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A Mixed Method Study on Schema-Based Instruction, Mathematical Problem Solving Skills, and Students with an Educational Disability

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by

Bill Casner

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Dr. Lynda Leavitt, Dissertation Chair — 11-18-2016 Date

Dr. Sherrie Wisdom, Committee Member — 11-18-2016 Date

Dr. Mollie Bolton, Committee Member — 11-18-2016 Date

Declaration of Originality

I do hereby declare and attest to the fact that this is an original study based solely upon my own scholarly work here at Lindenwood University and that I have not submitted it for any other college or university course or degree here or elsewhere.

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Abstract

The purpose of this study was to determine the student outcomes of implementing schema-based instruction on students in grades 3-8 identified with an educational disability and ascertain how students' developed mathematical problem solving skills. After special education teachers in a metropolitan school district in the Midwest administered a pre-assessment, the researcher used the results to select 21 students with an educational disability to participate in the mixed-methods study. Special education teachers implemented Asha K. Jitendra's (2007) educational program titled, *Solving Math Word Problems: Teaching Students with Learning Disabilities Using Schema-Based Instruction*, during the 2013-2014 school year and taught participants using these techniques. The researcher measured student achievement by using both a pre and post-assessment and M-CAP benchmark scores on mathematical problem solving. In addition, the researcher gathered perceptions of schema-based instruction via surveys and interviews with special education teachers, general education teachers, and student participants. The analysis of quantitative data from the pre and post-assessments of students participating in the schema-based program as well as the analysis of qualitative data from student participant surveys supported a positive outcome on the use of schema-based instruction with students with an educational disability; the findings of this study reinforced the then-current literature. However, the student participants'' M-CAP assessment data did not demonstrate the same amount of growth as the assessment data from the schema-based program. In addition, the analysis of survey and interview data

from the two teacher groups also displayed discrepancies between special education teachers' and general education teachers' overall perceptions of the schema-based instructional program. Despite this, the preponderance of evidence demonstrated most students who participated in the study did learn as a result of the schema-based instruction and developed mathematical problem-solving skills. Therefore, the findings of this study corroborated the then-current literature and supported the continual use of the researched program; *Solving Math Word Problems: Teaching Students with Learning Disabilities Using Schema-Based Instruction*, by Jitendra (2007). The researcher concluded this program a valid research-based intervention to increase mathematical problem solving skills for students with an educational disability.

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Chapter One

Overview

During the 1950s and 1960s, government and family associations started to develop appropriate practices for students with disabilities and later used those practices to develop quality special education programming (Esteves & Rao, 2008; U.S. Department of Education & Office of Special Education and Rehabilitative Services [USDOEOSERS], 2010). Landmark court cases also paved the way for including students with a disability in the regular classroom. Before 1975, students diagnosed with a disability were not typically included in public schools and placed in institutions (USDOEOSERS, 2010). In 1975, Congress passed Public Law 94-142 (PL 94-142), Education for the Handicapped Act; and for the first time every child in the U.S. with a disability had a right to a free and appropriate education (Esteves & Rao, 2008; USDOEOSERS, 2010). PL94-142 improved the identification and education of these students, as well as how procedural safeguards protected families (Esteves & Rao, 2008; USDOEOSERS, 2010). When students received a diagnosis of an educational disability, an Individualized Education Plan (IEP) was developed. The components of an IEP included a statement on how the student's disability impeded his or her learning, annual goals to address learning deficits, and educational services with the amount of time needed to address the learning deficits (Project IDEAL, 2013). Since 1975, there were many revisions to the Education for Handicapped Act, which later became known as the Individuals with Disabilities Education Act (IDEA, 2004). Some changes included providing appropriate special education programming for students from birth to age 21, educating students in the least restrictive environment, increasing awareness of parental involvement, and providing highly qualified teachers for students with disabilities (USDEOSERS, 2010).

In October 2001, President Bush created the Commission on Excellence in Special Education to study then-existing practices and provide recommendations. The three major recommendations included focusing on achieving the desired results, promoting a model of prevention instead of the discrepancy model, and first perceiving children with a disability the same as a general education child (U.S. Department of Education [USDOE], 2002). These recommendations were also noted in the No Child Left Behind (NCLB) Act of 2001 (USDOE, 2002). For the first time, schools became accountable for the progress of students with an educational disability; the act also required all students, regardless of disability, to participate in district and state assessments (Le Fave, 2010). NCLB forced schools to focus extra attention when educating students with a disability, to provide these students with research-based instruction through both sequential and objective methods (Le Fave, 2010).

All students required strong mathematical skills to effectively function in society and complete daily tasks. Expectations of all students in the U.S. needed to increase, including students with a disability (r4 Education Solutions, 2010). At the time of this study, 12th grade students in the U.S. trailed 21 other countries in mathematical skills (r4 Education Solutions, 2010, p. 1). Also, in 2012, 15-year-old students across 64 countries participated the Programme for International Student Assessment (PISA, 2012, p. 4). This assessment measured important skills that 15-year-olds needed to know to fully participate in a 21st-century society. The 2012 PISA focused primarly on mathematics; however, reading, science, and problem-solving were also areas assessed. The U.S.

ranked close to the middle of the 64 countries, with a ranking of 36 (PISA, 2012, p. 5), which meant students in the U.S. performed worse than half of the countries who participated in the assessment (Organization for Economic Cooperation and Development (OECD), 2014). The National Assessment of Educational Progress (NAEP, 2001) assessed students in the fourth grade in the area of math and found the average score for all students was 226, while students with an educational disability averaged 198 (r4 Education Solutions, 2010, p. 10). In 2009, the average score for all students was 240, while students with an educational disability averaged a score of 221 (r4 Education Solutions, 2010, p. 10). These results revealed, although some improvement occurred, the expectations for mathematical education for all students in the U.S. needed to increase, including students with an educational disability (r4 Education Solutions, 2010).

Moreover, the National Council of Teachers of Mathematics (NCTM, 2011) supported the use of rigorous and research-based interventions for students with difficulty with mathematics. Teachers utilized a variety of assessments to inform instruction (National Council of Teachers of Mathematics [NCTM], 2011). Assessments were necessary and identified specific interventions of benefit to each student, gaps among students in mathematical skills, and specific interventions that addressed those gaps (NCTM, 2011). Strategies or interventions used with students who struggle should be evidence-based or research-based in the learning gap (Forbringer & Fuchs, 2014). The NCTM (2011) suggested interventions be conducted in either the general education classroom or in small groups outside the classroom, to increase the students' conceptual and procedural knowledge and help them develop connections to other mathematical areas. These interventions increased the students' independent use of strategies, and fostered self-responsibility for their learning (NCTM, 2011).

Purpose of the Dissertation

The purpose of this study was to measure student achievement of schema-based instruction on mathematical problem-solving skills, for students in grades three through eight, identified with an educational disability. Student achievement, for the purpose of this study, was measured by pre and post-assessment and Math Concepts and Applications (M-CAP) benchmark scores on mathematical problem solving. This project utilized a mixed-methods study similar to Asha K. Jitendra's (2007) educational program titled, *Solving Math Word Problems: Teaching Students with Learning Disabilities Using Schema-Based Instruction.* Special education teachers implemented this program in grades three through five in various buildings during the 2012-2013 school year; however, the program lacked fidelity of implementation. The sample size of 21 students was larger than most studies on the achievement of students with a disability using schema-based instruction. Six-out-of-the-seven studies reviewed had a sample size that ranged from one to four students (Alter, Brown, & Pyle, 2011; Griffin & Jitendra, 2009; Jitendra, DiPipi, & Perron-Jones, 2002; Jitendra, et al., 1998; Jitendra, George, Sood, & Price, 2010; Jitendra & Hoff, 1996; Rockwell, Griffin, and Jones, 2011). Jitendra et al. (1998) originally completed a study on the use of schema-based instruction on 34 students who were at-risk or who had a mild disability. This project included the perspectives of the students, special education teachers, and general education teachers on the outcomes for those who participated in this program.

Rationale

Students identified with an educational disability were judged according to the same standards as their typically-developing peers (Le Fave, 2010) and frequently achieved below typically-developing peers (NCTM, 2011). Educators across the U.S. searched for different research-based strategies to help close this achievement gap (Le Fave, 2010). The NCTM (2011) recommended interventions be correlated with progress monitoring data collected by a teacher on a frequent and ongoing basis. The same group also noted specific areas of student deficiency be addressed after data analysis occurred (2011).

As the number of specific disability categories increased to include disabilities, such as autism, educators developed instructional repertoires to prepare every student for life after school. Problem solving was an important skill for all students to develop and when mastered assisted students to transfer math skills to the real world (Hudson & Miller, 2006). Real-world problem-solving skills, such as counting money, keeping score, and making a purchase, were deemed as necessary life skills for any individual to be successful in the workplace, daily living, and leisure activities (Hudson & Miller, 2006). Students with an educational disability frequently had difficulty with problem-solving skills due to the higher level of thinking required (Hudson & Miller, 2006). Numerous studies conducted by Jitendra and associates (1996, 1998, 2002, 2007, 2010, 2011) indicated positive outcomes of schema-based instruction with students who had a wide variety of disabilities and noted schema-based instruction helped close the achievement gap and teach students with an educational disability how to solve mathematical word problems. The process of schema-based instruction integrated the use of diagrams, reading comprehension strategies, and mathematical problem solving to teach problem solving skills (Jitendra, 2007). Students' conceptual and procedural understandings increased due to schema-based instruction and the use of a step-by-step strategy along with visual representations (Jitendra, 2007).

Research Questions

RQ1: How do special education teachers perceive the implementation of schema-based instruction?

RQ2: How do special education teachers perceive schema-based instruction and student achievement?

RQ3: How do general education teachers perceive schema-based instruction and student achievement?

Hypotheses

H1: There is an increase in mathematical problem solving skills of students with an educational diagnosis through the use of schema-based instruction, as measured by a pre-to-post assessment.

H2: There is an increase in AIMSweb Math Concepts and Application (M-CAP) benchmark scores of students with an educational diagnosis through the use of schema-based instruction.

H3: Students will positively perceive the schema-based instruction, as measured by a Likert-scale survey.

Limitations

This study had several limitations including sample size and type of sample. The sample size was limited due to the population of 21 students with an educational disability at the time of this study. The limited number of students received mathematical reasoning instruction from a special education teacher. The schema-based instruction program pre and post-assessment data sample consisted of 21 participants while the M-CAP benchmark assessment sample only consisted of 20 participants. One student was absent when students completed the assessment, and the school did not complete a make-up assessment. In addition, the student survey data sample consisted of 19 participants. The researcher received 19 parent permission slips for students to participate in the survey. Furthermore, one classroom completed all but three ‘problem types’ in the schema-based instructional program. The students in this classroom needed additional time to master the first two problem types, resulting in only 10 students who answered question five on the ‚compare’ problem type, on the student survey.

