x__ When necessary to intervene, does so briefly-Yes No

Teachers' Quality and Contents of Discussion

__x__ Introduces relevant considerations that have been missed-Yes No

_x___ Questions misconceptions, faulty logic, unwarranted conclusions- Yes No _x___ Distinguishes a value from a fact- Yes No

_x___ Requires student to defend his position, relate it to other ideas, or modify it- Yes No

__x__ Intervenes when discussion gets off track-Yes No

_x___ Uses questions to guide discussion-Yes No

_x___ Summarizes discussion periodically-Yes No

__x__ Paraphrases student comments for his own or students' Understanding-Yes No

__x__ Encourages expression of differences of opinion-Yes No

_x___ Supports the rights of speakers who hold minority or unpopular views-Yes No

__x__ Refrains from introducing his own opinion to avoid biasing discussion-Yes No _x__ Presents his own opinion to enhance seriousness of discussion-Yes No

__x__ Encourages students to examine a variety of points of view before drawing conclusions-

__x__ Sees that everyone hears questions and answer-Yes No

_x___ Asks group-oriented question, allows all to think independently, then one answer-Yes No

_x___ Calls on non-volunteers as well as volunteers-Yes No

_x___ Allows time for formulation of good answers-Yes No

_x___ Invites alternative or additional answers-Yes No

_x___ Involves a large portion of the class in a variety of activities-Yes No

__x__ Questions are easily understood, clear in intent and precisely expressed-Yes No _x__ Prompts with hints, rephrased or simplified questions-Yes No

__x__ Asks questions which focus student attention on a particular relevant aspect of the matter

_x___ Asks questions which require processing of information: grouping and classification, compare and contrast, specify cause and effect or other relationship, analysis, generate examples-

__x__ Asks questions which require student to generalize, make inferences, evaluate-Yes No

__x__ Asks questions that relate to the experience of the student-Yes No

__x__ Requires student to support answer with evidence or argument-Yes No

__x__ Asks a variety of questions for different pedagogical purposes: For emphasis, drill, self-

awareness, variety, student feedback, and review-Yes No __x__ Lets student know they are free not to respond, free to speak, safe to be wrong-Yes No

__x__ Holds attention of students who are not directly interacting with the teacher-Yes No

__x__ Allows students to respond to one another-Yes No

__x__ Gives evidence of listening to students' answers-Yes No

__x__ Tries to understand a divergent response rather than rejecting it outright-Yes No

__x__ Returns response to student for correction, clarification of thought, rewording of fuzzy

__x__ Gives reasons when rejecting the answer-Yes No

__x__ Accepts and acknowledges all answers. (&quote; I see what you mean. Quote;)-Yes No

__x__ Praises an answer selectively, finding some good part-Yes No _x___ Reminds student of relevant known information or evidence-Yes No

__x__ Encourages students to evaluate their own or one another's answers-Yes No

__x__ Allows, even encourages students to disagree-Yes No

Teacher's use of mechanics appropriate for a math class

_x___ Maintains eye contact with students-Yes No

__x__ Moves about room, notices and acknowledges questions from volunteers-Yes No

_x___ Varies activities over class period-Yes No

__x__ Assists in mastering new vocabulary (defines, uses)-Yes No

__x__ Uses illustrative materials or teaching aids-Yes No _x___ Paces delivery to students' skills-level and capacity to follow direction-Yes No

List #5: Teacher's appraisal of math Scholarship

__x__ Indicates how mathematical knowledge is obtained-Yes No

__x__ Shows relation of theory to practice: Answers first pedagogy-Yes No

__x__ Suggests implications of an idea, position, or theory-Yes No

__x__ Goes into detail, presents supporting evidence rather than just generalizations-Yes

__x__ Presents facts or concepts from related fields or relates topics to other areas of

_x___ Refers to recent developments in the field of mathematics-Yes No

__x__ Distinguishes between fact and opinion, data and interpretation-Yes No

_x__ Emphasizes ways of solving problems rather than simply solutions-Yes No

Opening: Focuses student attention through demonstration, activity, questions before and after.

__x__ Relates to previous topic and ties in-Yes No

__x__ States goals or objectives for class session-Yes No

__x__ Presents material in several short blocks-Yes No

_x___ Summarizes periodically and provides feedback-Yes No

__x__ Refers back to points made or terms used earlier-Yes No

__x__ Summarizes major points or sees that class does so-Yes No

__x__ Suggests an activity which builds on the day before and issues, topics, and something to do or think to encourage classroom engagement.