The researcher used convenience sampling to select the participants. From the total population, the researcher selected participants from the schools for which the researcher then-currently worked. A disadvantage of convenience sampling in this study was under-representation from the population, since the researcher had limited access to the entire population of students in the school district. In addition, because of its size, the convenience sample may not have been representative of the population.

All students in grades six through eight received mathematics instruction from the special education teacher, and the general education teacher surveys were limited to grades three through five. The only elementary school used for the study placed students in learning levels with the same teacher, for students who struggled in the area of mathematics. Therefore, the researcher received only four general education surveys for use in the study analysis.

Another limitation was the number of teacher participants; only four-out-of-the-six special education teachers interviewed utilized the schema-based instructional program in the 2014-2015 school year. Two of the special education teachers utilized the schema-based instructional program in the 2013-2014, however, they did not have any students who met the criteria to participate in the study. As a result, 67% of the special education teachers interviewed had quantitative data included in this study.

Definition of Terms

Autism:

> Autism spectrum disorder is a developmental disability that can cause significant social, communication and behavioral challenges. There is often nothing about how people with ASD look that sets them apart from other people, but people with ASD may communicate, interact, behave, and learn in ways that are different from most other people. The learning, thinking, and problem-solving abilities of people with ASD can range from gifted to severely challenged. ("Autism Spectrum Disorder," 2016, para. 1)

Conceptual understanding: Knowledge that helps students understand beyond rote skills and the meanings of certain procedures (Hudson & Miller, 2006).

Common Core State Standards: A set of standards that provides clear, consistent expectations from Kindergarten through 12th grade in the areas of mathematics and English Language Arts, drafted by a team of experts and educators (Common Core State Standards Initiative [CCSSI], 2016).

Declarative knowledge: Mathematical information that can be recalled without hesitation (Hudson & Miller, 2006).

Department of Elementary and Secondary Education: One of the state of Missouri departments that developed state educational regulations and monitored each school district's progress in meeting the state's assessment benchmarks (Department of Elementary and Secondary Education [MODESE], 2011).

Incidence: "Frequency of occurrence, such as the number of children identified with autism" (The Iris Center, 2016, para. 8).

Intellectual disability: An educational diagnosis with "a score that is equal to or below 2.0 standard deviations from the mean for that measure which is valid when considering age, ethnicity, and cultural background" (MODESE, 2012, para. 1) and "adaptive behavior is inconsistent with cognitive abilities" (MODESE, 2012, para. 2).

Language impairment: An educational diagnosis that has

> consistent inappropriate use of one (1) or more of the following structures of language: morphology (structuring words from smaller units of meaning), syntax (putting words together in phrases and sentences—sometimes referred to as grammar deficits), semantics (selecting words to represent intended meaning and combining words and sentences to represent intended meaning—sometimes referred to as vocabulary deficits) or pragmatics (using the functions of language to communicate with others). (MODESE, 2012, para. 1)

"The child's language functioning is significantly below the child's cognitive abilities" (MODESE, 2012, para. 2).

Learning disability: An educational diagnosis when

> the child does not achieve adequately for the child's age or to meet state approved grade-level standards in one or more of the following areas, when provided with

> learning experiences and instruction appropriate for the child's age or state-approved grade-level standards: basic reading skill, reading comprehension, reading fluency skills, written expression, mathematics calculation, mathematics problem solving, listening comprehension or oral expression. (MODESE, 2012, para. 1)

The child must also "exhibit a pattern of strengths and weaknesses in performance, achievement, or both, relative to age, state approved grade-level standards, or intellectual development" (MODESE, 2012, para. 2).

Math Concepts & Applications : "a test of short duration (8-10 minutes) that measures general mathematics problem solving expected in grades 2-8" (Pearson, 2014, para. 1) For the purpose of this study a norm-referenced local district assessment.

National Council of Teachers of Mathematics: A professional organization comprised of mathematical professionals that provides resources and professional development for the educational community (Hudson & Miller, 2006).

Other health impairment: An educational diagnosis of a child who had

> a comprehensive evaluation by a licensed physician that results in the diagnosis of a chronic or acute health problem and the documentation indicates the health impairment results in limited strength, vitality or alertness, including a heightened alertness to environmental stimuli. (MODESE, 2012, para. 1)

The child's health impairment adversely affects his/her educational performance (MODESE, 2012).

Procedural knowledge: The use of a procedural strategy to solve mathematical equations and problems (Hudson & Miller, 2006).

Schema-based instruction: Instruction that teaches students to identify the underlying schema of a mathematical word problem. Students identify and plan to solve three different schematic diagrams in addition and subtraction word problems: change, group, and compare. In multiplication and division, students identify and plan to solve two different schematic diagrams: multiplicative compare problems, problems that compare two problems using multiplication and division, and vary problems, problems that involve a ratio between things. This instruction incorporates reading comprehension, procedural knowledge, and conceptual understanding, and can be implemented with students in general education or special education programs (Jitendra, 2007).

Summary

The purpose of this mixed methods study was to investigate the use of schema-based instruction on mathematical problem solving for students with an educational disability in grades three through eight. Data collection included student assessment data, teacher and student surveys, and teacher interviews. The researcher believed this instruction would improve the students' abilities to solve a variety of mathematical word problems, specifically for students with an educational disability. Chapter Two reviews the then-current literature related to schema-based instruction, proficiency in mathematics, mathematical problem solving, best practices in mathematics, schema-based instruction studies, special education process, and educational disabilities. In Chapter Three, the researcher explains the methodology, participants, and procedure for data collection. The researcher analyzed the data described in Chapter Four and discussed the researcher's interpretation of the data, along with recommendations for future studies in Chapter Five.

Chapter Two: The Literature Review

Introduction

The researcher reviewed then-current best practice for students who struggled in the area of mathematics and aimed to provide the reader an understanding of the history of mathematics education, mathematical learning, general best practice in mathematical problem solving, a description of special education and specialized instruction in mathematics, and an explanation of schema-based instruction. This review informs the researcher, schema-based instruction could increase academic results with students with an educational disability and who also struggle in the area of mathematics. The predominant researcher, found repeatedly throughout the then-current literature on schema-based instruction, Jitendra (2007), who along with fellow colleagues developed a unique method. Multiple studies from other researchers, such as Allsopp, Kyger, and Loving, (2007), Hong, Lim, and Mei (2009), and Sousa (2008), are also included in this literature review.

History of Mathematics Education in the United States

After the Soviet Union launched Sputnik in 1957, Americans were concerned the U.S. might fall behind the Soviet Union in achievement in the subjects of mathematics and science. This fear served as a catalyst for a national movement to reform and improve mathematics instruction in the U.S., which became known as the *New Math* of the 1950s and 1960s (Barnhill, 2011; Klein, 2003; Phillips, 2014). During this reform, the School Mathematics Study Group, financed by the National Science Foundation and composed of mathematicians and mathematics teachers, established high school math programs, such as the study of calculus and wrote curriculum for elementary schools

(Barnhill, 2011; Klein, 2003; Phillips, 2014). The New Math era focused on a theoretical approach to math and less on instruction in basic arithmetic and application of mathematical content (Barnhill, 2011; Burris, 2005; Klein, 2003; Phillips, 2014). The public, including parents and teachers, criticized the emphasis of New Math and eventually caused its demise (Burris, 2005; Klein, 2003; Phillips, 2014).

According to Americans' perceptions, the New Math era was a failure and led to detrimental outcomes of students' understanding of mathematics, and in the 1970s a renewed focus on students learning the basics emerged, a movement called, *Back to Basics* (Barnhill, 2011; Klein, 2003; Weiss, 2005). However, the Open Education movement, a progressive reform previously introduced in the 1920s, challenged the Back to the Basics movement, as progressives perceived the movement to be regressive and unable to provide students with the necessary skills to understand and apply mathematical concepts (Barnhill, 2011; Klein, 2003). The Open Education movement allowed each student to decide what he or she would learn each day (Barnhill, 2011; Klein, 2003). Teachers of students who lived in poverty criticized the movement, since students lacked support outside of school and had limited resources. In addition, in the 1970s, most states developed competency assessments in mathematical basic skills to increase the graduation rate (Barnhill, 2011; Klein, 2003; Weiss, 2005). Unfortunately, due to these assessments not holding students to high standards, standardized testing scores declined and both movements slowly dwindled (Barnhill, 2011; Klein, 2003).

In 1980, due to public critique about the quality of mathematics instruction, the NCTM published a report called *An Agenda for Action*, and emphasized the importance of mathematical problem solving, integration of technology, usage of cooperative learning, and the use of manipulatives (Barnhill, 2011; Dossey, McCrone, & Halvorsen2012; Klein, 2003). However, another report titled, *A Nation at Risk*, (National Commission on Excellence in Education [NCEE], 1983) overshadowed the NCTM's report (Barnhill, 2011; Klein, 2003). A *Nation at Risk* (NCEE, 1983) cautioned Americans:

> The educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people. What was unimaginable a generation ago has begun to occur--others are matching and surpassing our educational attainments. (para. 1)

The *Nation at Risk* (NCEE, 1983) report stressed accountability from standardized assessments, remedial mathematical courses offered in colleges, and an increase of content and rigor for teachers and in textbooks. As a result of this publication, the public demanded a change in how teachers taught mathematics in school and many states initiated a task force to compare a state's educational programming (Barnhill, 2011; Klein, 2003; NCEE, 1983). This provided foundation for additional research in the area of mathematics instruction and preempted the need for standards (Barnhill, 2011; Klein, 2003).

In 1989, with public support of higher standards, NCTM published, *The Standards*, a document which expounded upon the ideas from, *An Agenda for Action* and focused on constructivism where students learned by discovery (Barnhill, 2011; Dossey et al., 2012; Klein, 2003). The Standards (NCTM, 1989) were comprised of grade-level bands and emphasized important content, pedagogy, and technology (Barnhill, 2011; Klein, 2003; NCTM, 1989). At the same time, the U.S. perceived an urgent need for an improvement in mathematical education because standardized test scores were still low. The Standards (NCTM, 1989) became the concepts the nation utilized (as cited in Barnhill, 2011; Dossey et al., 2012; Klein, 2003).

Shortly after the nation embraced The Standards (NCTM, 1989), companies created mathematical curricular materials for elementary, middle, and high school levels based on the report's ideas while states adopted frameworks and curriculum based on The Standards (Barnhill, 2011; Klein, 2003; (NCTM, 1989). This marked the period titled *Math Wars*, where argument ensued about mathematical education, curriculum, and materials in the U.S.; still present in the educational literature at the time of this writing (Klein, 2003; Magid, 2015; Schoenfeld, 2003).

In 2000, NCTM revised *The Standards* (1989) by creating a set of principles needed for college readiness titled, *Principles and Standards for School Mathematics* (Barnhill, 2011; Klein, 2003; NCTM, 2015). This set of principles and standards provided a rigorous outline for mathematical education in the 21st century (NCTM, 2015). By this time, almost every state constructed a set of educational standards (Klein, 2003). In 2009, many state leaders initiated a Common Core State Standards (CCSS) movement due to the lack of student growth in the U.S. on standardized assessments (CCSSI, 2016).

The CCSS were intended to provide a unified and detailed set of standards in English Language Arts and mathematics, recommended for students to master by the end of each grade throughout the U.S. for grades Kindergarten through 12 (CCSI, 2016). In 2015, 42 states adopted CCSS (2016, para. 1). However, the public debated CCSS and new ways of teaching and an increased encroachment of the federal government in education occurred (CCSI, 2016; Crawford, 2014).

Math and Student Learning

When designing a balanced mathematical curriculum for students, Hudson and Miller (2006), the National Research Council (NRC, 2001), and the NAEP (2003) agreed on specific domains, strands, and abilities mathematical learners needed to become proficient learners. Each uniquely described the strands, and strong similarities existed between them. Hudson and Miller (2006) stated teachers should consider the four instructional mathematical domains: conceptual understanding, declarative knowledge, procedural knowledge, and problem solving, when programming for students who struggled in the area of mathematics. The NRC (2001) described five mathematical strands necessary for student success in mathematics: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition, while the NAEP (2003) described three mathematical abilities students should possess to be competent in mathematics: conceptual understanding, procedural knowledge, and problem solving. Although they used different terminology in the description of each instructional approach, each of the organizations noted perceived the different domains, strands, and abilities as interdependent; a teacher should instruct a student in each, so he or she becomes a proficient mathematical learner. Effective design of a mathematical curriculum incorporated this understanding if learners were to become proficient (Hudson & Miller, 2006; NAEP, 2003; NRC, 2001). In essence, throughout instruction and practice, students should be required to use conceptual understanding and procedural knowledge to problem solve (Hudson & Miller, 2006); problem solving was the ultimate goal of mathematical instruction (Hudson & Miller, 2006; Sherman, Richardson, & Yard, 2013).

In the literature, conceptual understanding was a fundamental goal of mathematical instruction and assisted students to transfer problem-solving skills to real world problems. To attain understanding in math, students required mastery of the following concepts: addition, multiplication, place value, equality, and quantity (Hudson & Miller, 2006; NRC, 2001). A successful way to teach conceptual understanding was through use of the concrete-representational (pictorial)-abstract (CRA) instructional process. Students first experienced the concept by using manipulatives, then through the use of visuals, and finally through a mathematical equation (Hudson & Miller, 2006; Korn, 2014; Sousa, 2008). Conceptual understanding was the foundation of math instruction and needed to be mastered before more complex instruction took place (Hudson & Miller, 2006; Korn, 2014; NRC, 2001).

Procedural knowledge, or fluency, was important for students to complete mathematical equations or problem-solving with accuracy. Procedural fluency referred to the understanding of mathematical procedures, to the ability to use the procedures appropriately, and to the ability to use the procedures effectively (Hudson & Miller, 2006; Korn, 2014; NRC; 2001). Mercer and Pullen (2008) and Hudson and Miller (2005) described the importance of using a procedural strategy, taught to help students understand and utilize the step-by-step process necessary to solve many math problems and a sequential process that helped lead students to solve problems. A procedural strategy included action steps, easily understood, generalizable, and easy to remember. Creating a clear, concise procedural strategy led to students performing better when presented with lengthy math problems, as the strategy provided students with a method to successfully approach the task (Hudson & Miller, 2006; Korn, 2014; Mercer & Pullen, 2008). Students who struggled in math benefitted from a procedural strategy, due to poor memory, students' difficulty attending to details, and/or passivity in problem solving (Hudson & Miller, 2006).

Golman and Hasselbring (1997) and Hudson and Miller (2006) described declarative knowledge as math fluency or information easily memorized (Fosnot, Leinwand, Mark, O'Connell, & Ray-Riek, 2015; Goldman & Hasselbring, 1997; Hudson & Miller, 2006). When learning a mathematical concept, students who struggled required conceptual understanding and procedural knowledge before a teacher worked on declarative knowledge (Hudson & Miller, 2006). For example, a student needed to understand addition and the steps used to add numbers before a student memorized simple addition facts. Instruction in declarative knowledge included flashcards, computer-based games, and probe sheets (Fosnot et al., 2015; Hudson & Miller, 2006; O'Connell, 2007).

Problem Solving

As stated, experts perceived problem solving as the ultimate goal of mathematical instruction (Hudson & Miller, 2006; NCTM, 2000; Sherman et al., 2013). Teachers needed to integrate problem solving into every aspect of mathematics instruction (NCTM, 2014). If students were unable to problem solve, there was no purpose to mathematics (NTCM, 2014) since the student used conceptual understanding, procedural knowledge, and declarative knowledge to correctly solve a problem.

Without knowledge of the three domains and an ability to correctly utilize each, the fourth domain of problem solving became difficult for a student (Hudson & Miller, 2006). Instruction in problem solving focused on transferring the students' math skills to the real world; a fundamental requirement in the workplace, daily life, and leisure activities. Real world skills included use of counting money, balancing a checkbook, record keeping, keeping score, and calculating an appropriate tip when paying at a restaurant (Hudson & Miller, 2006; NTCM 2014; O'Connell, 2007).

A student who problem solved had the skills to follow a multistep process, including: problem comprehension, formulation of a plan to solve, mathematical calculation, the ability to reflect on the answer, and ability to communicate one's results (NCTM 2014, O'Connell 2007). Comprehension of the problem was the first step in successfully solving a mathematical word problem. A student required reading strategies to understand and interpret the information to formulate a plan to solve the problem (Hyde, 2006).

A student had many different ways to plan and solve a problem, including the four operations (addition, subtraction, multiplication, or division), or a student could make a visual representation of the information (O'Connell, 2007). Younger students used manipulatives or drew pictures to solve a problem (O'Connell, 2007), as older students used an algebraic expression or a calculator to problem solve (CCSSI, 2016). Once a plan had been determined, the student correctly solved the mathematical equation by using procedural knowledge and declarative knowledge (Hudson & Miller, 2006; O'Connell, 2007). To ensure successful solving of the problem, the student reflected and checked his or her answer (NCTM, 2014; O'Connell, 2007). A student was unable to solve a problem, unless the solution was successfully communicated (NCTM, 2000).

Problem Solving Struggles

The U.S. struggled to increase students' problem solving abilities, even with the advances in technology, at the time (Jitendra, 2007; OECD, 2014) and the inclusion of students who received special education services in the measurement of these skills. Students frequently struggled to answer mathematical word problems because of an inability to organize the information presented in the problem or create a plan to solve the issue (Jitendra, 2007). With the demand of the Missouri Learning Standards or the CCSS, mathematical word problem solving was vital to a student's success in school and life (Gray, PowerUp What Works, & Zorfass, 2014).

Some students used the same mathematical operation for every problem, and always added, even when solving was a subtraction problem. Using this approach, students may have answered the problem correctly, but did not actually utilize the correct means to solve the problem, because the student lacked understanding (Jitendra, 2007). In addition to always using the same operation, some students used a key-word approach to solving mathematical word problems. For example, when a student saw the word 'left,' he automatically assumed that this problem was a subtraction problem (Jitendra, 2007). Some mathematical textbooks used in schools, at the time of this writing, taught this approach during problem solving activites (Van de Wallex, Karp, & Bay-Wiliams, 2012). The key-word approach initially helped students who struggled with solving mathematical word problems; however, as the word problems increased in complexity, the key-word approach became less effective and more harmful for students (Groth, 2013; Jitendra, 2007).

Textbooks also frequently taught Polya's (1945) problem-solving model. This alternate model was a four-step process where students first comprehended the word problem, then developed a plan, carried out the plan, and reflected. This model did not provide students with specific steps to solve a mathematical word problem. Therefore, the model assisted a select group of students, who received special education services, due to its general approach (Jitendra, 2007).

Students struggled with solving mathematical word problems for different reasons. One common reason was an inability to understand what was being asked, due to the student's difficulty in translating or comprehending the word problem as a mathematical equation (Barwell, 2011; Sherman et al., 2013). Literacy issues frequently played a role in students' difficulty with problem solving (Barwell, 2011; Hyde, 2006). Students lacked an understanding of mathematical words, such as difference, quotient, and factor and struggled with the ability to read and comprehend the text of the problem (Hyde, 2006; Sherman et al., 2013).

Reading comprehension was involved when solving mathematical word problems, especially when the problem involved a higher level of thinking (Jitendra, 2007; Hyde, 2006). Students who struggled in reading comprehension had difficulty when solving mathematical word problems (Jan & Rodrigues, 2012; Sherman et al., 2013) and difficulty providing a rationale for how they computed an answer (Sherman et al., 2013). Then-current assessments required students to provide justification for answers and created a situation where students failed to attempt the problem, since the students were unable to successfully show their work (Battista, Mayberry, Thompson, Yeatts, & Zawojewski, 2005; Sherman et al., 2013).

When struggling with reading comprehension, students had difficulty discerning the important information in a word problem. Extraneous information, symbols, or shapes distracted or confused the student; as a result, students were unable to create a plan to successfully solve the problem (Sherman et al., 2013). Students also had difficulty visualizing the situation in the problem, due to limited background knowledge or vocabulary. If a problem involved a train conductor and a student lacked knowledge of what a train conductor did, the student had difficulty understanding the problem (Hyde, 2006). Students also had difficulty self-checking their answers, due to a lack of knowledge of what a reasonable answer might be to the problem; for instance, a student may give an answer in the hundreds when the problem involved numbers in the thousands. Students either asked the teacher if the answer was correct or simply were satisfied they had an answer to the problem, even though it may be incorrect and demonstrated a lack of number sense (Fosnot & Dolk, 2001; Sherman et al., 2013).

Students also displayed little motivation to solve a word problem (Hart, 1996) and felt unconnected if unable to find meaning when reading. A student who played baseball was more willing to answer a word problem involving baseball than badminton (Hart, 1996; Technical Education Research Center, 2008). Another issue involved time; students may have lacked enough time to finish a problem or, if time ran out, quickly finished the work, yet applied knowledge incorrectly. Teachers who ensured a proper amount of time for students to work on problem solving and review work experienced greater student success (Battista et al., 2005; Sherman et al., 2013).

Best Practices in Mathematical Problem Solving

There were many instructional best practices on mathematical problem solving noted throughout the literature. One way to solve mathematical word problems was the use of an instructional process referred to as CRA (The Access Center, 2009; Hong, Lim, & Mei, 2009; Sousa, 2008). CRA was a three-part instructional process and utilized three distinct layers of instruction to help teach specific skills and provided a sequential process, developed to help students learn concepts through an abstract level of understanding. In the first stage, the concrete stage, teachers used manipulatives (3-D) or real objects to model a math concept noted as the 'doing stage' (The Access Center, 2009). After the teacher modeled the concrete stage, students practiced with the real object; so, students understood the newly taught math concept or word problem. Manipulatives or real objects included chips, blocks, an abacus, apples, and counters (The Access Center, 2009; Hong et al., 2009). The concrete stage served as the basis for conceptual understanding (The Access Center, 2009).