__x__ Appears interested and enthusiastic-Yes No

__x__ Calls students by name-Yes No

_x___ Relates goals and content to social context, course or personal goals-Yes No

_x___ Prompts awareness of students' relevant knowledge or experience (gives or asks

for examples and refers to students 'prior learning-Yes No

__x__ Uses humor regularly during instruction to enhance students' engagement-Yes No

__x__ Teacher focusses on students' interests and not pursue spontaneous personal goals-

__x__ Makes value implications explicit-Yes No

_x___ Suggests resources for students to explore independently-Yes No

_x__ Provides opportunities for and encourages audience participation and questions-Yes __x__ Calls for questions in a way that does not embarrass or belittle the questioner-Yes

_x___ Allows time for formulation of questions-Yes No

__x__ Makes sure that comments or questions have been heard by all-Yes No

__x__ Checks to see if answers have been understood-Yes No

_x___ Helps student answer his own question-Yes No

__x__ Encourages students to answer peer questions-Yes No

_x___ Relates student comments to one another-Yes No

_x___ Uses student questions or comments to introduce new material-Yes No

The above fidelity observation form must be used in conjunction with video-recordings of Special Education classroom activities to evaluate program intervention by principal investigator, but not included in research. Erase and discard immediately after use. (Adapted from the Oklahoma Baptist University website: Author. n.d. www.okbu.edu/b.teachingchecklist.doc) Written and modified with permission pending.

Differences Between the DAB-4 and the TEMA-3 Testing Materials

Some differences exist between the Diagnostic Achievement Battery-fourth edition (DAB-4) and the Test of Early Mathematics Ability-third edition (TEMA-3). The DAB-4 is a popular and well-streamlined assessment instrument designed for identifying students' strengths and weaknesses among students between ages 6 to 14 years of age.

(4) The DAB-4 is a clinician's favorite for assessing the integration of generalized math ability with a focus on procedural and substantive math awareness of students with learning disabilities in the middle grades (5) Because the DAB-4 is arranged in 8 individually administered subtests, this arrangement helps the teacher to plan, organize, and implement instruction to target perceptual and procedural as well as reasoning and mathematical computation skills in (6) Using the independent assessment probes, the teacher is capable of implementing the DAB-4 instrument in a developmental sequence, such that, it is possible for the teacher to proffer test and retest comparisons. On the other hand, TEMA-3 is different from DAB-4 in that, its emphasis is on acquisition of early mathematics skills

(4) TEMA-3 specifically measures both formal and informal concepts in number enumeration skills, number comparisons, and mastery of number facts. TEMA-3 focuses on the conceptual understanding of math ideas and math calculation skills involving

(5) TEMA-3 can also be used as a screening devise for mathematical readiness, and for measuring student progress in elementary to middle school mathematics.

(6) Embedded within TEMA-3, are bias studies included to demonstrate the absence of bias based on gender and ethnicity.

Appendix D: Common Core Math Using Direct Instruction Support Systems in Search of Purpose, Understanding, and Student Engagement

Purpose:

Focus Question: How can students use the measures of central tendency and or measures of variability to (determine pay equity), and make informed decisions about real life situations involving teachers' salaries in urban and rural areas of the state of Maryland?

By the end of this lesson students will know and or be able to:

Do mathematical calculations involving the Mean and do mathematical calculations?

1. What will students say or do to show that they understand the lesson content both. Students will be able to count out and write, 4, 7, 3, and 6; and organize these numbers from the least to the highest points. At the end, students will be able to determine the computation strategy for the Mean, Median, and the Mode.

2. What Questions can the teacher ask to uncover student thinking? For example, teacher will ask, what are the three measures of central tendency?

What is the importance of the Mean in determining the accuracy of a given data?

When must we use the Mean, and not the Mode nor the Median in making decisions.

Getting Students Unstuck when they get stuck

What did you do in Math class today?

Evidence of Student Misunderstanding: Assume that I am your mother confused about going into teaching. How would you convince me that teachers make good money and can have a better life? Student is unable to describe the mean. Student does not collect data. Student fails to analyze data using and following a specific set of instruction. Student simply says, “I don’t know”. In this instance, student’s misunderstanding of the basic concept of the “Mean” in data analysis is evident.