After the student mastered the concrete stage, he or she moved to the representational stage, where the teacher used pictures, diagrams, tallies, or dots (2-D) to help transfer what the student learned from the concrete stage to the semi-concrete stage (representational). The student drew a picture or used some representation of the word problem to solve; commonly referred to as the 'seeing stage' (The Access Center, 2009; Hong et al., 2009). In the final level stage, 'the abstract,' the teacher transitioned the student from a semi-concrete level to a symbolic level. Teachers used the operation symbols and other mathematical symbols to teach this stage, and the student used mathematical symbols to solve the problem. The highest level of understanding was the abstract stage; and, if a student mastered this stage, he or she understood the concept (The Access Center, 2009; Hong et al., 2009). Successfully moving through the CRA instructional process was key to truly understanding a mathematical concept or word problem (The Access Center, 2009; Hong et al., 2009; Sousa, 2008).

Solving a mathematical word problem was a sequential, step-by-step process. The use of a checklist helped a student remember and properly move through a mathematical word problem (O'Connell, 2007). Polya (1945), one of the first to use this process, developed a four-step problem-solving model that guided students to a solution. Understanding the problem was the first step for students to complete. The second step was to develop a plan to solve the problem, and the final steps were to execute the plan by calculating the answer and reflect about the answer, to see if one had a correct solution (Polya, 1945). Polya's problem-solving process provided educators with an organized approach, when teaching mathematical word problem solving (Florida Department of Education, 2010).

Mnemonic strategies assisted students to remember steps in problem solving, through the use of a cue to help students remember using the first letter of the step (The Access Center, 2006; Allsopp, Kyger, & Loving, 2007). One problem solving mnemonic strategy, STAR, stood for "S - Search the word problem; T -Translate the words into an equation in picture form; A - Answer the problem; and R- review the solution" (The Access Center, 2006, para. 14). Mercer and Mercer (1993) developed a mnemonic strategy called RIDE, similar to STAR, where each letter stood for a step in problem solving: "R - Read the problem correctly; I - Identify the relevant information; D- Determine the operation and unit for expressing the answer; and E - Enter the correct numbers and calculate" (as cited in Florida Department of Education, 2010, p. 11). Mnemonics strategies helped students solve word problems by giving them a systematic cue to remember each step (The Access Center, 2006; Florida Department of Education, 2010).

Problem solving involved reading, and students who struggled with mathematical problem solving benefited from instruction in reading comprehension strategies. Hyde (2006) stated, "The math problem solving of most students by fourth grade suffers from a profound lack of thinking and questioning" (p. 17). Hyde (2006) focused on six reading strategies, when incorporated into mathematics instruction, helped students become better problem solvers by asking questions, making connections, visualizing, inferring and predicting, determining importance, and synthesizing. As stated, students needed to understand the word problem (Polya, 1945). Therefore, teachers who included reading comprehension strategies in math lessons led to students who comprehended and applied knowledge to solve the problem (Franz, 2015; Hyde, 2006).

Another important part of reading was vocabulary instruction. Students who struggled in the area of mathematics required instruction in mathematical vocabulary (Smith & Angotti, 2012). Marzano and Pickering (2005) stated vocabulary instruction could improve a student's prior knowledge and understanding of academic content. The Frayer model (1969) was a useful graphic organizer to understand mathematical vocabulary and involved a definition, picture, example, and non-example of the word (Dunston & Tyminski, 2013). Students also created a math dictionary to help learn difficult math vocabulary; for example, the word volume had two meanings:

measurement in geometry and sound in the environment. Students were encouraged to draw a picture with the definition to help increase understanding (Sherman et al., 2013).

Along with instruction in vocabulary, the use of the think-aloud strategy improved mathematical problem solving. Teachers modeled the think-aloud strategy by verbalizing their thought processes and reason why and how they solved the problem (Institute of Education Services, 2012). The researchers taught students to use an inner voice to ask questions, reflect when solving a problem, and verbalize the thought process out loud (Barrera, Liu, & Thurman, 2009). A study completed by Barrera, Liu, and Thurman (2009) revealed students with educational disabilities, who were learning the English language, benefited from the use of the think-aloud.

Cooperative learning was another best practice in education, when integrated successfully in math "provides students with opportunities to interact with one another in ways that enhance their learning" (Dean, Hubbell, Pitler, & Stone, 2013, p. 16). Cooperative learning helped prepare students to live and work in the 21st century, since working in isolation did not prepare students for the future (Dean et al., 2013). Students who struggled worked in structured cooperative learning groups to solve a problem enjoyed being part of a team. As peers continued to share the thought process, others benefitted and helped the group learn (Allsopp et al., 2007; Sherman et al., 2013). Terwell (2011) stated cooperative learning and mathematics education were essential and needed to be taught at the same time. However, there should be other instructional strategies used in conjunction with cooperative learning to increase student achievement (Terwell, 2011).

There were other best practices on mathematical problem solving described in the then-current literature. The teacher considered the various, sequential dimensions of word problems and included single and multiple calculations, extraneous and no extraneous information, or directly stated problems and indirectly stated problems (Hudson & Miller, 2006). When teaching one of these dimensions, a teacher appropriately planned strategies to ensure student understanding (Hudson & Miller, 2006).

Grouping problems with the same strategy increased a student's fluency in utilizing the technique to problem solve successfully through repetition and helped students transfer these skills (Sherman et al., 2013). Another way to increase student understanding was through practice in the functional application of problem solving; important life skills and knowledge students needed, to successfully function in the real world. Examples included creating word problems involving money, time, and measurement (Hudson & Miller, 2006; NCTM, 2014; O'Connell, 2007).

An additional technique, to provide successful instruction in problem solving included stimulating student interest to increase motivation (Sherman et al., 2013,) crucial for academic success (Forbringer & Fuchs, 2014). After giving an interest inventory to students, a teacher generated content problems based on a student's interest and motivated the individual to solve the problem correctly (Sherman et al., 2013). A teacher incorporated a motivational/reward system tied to effort, perseverance, and outcomes with rewards, such as verbal praise, candy, and coupons (Forbringer & Fuchs, 2014).

Special Education

In 1975, Congress passed PL 94-142, Education for the Handicapped Act, which stated every child in the U.S. who had a disability had a right to a free and appropriate education (USDOEOSERS, 2010). The state of Missouri developed an educational policy noted as Child Find (MODESE, 2014) and required all children with a disability be identified by a private or public agency. Most schools had a process for the identification of students who struggled and a discussion on possible interventions to appropriately aid these students. This type of process occurred prior to referring students for special education (MODESE, 2014; O'Connor, Wright, & Wright, 2015; Pacer Center, 2015). If students were not making adequate progress after receiving research-based interventions in an area of deficit, a special education evaluation occurred (MODESE, 2014; O'Connor et al., 2015).

To determine if an evaluation was warranted, a team of a student's parents, the school psychologist, a general education teacher, a special education teacher, and any other related service provider was created to review existing data. From the existing data, the team determined if testing would occur in specific areas: vision, hearing, health/motor, academics, adaptive behavior, assistive technology, social/emotional/behavioral, and cognition (MODESE, 2014; O'Connor et al., 2015; Pacer Center, 2015). The school psychologist evaluated the child in the areas of concern indicated by existing data. The results of the evaluation needed to be completed and discussed within 60 days from parent consent to evaluate, dependent upon the areas of deficits, included observations, rating scales, cognitive assessments, and academic assessments (MODESE, 2014; O'Connor et al., 2015). From the data gathered during the evaluation, the team agreed upon an educational disability or disabilities from the 13 educational disability categories delineated in the IDEA (2004): autism, deaf-blindness, deafness, emotional disturbance (ED), hearing impairment, intellectual disability, multiple disabilities, orthopedic impairment, other health impairment (OHI), specific learning disability (LD), speech impairment, language impairment, traumatic brain injury, and visual impairment (MODESE, 2014; O'Connor et al., 2015).

For students eligible for special education, the team created an IEP. The components of an IEP included a statement of how the student's disability related to his or her learning, strengths identified by both school staff and parents, annual goals and/or objectives to address learning deficits, and classroom and assessment accommodations (Project IDEAL, 2013). Based on the learning deficits of the student, the IEP team developed annual goals, and determined the amount of time needed to meet the goals and an educational placement. The law required all students be educated in the least restrictive environment (LRE) and with typically-developing peers, to the greatest extent possible. LRE was not based upon a student's educational disability (MODESE, 2014; O'Connor et al., 2015).

As stated, a team of qualified individuals carefully selected an educational diagnosis or diagnoses based upon the data gathered from the evaluation. Autism was one of the diagnoses recognized by IDEA (MODESE, 2014). People with Autism Spectrum Disorder had difficulties in the areas of communication, language, social skills, and stereotyped behaviors. The spectrum ranged from classic autism, which was the most severe, to a less severe type known as high-functioning autism (Autism Speaks, 2015). Students with classic autism typically required a higher level of support in communicating wants and needs; a student who had high-functioning autism typically required support in the area of social skills (Autism Speaks, 2015). The Centers for Disease Control and Prevention (CDC) approximated one in 68 people in the U.S. were then-currently on the autism spectrum (Centers for Disease Control and Prevention [CDC], 2014, para. 1).

A medical diagnosis of autism could be received as early as infancy; early indicators included little eye contact, minimal social responsiveness to the caregiver, no babbling by one-year-of-age, and loss of language (Autism Speaks, 2015; Olsson, 2016). Although there were early indicators, some people with autism were not diagnosed until later in life. Indicators considered in making a later diagnosis included difficulty making friends, lack of imaginative play, perseveration of certain topics/items, repetitive use of language, and difficulty sustaining appropriate social interactions (Autism Speaks, 2015; Olsson, 2016). At the time of this writing, Autism had no known cause, which made it difficult to diagnose, although scientists believed both genetics and environmental factors contributed to the likelihood of a person developing autism. Professionals treated individuals with autism with educational interventions, behavior interventions, medications, and other treatments, like restricting certain foods in a person's diet (Autism Speaks, 2015; CDC, 2016). If a person began treatment for autism early on, symptoms were less severe (Autism Speaks, 2015; CDC, 2016a).

Students with autism had difficulty with math, because the subject required high-cognitive functioning. Some students with autism responded to learning rote math skills, such as number identification, counting and shape identification, while others were able to learn money skills, calculator use, geometry, and algebra (r4 Education Solutions, 2010). Students with autism benefited from visual supports, such as manipulatives, number lines, graphic columns, written models, highlighting important words, graphic organizers, and number cards. Some students with autism relied on visual supports long term (Cohen & Sloan, 2007). Students with autism were also supported by a visual schedule with identified breaks, clear transition times, positive reinforcement, paired verbal language with visual support, and placing a preferred activity after an a non-preferred activity (r4 Education Solutions, 2010).

Another diagnosis recognized by IDEA was emotional disturbance (ED) (MODESE, 2012)**.** Students with an ED had many difficulties in school, including regulation of internal and external behavior(s). The frequency and intensity of the behaviors negatively lowered academic scores (Kern & Wehby, 2014). According to the CDC (2016), between the years 2005 and 2011, 3.5% of children with an educational diagnosis of ED had a behavior or conduct problem (para. 2).

For a student diagnosed with an educational disability of ED, he or she demonstrated one of the following characteristics: an unexplained inability to learn, difficulty relating to people, inappropriate behaviors during typical situations, depression, or fears over a long period of time and to a severe degree (MODESE, 2012). Medical diagnoses associated with an educational disability of ED were anxiety disorders, psychotic disorders, obsessive-compulsive disorder, bipolar disorder, and Tourette's syndrome (National Dissemination Center for Children with Disabilities, 2010).

Students with an ED benefited from a variety of positive behavior techniques, such as utilization of behavioral contracts, frequent positive reinforcement, token economies, breaks throughout the day, and predictable routines (Kern & Wehby, 2014).

Sometimes an individual or individuals trained in providing behavioral supports developed a positive behavior support plan to help substitute the inappropriate behaviors with an acceptable replacement behavior. Before implementing a positive behavior support plan, the individual(s) conducted a functional behavior assessment and determined the function of the inappropriate behavior (Blakely & von Ravensberg, 2014). Determining the reason why a student executed an inappropriate behavior aided in the selection of an appropriate replacement behavior. Experts hoped putting these supports in place decreased the inappropriate behaviors and increased academic performance (Blakely & von Ravensberg, 2014).

IDEA also recognized a learning disability (LD) as an educational diagnosis (MODESE, 2014). Students with an LD, described as a neurological disorder, had difficulty learning new skills in a traditional way. The individuals struggled in reading, math, writing, thinking, organizing, or spelling. The National Center of Learning Disabilities (2015) stated 4.6 million people who lived in the U.S. reported a type of LD (p. 25). For a student diagnosed with an LD in Missouri, there must have been a discrepancy between the student's intellectual ability (IQ) and achievement of at least 1.5 standard deviations (MODESE, 2012, para. 3). A student was diagnosed as learning disabled in one or more of the following areas: basic reading, reading comprehension, listening comprehension, fluency, written expression, math calculation, math problem solving, and oral expression. Before a diagnosis, students received research-based interventions and an observation in the general education setting (MODESE, 2012).

Students with learning disabilities possibly struggled with accessing long and short-term memory. Instructional supports for students who struggled with memory deficits included the use of a problem-solving organizer, a reduction in the amount of copying required from a textbook or board, use of mnemonic devices, and use of a calculator, instead of memorization of math facts (r4 Education Solutions, 2010). Other students diagnosed with an LD struggled with processing information cognitively, auditorally, or visually and necessitated the use of nonlinguistic representations paired with a verbal explanation, use of manipulatives to model a problem, assignments given in chunks, preferential seating close to the teacher, and a review on important vocabulary (r4 Education Solutions, 2010).

Interventions that helped students with an LD in mathematics included self-regulation, direct instruction, goal-setting, and the CRA instructional process (Donaldson & Zager, 2010; Forbringer & Fuchs, 2014). Self-regulation was the use of checklists students completed during different math tasks (Donaldson & Zager, 2010). Direct instruction was a systematic approach to teaching specific, identified skills through the use of prompts and guides, and followed by a reinforcement for correct student responses. Direct instruction focused on universally applicable strategies to solve any mathematical problem (Donaldson & Zager, 2010; Forbringer & Fuchs, 2014). Goal setting challenged students to set a realistic math goal for themselves before or while they learned a skill. Students' academic performance increased when students understood the goal (Donaldson & Zager, 2010).

Language impairment was also an education diagnosis recognized by IDEA (MODESE, 2012). A person with a language impairment had difficulty understanding and/or using words in context; identified with an expressive disorder, such as difficulty conveying ideas or a receptive disorder, such as difficulty understanding what other people were saying (Center for Parent Information and Resources, 2015b).

A person described as educationally disabled in one or more of four areas, syntax, semantics, morphology, and pragmatics, received the educational diagnosis of language impairment. Syntax was the way people put words together to make a sentence, evidenced by students who mixed-up the order of words in the sentence and left the listener with an inability to interpret what was stated (American Speech-Language-Hearing Association [ASHA], 2014; Clark & Kamhi, 2010). Semantics was the meaning behind a word or sentence (ASHA, 2014). Students diagnosed in the area of semantics had difficulty with curriculum vocabulary and often had difficulty understanding the meaning of new terminology or the multiple meanings of one word (Clark & Kamhi, 2010).

Morphology was how word forms were put together (ASHA, 2014). Students with a morphology diagnosis had difficulty adding suffixes correctly on the end of a word or were unable to use an irregular verb (Clark & Kamhi, 2010). Pragmatics was the use of language in a social context. Students diagnosed in the area of pragmatics struggled with interacting appropriately with peers and adults (ASHA, 2014). To be diagnosed with a language impairment in the state of Missouri, a 1.5 standard deviation existed between the student's language scores and the student's IQ. The diagnostician must have completed two different language assessments to document the student's language difficulties (MODESE, 2012).

IDEA (2004) also recognized an intellectual disability as an educational diagnosis; described as a person who experienced limitations in problem-solving abilities, communication skills, self-care skills, and/or social skills. Students with an intellectual disability frequently learned at a slower rate than typically-developing peers (Hallahan, 2015). These students were capable of learning, but needed the concepts presented repeatedly until mastery and had difficulty with learning complex concepts or higher order thinking concepts (Center for Parent Information and Resources, 2015a; Hallahan, 2015). Reasons for an intellectual disability included genetic conditions, specifically Down syndrome or problems during pregnancy, like Fetal Alcohol Syndrome, complications at birth, or health problems, such as lead poisoning, which led to memory deficits, an inability to solve his or her own problems, and difficulty understanding the consequences of his or her actions (Center for Parent Information and Resources, 2015a). For an educational diagnosis of intellectual disability in the state of Missouri, a student possessed an IQ below two standard deviations from the mean or below 70 (MODESE, 2012, para. 1). The student also demonstrated difficulty with adaptive behaviors, such as navigating the school building or taking care of personal belongings (MODESE, 2012).

Students with an intellectual disability benefited from task analysis, when taught math. The teacher reduced the complexity of the math skill and developed small steps and sequentially taught each step repeatedly until the student reached mastery (Dombeck, Reynolds, & Zupanick, 2013; Project Ideal, 2013). Students with an intellectual disability also benefited from a kinesthetic and visual approach, as both involved a concrete level to teach concepts (Dombeck et al., 2013). Repeat, review, and drill was another strategy, when teaching students diagnosed with an intellectual disability, as this process provided students with the needed repetition and practice to internalize the concept (Dombeck et al., 2013).

An educational diagnosis of Other Health Impairment (OHI) interfered with a student's educational progress. The state of Missouri required a medical diagnosis with documented evidence the health impairment limited a student's strength, vitality, or alertness (MODESE, 2012). Common health impairments included attention deficit hyperactivity disorder (ADHD), diabetes, epilepsy, seizures, and leukemia (National Dissemination Center for Children with Disabilities, 2012).

The Centers for Disease Control and Prevention and the Health Resources and Services Administration's (2011) report stated that 11% of children between the ages of four and 17 years were diagnosed with ADHD (para. 4) compared to 7.8% in 2003 (para. 3). Students with ADHD were distracted, impulsive, and/or had an excessive amount of body movement during the school day. The inability to focus on the instruction resulted in a decrease in students' educational performance (National Institute of Mental Health, 2016).

Specialized Instruction in Math

In 2004, President Bush reauthorized the Individuals with Disabilities Act (IDEA); focused on the importance of scientifically-based or research-based instructional practices and reinforced the practice of, " implementing professional development, instructional strategies, and methods of instruction that are based on scientifically based research" (Individuals with Disabilities Act [IDEA], 2004, 118 STAT. 2734). Following the reauthorization of IDEA (2004), many state leaders initiated the CCSS; described as a set of standards on what each student should know from Kindergarten through12th grade in mathematics and English Language Arts (Coleman, Gallagher, & Kirk, 2015). The team of professionals who created the CCSS stressed the importance of professional educators delivering evidence-based, individualized instruction (Coleman et al., 2015; CCSSI, 2016).

Specialized instruction in mathematics required an emphasis on computation skills, conceptual understanding, and problem solving through the use of direct, research-based based instructional strategies (Forbringer & Fuchs, 2014; Graham, Harris, & Swanson, 2013). Before implementing a specialized math program, a special educator identified the problem using formative and summative assessment data (Forbringer & Fuchs, 2014). Once the special educator identified the deficit, he or she developed an instructional plan targeted on the deficit of the student (Hagaman, Lienemann, & Reid, 2013). To remediate the deficit, the educator carefully selected a research-based instructional strategy tied directly to the area of deficit (Hagaman et al., 2013). While the special education teacher instructed the student using the strategy, the special educator monitored progress by using a curriculum-based measurement or a progress-monitoring tool to ensure the instruction produced a positive academic result (Forbringer & Fuchs, 2014; Graham et al., 2013).

As required by the reauthorization of IDEA in 2004, a special educator utilized research-based instructional strategies (IDEA, 2004). As discussed earlier in this literature review, the CRA instructional process, mnemonics strategies, reading comprehension strategies, vocabulary instruction, think-aloud strategy, and cooperative learning were research-based instructional strategies a special educator could select to remediate a student's mathematical deficit (The Access Center, 2006; Dean et al., 2013; Franz, 2015; Hong et al., 2009; Institute of Education Services, 2012; Marzano & Pickering, 2005).

Schema-Based Instruction

In 1952, Piaget constructed a cognitive theory of how children and adults understood the world around them. One specific component was a schema Piaget described as "a cohesive, repeatable action sequence possessing component actions that are tightly interconnected and governed by a core meaning" (as cited in McLeod, 2015, para. 14). Schemas were a way to organize and process incoming information in the brain. As a child or adult experienced new information, new processes were modified or added to schemas already constructed in the brain (Huitt & Hummel, 2003; McLeod, 2015). Therefore, with new information, a child or an adult changed the way he or she reacted to a situation. Jitendra (2007) developed schema-based instruction for students to organize the information from a mathematical word problem, to provide strategy to successfully solve it. Schema-based instruction was described as research-based by numerous researchers (Adams et al., 2007; Church et al., 2013; Deatline-Buchmann, Jitendra & Xin, 2005; Fang, Hartsell, Herron, Mohn, & Zhou, 2015; Fede, Pierce, Matthews, & Wells, 2013; Griffin & Jitendra, 2009; Jitendra et al., 2002; Jitendra et al., 1998; Jitendra et al., 2010; Jitendra & Hoff, 1996; Rockwell et al., 2011).

Schema-based instruction helped students see the whole picture by integrating the use of diagrams or schemas with reading comprehension strategies and mathematical problem-solving strategies (Church et al., 2013; Jitendra, 2007). The approach concentrated on building students' conceptual and procedural understanding through the use of a step-by-step strategy reinforced with visual representations (Fang et al., 2015; Jitendra, 2007). After reading and retelling the math word problem, students selected an appropriate schematic diagram, change, compare, or group problems (Fang et al., 2015;

Jitendra, 2007; Jitendra & Star, 2011). The instructor encouraged students to fully understand the problem before attempting to solve it (Fang et al., 2015; Jitendra, 2007; Jitendra & Star, 2011) and taught reading comprehension strategies, such as summarizing, retelling, reading aloud, and asking clarifying questions (Fang et al., 2015; Jitendra, 2007).

Students used a checklist when introduced to schema-based instruction. The checklist included the procedural strategy of FOPS: "F - Find the problem type, O - Organize the information in the problem using the diagram, P - Plan to solve the problem, and S - Solve the problem" (Jitendra, 2007, p. 21). The representational strategy of FOPS was a useful tool for educators to teach; so, students self-regulated and ensured the steps were followed correctly to solve the problem (Jitendra, 2007; Jitendra et al., 2010). The student needed to identify the problem type, compare, group, or change. To do this, the student read the word problem and asked him or herself, 'What type of problem is this?' In the organize step, the students needed to organize the information into the appropriate diagram and place the known information into the diagram, as well as to mark unknown information (Jitendra, 2007; Jitendra et al., 2010). In the plan step, the students solved the word problem by finding the total amount of the word problem and marking it with a letter, T. The student determined if the problem needed addition or subtraction, using this rule (Jitendra, 2007; Jitendra et al., 2010). To solve the problem, the student performed the correct operation, checked to ensure the answer made sense, and recorded the answer (Jitendra, 2007; Jitendra et al., 2010). By using this strategy, students established a successful routine to problem solve correctly, which ensured the student followed the correct procedure (Jitendra, 2007; Jitendra et al., 2002; Jitendra et al., 2010). If a student made a mistake, teachers performed an analysis and determined the type of error or where in the FOPS checklist the student required further assistance (Griffin & Jitendra, 2009; Jitendra, 2007). The teacher addressed the error with additional remediated instruction (Griffin & Jitendra, 2009; Jitendra, 2007). The checklist provided necessary scaffolding to ensure student success, for those who struggled in math (Griffin & Jitendra, 2009; Jitendra, 2007; Jitendra et al., 2010).

Schematic diagrams were an important part of schema-based instruction and helped students organize the information to make sense of the word problem; similar to the use of a graphic organizer during the writing process. Schematic diagrams assisted the student to find the correct solution through the use of three different types of schematic diagrams for addition and subtraction, change, compare, and group (Adams et al., 2007; Church et al., 2013; Deatline-Buchmann et al., 2005; Griffin & Jitendra, 2009; Jitendra et al., 2002; Jitendra et al., 1998; Jitendra et al., 2010; Jitendra & Hoff, 1996; Rockwell et al., 2011). For instance, when the students solved a change problem, students determined if the problem ended with more or less than the original amount (Church et al., 2013; Jitendra et al., 2002; Jitendra, 2007). If the answer had more than the original amount, the total was revealed; if the answer had less than the original amount, then the starting amount was the total (Church et al., 2013; Jitendra et al., 2002; Jitendra, 2007). Change problems focused on one variable over a period of time (Church et al., 2013; Jitendra, 2007; Jitendra et al., 2002).

The part-part-whole concept included a process of solving group problems by combining two separate groups into one new group, with the largest number always the total, because the two smaller numbers made up the larger number (Jitendra, 2007;

Jitendra et al., 2002; Jitendra et al., 2010). Group problems did not occur over a period of time (Church et al., 2013; Jitendra, 2007; Jitendra et al., 2002).

The compare schematic diagram showed the relationship between two numbers and included two distinct sets, called the compared and referent (Jitendra, 2007; Jitendra & Hoff, 1996; Jitendra et al., 2010). The problem stressed the relationship between the compared and referent. When solving, the student decided if the compared set was the biggest value (Jitendra, 2007; Jitendra et al., 2010; Jitendra & Hoff, 1996).

In all the problem types, one rule always applied on the use of addition or subtraction (Fang et al., 2015; Jitendra, 2007). If the total was unknown, the problem required addition to solve. If the total was known, the problem required subtraction (Fang et al., 2015; Jitendra, 2007).

An important component of schema-based instruction was to fade or to remove the supports, such as the checklist and diagrams, as students showed proficiency using the strategy. To help students develop proficiency, students only learned one problem type at a time (Church et al., 2013; Jitendra et al., 2002; Jitendra et al., 2010). As the student showed mastery with one type, another type emerged. After each session, students completed word problem tests and informed the teacher whether the student mastered the problem type, a form of progress monitoring (Church et al., 2013; Jitendra et al., 2002; Jitendra et al., 2010).

Jitendra's (2007) schema-based instructional program incorporated progress monitoring or small word problem assessments, based on one specific schematic diagram similar to the previously mentioned studies. The teacher examined the students' completed assessments for common errors, such as trouble following the strategy steps, using the diagrams, selecting the correct operation, or following the checklist (Church et al., 2013; Jitendra et al., 2002; Jitendra et al., 2010). Once the teacher identified the error, the students who needed additional remediated instruction addressed mistakes and received remediation before any new information was introduced (Church et al., 2013; Jitendra et al., 2002; Jitendra et al., 2010).

As students demonstrated accuracy and proficiency in all problem types, assessments included all problem types mixed together (Church et al., 2013; Jitendra et al., 2002; Jitendra et al., 2010). Jitendra's (2007) schema-based instructional program incorporated assessments with all problem types mixed together, along with introduction of two-step word problems. Assessments demonstrated how the students maintained or generalized the skills taught for each type of problem (Church et al., 2013; Jitendra et al., 2002; Jitendra et al., 2010).

Research studies between 1996 and 2015 indicated positive results of schema-based instruction with students who struggled in the area of mathematical problem solving. The majority of research participants were students who received special education services (Adams et al., 2007; Church et al., 2013; Deatline-Buchmann et al., 2005; Fede et al.., 2013; Griffin & Jitendra, 2009; Jitendra et al., 2002; Jitendra et al., 1998; Jitendra et al., 2010; Jitendra & Hoff, 1996; Rockwell et al., 2011). The students in the studies spent the majority of the day in the general education environment and received specialized instruction in math for a part of the day. The educational disabilities of the students studied included learning disabilities, ED, and autism (Adams et al., 2007; Deatline-Buchmann et al., 2005; Fede et al., 2013; Griffin & Jitendra, 2009; Jitendra et al., 2002; Jitendra et al., 1998; Jitendra et al., 2010; Jitendra & Hoff, 1996Rockwell et al., 2011).

In the 2013 study conducted by Church et al., the researchers compared the academic outcomes of schema-based instruction to the academic outcomes of a standards-based mathematical curriculum. The results of this study demonstrated a student who entered the study with higher scores in problem solving performed better using schema-based instruction than student who entered the study with lower scores in problem solving (Church et al., 2013). Previous studies also included students in the general education environment who demonstrated positive results using schema-based instruction (Adams et al., 2007; Church et al., 2013; Deatline-Buchmann et al., 2005; Fang et al., 2015; Fede et al., 2013; Jitendra et al., 1998).

While the complexity of mathematical word problems increased as students progressed through school (CCSSI, 2016), previous studies from 1996 to 2015 also demonstrated schema-based instruction yielded positive results for students ranging from second to eighth grades (Adams et al., 2007; Church et al., 2013; Deatline-Buchmann et al., 2005; Fang et al., 2015; Fede et al., 2013; Griffin & Jitendra, 2009; Jitendra et al., 2002; Jitendra et al., 1998; Jitendra et al., 2010; Jitendra & Hoff, 1996; Rockwell et al., 2011). The intent of schema-based instruction was for use in upper elementary to middle school (Jitendra, 2007).

One study conducted by Fang, Hartsell, Herron, Mohn, and Zhou (2015) concentrated on improving the mathematical problem-solving skills of second grade students using a simplified schema-based instruction approach and one-step addition and subtraction word problems (Fang et al., 2015). The simplified schema-based instruction shortened the schema-based instruction approach by not utilizing the FOPS checklist, and students did not identify the problem type, but had to rearrange the numbers of the word problem into one schema to solve for both operations (Fang et al., 2015). The simplified schema-based instruction yielded positive results for the participants and demonstrated that students were able to maintain the skills taught (Fang et al., 2015).

Three of the previous schema-based instruction studies compared schema-based instruction to a general-strategy instruction normally presented in mathematical textbooks (Adams et al., 2007; Church et al., 2013; Deatline-Buchmann et al., 2005). The study conducted by Deatline-Buchmann, Jitendra, and Xin (2005) yielded positive results for the schema-based instruction over the general-strategy instruction. Both schema-based instruction and the general-strategy instruction included reading the mathematical word problem for understanding and checking an answer to ensure accuracy (Deatline-Buchmann et al., 2005). However, the schema-based instruction emphasized identifying the problem type using a schematic diagram, while the general-strategy instruction focused on drawing a picture to solve (Deatline-Buchmann et al., 2005).

The study conducted by Adams et al. (2007) compared the outcomes of schema-based instruction and a general-strategy instruction. The general-strategy instruction included strategies generally found in a textbook, such as drawing a diagram, using data from a graph, using concrete objects, and writing a number sentence with results that favored schema-based instruction in improving a student's mathematical word problem-solving skills over the general-strategy instruction (Adams et al., 2007). The researchers discussed the benefit of schema-based instruction as a student's ability to find the underlying meaning of the problem, rather than simply applying a strategy (Adams et al., 2007).

Another study conducted by Church et al. in 2013 also compared schema-based instruction to a general-strategy instruction in a standard-based curriculum approach, which resulted in mixed positive results for schema-based instruction. Students who scored higher on the pre-test benefited at a higher rate with the schema-based instruction; whereas students who scored lower on the pre-test benefited higher from the general-strategy instruction normally presented in a standards-based curriculum (Church et al., 2013). Both studies supported the use of schema-based instruction on improving mathematical problem solving of students (Church et al., 2013; Deatline-Buchmann et al., 2005).

Summary

This literature review provided then-current research on the use of schema-based instruction with students identified with an educational disability, specifically proficiency in mathematics and best practice(s) in mathematical problem solving. The researcher provided an explanation of schema-based instruction, along with description of studies that reinforced schema-based instruction as beneficial to students who struggled in the area of mathematical problem solving (Adams et al., 2007; Church et al., 2013; Deatline-Buchmann et al., 2005; Fede et al., 2013; Griffin & Jitendra, 2009; Jitendra et al., 2002; Jitendra et al., 1998; Jitendra et al., 2010; Jitendra & Hoff, 1996: Rockwell et al., 2011). An overview of the special education process and educational disabilities, along with best practice to meet the needs of students with a disability was also discussed. Chapter Three depicts the methodology used in this study, while Chapter Four describes the results. A dialogue and recommendations for future research are included in Chapter Five.

Chapter Three: Methodology

Overview

The intent of this study was to measure student achievement of schema-based instruction on mathematical problem-solving skills for students in grades three through eight, who were identified with an educational disability. This project utilized a mixed-methodology, similar to Jitendra's (2007) educational program titled, *Solving Math Word Problems: Teaching Students with Learning Disabilities Using Schema-Based Instruction.* A pre and post-assessment, along with M-CAP benchmark scores determined student achievement. Special education teachers were interviewed to gain perceptions on the implementation and their perception of a schema-based instructional program. Student participants responded to surveys on this specific type of instruction to allow the researcher to gain their perception of the schema-based instructional program. The researcher also administered surveys to general education teachers to gain their perception of the schema-based instructional program, along with their perception of student achievement following utilization of this type of instruction.

Problem Statement

The sample size of 21 students, who received special education services, was larger than previous studies on the use of schema-based instruction with students diagnosed with an educational disability. Six-out-of-the-seven studies had a sample size ranging from one to four students (Alter et al., 2011; Griffin & Jitendra, 2009; Jitendra et al., 1998; Jitendra et al., 2002; Jitendra et al., 2010; Jitendra & Hoff, 1996; Rockwell et al., 2011). Jitendra et al. (1998) completed a study on schema-based instruction with a sample size of 34 students, who were at-risk or displayed a mild disability (Alter et al., 2011; Griffin & Jitendra, 2009; Jitendra et al, 1998; Jitendra et al., 2002; Jitendra et al., 2010; Jitendra & Hoff, 1996; Rockwell et al., 2011).

Context Description

This study was conducted in a public school district in the Midwest with an enrollment of approximately 5,500 K-12 students (MODESE, 2013, p. 1), and 47.2% of the district qualified for free-and-reduced lunch (MODESE, 2013, p. 2). The study context included two elementary buildings (K-5) and one middle school (6-8) in special education classrooms, with students diagnosed with an educational disability. The incident rate in the researched school district was 16.41% (MODESE, 2013, para. 8474), compared to a state average of 12.59% (MODESE, 2013, para. 8588). In the 2013-2014 academic year, there were 913 students identified with an educational disability in the researched school district (MODESE, 2013, para. 8474).

Participant Description

The study participant recruitment occurred during the 2013-2014 school year, during an informational meeting in which all components of the study, specifically the purpose, requirements, and how to identify student participants, were discussed with teachers. Thirty-two special education teachers attended the first informational meeting at one elementary school. Four special education teachers signed a consent form to participate in the study; two special education teachers implemented the program with students, and two special education teachers who previously implemented schema-based instruction, at the time of the study had no students who met the criteria to participate. The researcher held a second informational meeting at a middle school, following the same agenda. Five special education teachers attended this meeting, and two additional special education teachers signed consent forms. Both of these special education teachers had students who met criteria to participate in this study.

Two special education teacher participants taught in one elementary school, and two special education teacher participants taught in one middle school. Both teachers in the elementary school held special education certification (K-12) and elementary education (1-6). The teachers in the middle school were the primary mathematics instructors for the students who participated in the study (see Table 1). Both middle school teachers had special education certification (K-12) and mathematics certification (5-9).

Table 1

Special Education Teacher Demographics

	Elementary (3-5)	Middle (6-8)	Taught Program in 12-13 School Year	Taught Program in 13-14 School Year	Primary Mathematics Teacher
ST1		X		X	X
ST2		X		X	X
ST3	X			X	
ST4	X			X	
ST5	X		X		
ST6	X		X		

The general education teachers who served as the primary mathematics instructors for the elementary students received an e-mail explaining the components of the study, along with a consent-to-participate form attached. All student participants received instruction during special education services in a special education setting. All settings provided a small group, ranging from two to eight students.

Student Participants

All student participants were previously identified with an educational disability or disabilities. The researcher took precautions to ensure the students' identities and all material collected for the purpose of this study were confidential and anonymous, due to the sensitive nature of the students' disability identification. Students were assigned pseudonym names during the study. The pre and post-assessment and benchmark data remained confidential, and student names were removed. In addition, the school district and specific schools used in this study remained anonymous to ensure anonymity of the student participants.

To select students for the addition and subtraction portion of the program, the special education teachers received the following description, from Jitendra (2007):

> The addition and subtraction word-problem solving lessons [were] designed for third graders, but [could] be used with second graders by modifying the difficulty level of the language and computation skills. In addition, the lessons can be used with older children who have experienced consistent difficulties in solving addition and subtraction word problem. (p. xiii)

For the purpose of this study, all student participants had an educational diagnosis of disability verified by the students' eligibility reports (see Table 2). Students completed the pre-assessment with ten mathematical word problems with three different schemas: change, group, and compare. Based on the professional opinion of special education teachers, who previously implemented this program, students who scored 70% or less on the pre-assessment were appropriate for the study (T. Hilgenbrink & P. McConnell, personal communication, May 16, 2013). Each participant required parent permission. For each student who scored below 70% on the pre-assessment and before students participated in the survey, the researcher received 19 signed parent permission forms. Two additional students' pre and post-assessment data and M-CAP benchmark scores were also included in the study, since parent permission was only needed for students to participate in the survey. The district gave permission for use of scores as secondary data. However, two students were unable to participate in the surveys, since no permission form was completed and returned.

Table 2

Number of Students by Disability

Disability	Number of Students
Autism	12
Emotional Disturbance	1
Learning Disability	4
Intellectual Disability	2
Speech Impairment	3
Language Impairment	2
Other Health Impairment	2

Research Questions

RQ1: How do special education teachers perceive the implementation of schema-based instruction?

RQ2: How do special education teachers perceive schema-based instruction and student achievement?

RQ3: How do general education teachers perceive schema-based instruction and student achievement?

Hypotheses

NH1: There is no increase in mathematical problem solving skills of students with an educational diagnosis through the use of schema-based instruction, as measured by a pre-to-post assessment.

NH2: There is no increase in AIMSweb Math Concepts and Application (M-CAP) benchmark scores of students with an educational diagnosis through the use of schema-based instruction.

NH3: Students will negatively perceive the schema-based instruction, as measured by a Likert-scale survey.

Procedure for Data Collection

During the 2013-2014 school year, the special education teachers implemented the program, *Solving Math Word Problems: Teaching Students with Learning Disabilities Using Schema-Based instruction,* by Jitendra (2007). Teachers administered the pre-assessment to students who received specialized instruction in the area of mathematical problem solving. Students who scored 70% or lower became the potential participants for this study. Parent consent for this instructional approach to mathematics was not necessary at this time, because the program was already under implementation in the school setting and was not implemented solely for purposes of this research study.

Next, teachers began implementation of the schema-based instructional program with strategies applied an average of three times a week. To ensure fidelity of the program, the researcher created a fidelity checklist concentrated on the important instructional components. The researcher and an administrator observed the four special education teachers, separately, one time, for a 40-minute class period.

Upon completion of the 21 lessons of the addition and subtraction problems, or the end of the school year, the researcher obtained a copy of the secondary data from teachers, including pre-assessment and post-assessment data, along with the AIMSweb M-CAP benchmark data for each student. One special education teacher did not complete the 21 lessons of addition and subtraction, because her students were unable to master the ‘compare’ schematic diagrams within the 2013-2014 school year.

The researcher or an administrator interviewed the special education teachers who implemented the schema-based program. Students who participated in the study completed the survey to determine individual perceptions on the use of schema-based instruction. General education teachers who had a student in his or her classroom and who participated in the study were also surveyed.

Finally, the researcher organized the quantitative data by creating a spreadsheet. For the pre and post-assessments, the researcher created columns for the scores of the pre-assessments, post-assessments, and a column to display growth using the difference between the two assessment scores. Once this data was compiled, the researcher sorted the data by grade spans for grades three through five and grades six through eight, to analyze null hypotheses one and two. The researcher also disaggregated the data by disability category to further analyze null hypotheses one and two. The researcher organized the survey data by creating a scale of 1to 3 for the student survey, in order to analyze null hypothesis three, and by creating a scale of 1 to 5 for the general education teacher survey in order to assist in analyzing research question three. The researcher placed the participant’s responses on the spreadsheet, using the scale from the survey. The researcher created a table to depict the percentages of each response, by question.

The researcher also organized the qualitative data. Each interview was scribed, then coded and analyzed to identify common themes across all responses.

Instrumentation

Scripted lessons and pre and post-assessment. The scripted lessons and pre and post-assessments previously developed by Jitendra (2007) were a published component of her program titled, *Solving Math Word Problems: Teaching Students with Learning Disabilities Using Schema-Based Instruction*. Each scripted lesson included addition, subtraction, multiplication, and division problems (Jitendra, 2007). The three addition and subtraction schematic diagrams of change, group, and compare were taught individually, until students reached mastery as defined by successful completion of three mathematical word problems using the corresponding schematic diagram. This program, included scripted teacher directions with a display of ideal student responses. Jitendra (2007) described the scripted lesson as a model that should not be read verbatim. The program included one pre-assessment before the intervention began and a post-assessment after the intervention had ended. Each assessment had ten questions with either the addition or subtraction schematic diagrams. Since the pre and post-assessments were not norm-referenced, students utilized their testing accommodations (e.g., extended time, multiple sessions), as stated in their individual IEPs.

Math concepts and applications. AIMSweb M-CAP scores were also used for the assessment of students' problem solving skills in second through eighth grades. The assessment was administered in eight-minute increments and within a small group setting. M-CAP assessed problem-solving skills in the following domains for grades three through eight: number sense, number and operations, patterns and relationships, measurement, geometry, and data and probability. The assessment was administered three times a year in August 2013, January 2014, and May 2014. Since the M-CAP assessment was norm-referenced, students were unable to utilize their accommodations found in their IEPs. Mathematics teachers and experts in the U.S. reviewed M-CAP for content validity. Inter-rater reliability and alternate-form reliability were used when developing the M-CAP probes (Pearson, 2012).

Special education teacher interview. The special education teachers who implemented the schema-based instruction program were interviewed to gain their perception of the effectiveness and implementation of the program (see Appendix A).

Surveys. The general education teachers were surveyed to gain perceptions on schema-based instruction and student achievement related to this instruction. The survey included three Likert-scale questions, with responses ranging from ‘none’ to ‘always’ to the following prompts: ‘my students used the schema-based strategy when solving mathematical word problems,’ ‘the schema-based strategy helped my students solve mathematical word problems,’ and ‘my student(s) is more confident when solving mathematical word problems now compared to the beginning of the school year’ (see Appendix B).

Students were surveyed to gain perceptions of schema-based instruction. The Likert-scale survey consisted of five survey questions on a Likert scale, with responses ranging from ‘none’ to ‘always’ on the following prompts: ‘the diagrams helped me solve word problems,’ ‘the FOPS checklist helped me solve word problems,’ ‘change problems are easy for me to solve,’ ‘group problems are easy for me to solve,’ and ‘compare problems are easy for me to solve.’ Students in grades three through five had a picture response to eliminate reading, while students in grades six through eight had a word response (see Appendix C). Students were able to utilize their accommodations, as stated in their IEPs.

Data Analysis

Statistical analysis occurred on the following data: the pre and post-assessment, along with the M-CAP benchmark scores. The researcher conducted a *t*-test to find potential differences in means between the assessments and to answer null hypotheses one and two. A *Chi Square*, test along with a *t*-test were performed to find potential differences in means when analyzing the pre and post-assessment disaggregated data. The disaggregated data gathered from grades three through five-5 and grades six through eight, assisted the researcher in the analysis for null hypotheses one and two. Data was also disaggregated by each disability category, in order to help answer null hypotheses one and two.

For the survey data, a *t*-test was performed when finding a potential difference in means for responses to each question on the student survey. The *t*-test was an appropriate analysis due to the nineteen responses in each sample. A *Chi-Square* test along with a *t*-test was performed when finding a potential difference for each question on the general education teacher survey. A *Chi-Square* test along with a *t*-test was performed due to only four participant responses in the sample data.

When analyzing the qualitative data, the interviews were coded and analyzed, seeking common themes across all responses. The researcher created a pre-list of codes, based on the research questions. As the researcher analyzed the data, some codes were created to accurately depict the teachers' responses to each interview question. As the data were coded, the researcher wrote down ideas and connections to each research question. Coding the data assisted the researcher to develop common themes across all responses.

Summary

This study examined the use of schema-based instruction with students with an educational disability in grades three through eight in three different schools, within one single school district. The researcher collected and analyzed multiple sources of data, quantitative and qualitative, to measure student outcomes and student and teacher perceptions on the use of schema-based instruction. The researcher analyzed the data using a *t*-test for difference in means, descriptive statistics, and common themes from qualitative data and reported the results in Chapter Four. Chapter Five discusses the researcher's interpretation of the data along with recommendations for future studies.

Chapter Four: Results

Overview

This study investigated the achievement of students in grades three through eight, who were previously identified with an educational disability, using schema-based instruction on mathematical problem-solving skills. The researcher also explored the perceptions of special education teachers, general education teachers, and students on the schema-based instructional program in a Midwest school district. This chapter contains the results of the data analysis, which helped to answer the research questions and null hypotheses developed by the researcher. The data collected included pre and post-assessment data, transcribed special education interview responses, student survey responses, and general education teacher survey responses.

Research Questions

RQ1: How do special education teachers perceive the implementation of schema-based instruction?

RQ2: How do special education teachers perceive schema-based instruction and student achievement?

RQ3: How do general education teachers perceive schema-based instruction and student achievement?

Hypotheses

NH1: There is no increase in mathematical problem solving skills of students with an educational diagnosis through the use of schema-based instruction, as measured by a pre-to-post assessment.

NH2: There is no increase in AIMSweb Math Concepts and Application (M-CAP) benchmark scores of students with an educational diagnosis through the use of schema-based instruction.

NH3: Students will negatively perceive the schema-based instruction, as measured by a Likert-scale survey.

Qualitative Data

The researcher transcribed the interview responses provided by the special education teachers and coded the transcripts to determine common themes. Five themes and sub-themes emerged from analyzing the data: organization, routines and structures, language, individualization, and generalization. The researcher found a total of seven common themes related to each research question (see Table 3).

Table 3

Emerging Themes by Research Question

Themes	RQ1	RQ2
Organization	x	x
Routine/Structure	x	
Language	x	x
Individualization	x	
Generalization		x

The researcher analyzed the data generated by the Likert-scale survey by using descriptive statistics for each question from the general education teacher survey, along with the percentage of selection for each category (see Table 4).

Table 4

Descriptive Statistics of General Education Teacher Surveys

GE Teacher Survey Question	Average
1	1.75
2	1.75
3	2.25

Emerging Theme - Organization

Organization was a common theme in responses from five out of the six respondents. The researcher coded data with a letter, O, for organization when the interviewee mentioned the following words and/or descriptions: organize, plan, setup, and accessible. Two sub-themes of organization emerged: teacher organization and student organization. The researcher identified the sub-theme of teacher organization when the interviewee discussed how the materials were organized or easily accessible. The sub-theme of student organization emerged when the interviewee discussed how the materials helped the students organize the information to solve the word problem.

Three special education teachers discussed how the materials of schema-based instruction were organized. Participant ST5 described how two main parts of addition or subtraction and multiplication or division separated the program, ‘Each part followed the same pattern of introducing the problem type one at a time and then combining all the problem types toward the last few lessons.’ Participants ST5 and ST6 described how each lesson included a script informing the teacher what to say and how each lesson contained a material list. Participant ST6 also stated each lesson had answers to completed problems for the students. Participant ST2 noted how the checklists helped to organize the information and stated, ‘I like it [program], but I’m also a checklist person. I like the boxes like that.’ Participant ST2 also stated, ‘I think for some of the kids the organization helped. . . . They would use pieces from it [FOPS checklist].' All three of the special education teachers mentioned in the interview that the program was organized.

Five out of six special education teachers noted how the schema-based instructional program helped students organize information to solve a mathematical word problem. The responses in Table 5 list how students organized information to solve a mathematical word problem.

Table 5

Interview Responses Related to Students Organizing Information

Question No.	Special Education Teacher No.	Interview Responses
6	2	He was able to organize the information without looking at all the parts of it.
6	3	… and knowing how to setup the problem and knowing what was being asked.
6	4	I think it helped the kids to learn how to attack a word problem.
6	5	For some students, it may be helpful for setting up basic addition and subtraction word problems.
6	6	Students learned how to organize the information/numbers from the math problems.

The special education teachers referred to organization for schema diagrams and the FOPS checklist. The interview responses in Table 6 focused on organization when the special education teachers discussed the schema diagrams and FOPS checklist.

Table 6

Interview Responses Related to Organization Using Diagrams and Checklist

Special Education Teacher No.	Interview Responses
2	'I think the diagrams were effective for a way to organize the material.'
3	'That [FOPS checklist] seemed to help because they were putting in the operations, key words, vocabulary, and details that were needed for the problem solving.'
4	'I think the effectiveness of the diagrams lies in how they are setup.'
5	'[diagrams] provide a consistent visual to use when organizing information in a problem.'
6	'The FOPS is a consistent way to teach students to approach a problem.'

Emerging Theme – Routines or Structure

Another common theme in the special education teacher interview responses was routine or structure. The researcher coded with a letter, R, for routine when the interviewee mentioned the following words and/or descriptions: routines, structure, repetition, step-by-step, and sequential. Three out of the six special education teachers discussed how routine and/or structure were a key component of this program.

Table 7

Interview Responses Related to Routine and/or Structure

Question No.	Special Education Teacher No.	Interview Responses
1	1	'Probably the diagrams, checklists, routines, structure of it.'
1	3	'I have seen through the repetition and routine that they have improved over the course of time in that area [explaining their answer] in particular.'
1	4	'I think the fact that it is sequential…'

Table 7 provides participant responses to the characteristics of routine and structure of the key components of the program. Two special education teachers described how routine was important in the implementation process. Participant ST1 discussed how one must go step-by-step through the program by reading what is in the script and stated, '[The program] started out by going step-by-step through the book. Participant ST1 also stated positive comments related to having a script to follow and the structure of the program; 'I really like knowing what to say and the structure of it [the program].' Participant ST2 described the implementation process by the program as needing lots of repetition; '[The program] needs a lot of repetition and the checklists.'

Emerging Theme - Language

Language emerged as another common theme in the responses of the special education teachers. The researcher coded with a letter, L, for language when the interviewee mentioned the following words and/or descriptions: language and wordy. Two sub-themes emerged during the coding process: low language and the wordiness of the program. The sub-theme for low language included how the script and/or materials were too difficult for students with low language skills. The sub-theme for the wordiness of the program included how special education teachers perceived the script and/or materials as too wordy for students.

Two special education teachers noted the sub-theme of low language. Participant ST5 described the language and the materials (schema diagrams and FOPS checklist) as confusing for students; 'The language [of the program] becomes confusing for students with learning/language difficulties.' Participant ST5 also stated, 'Some of the steps [in the FOPS checklists] were unclear for students with learning/language issues,' and 'Some students with language weaknesses have difficulty understanding the parts of the [schema] diagrams.' Participant ST6 also described how the program was difficult for students who have language concerns, when questioned about the overall effectiveness of the program and stated, 'Low language kids tend to struggle with the wordiness [of the program].'

Three out of the six special education teachers referred to the sub-theme of the wordiness of the program. The three special education teachers described the ineffectiveness of the program, related to the wordiness of the materials/script (see Table 8).

Table 8

Interview Responses Related to Wordiness of the Program

Question No.	Special Education Teacher No.	Interview Responses
4	4	'The students were able to tell the correct problem type, but were not able to think through some of the language to put the numbers in the correct diagram.'
5	4	'Ineffectiveness was that it [the FOPS checklist] was rather wordy.'
5	5	'The [FOPS] checklist had too many steps to follow. It was wordy for students with reading problems.'
5	6	'There were a lot of words with FOPS and it made it difficult for the kids to follow it.'
6	4	'Some of the examples were not relevant. A lot of my kids didn't know what blossoms on the rose bush was. Some of the question types need to have real world examples or fourth grade friendly.'
6	4	'And I also thought the verbatim dialogue was too wordy. I paraphrased most of what the teacher says.'
6	5	'The script is overwhelming. It was difficult to pick out key information in the lesson.'

Emerging Theme - Individualization

Individualization emerged as a theme from the special education teachers' interviews. The researcher coded an "I" for individualization when the interviewee mentioned the following words and/or described the following words: create, extra, individualize, and make. Five out of the six special education teachers referred to the theme of individualization in responses about the program (see Table 9).

Table 9

Interview Responses Related Individualization

Question No.	Special Education Teacher No.	Interview Responses
2	1	'Then, some of my kiddos needed help so I made extra worksheets before moving ahead.' 'Found that as we worked through the different types of problems it was important to write my own follow-up problems.'
2	4	'I needed to create extra practice problems to help students understand.'
2	5	
4	6	'To help the kids understand the [schema] diagrams, I made additional problems.'
5	4	'To be most effective, they didn't want to read through most of it [FOPS checklist] so I had to try to make my own with fewer words.'
6	3	'I had to look at individual needs to determine what were needed. I individualized according to the needs.'
6	4	Some of the question types to have real world examples or fourth grade friendly. I ended up writing some of my own like video games or pizza so they could connect with it.'

Continued

Table 9. *Interview Responses Related Individualization* – Continued.

7	3	‘I staggered my groups so that I could have more time individually with students.'
7	3	‘He needed more help with the writing part of the program. That was challenging for him. I looked at needs of students, individualized for the best I could and I saw progress so that’s how I did it.'
7	4	‘I thought the additional supports [teacher-created problems] in there that it was very effective. I think it was helpful when I took one type of problem and I had the same people and items in the problem and changed the type of problem. They saw that the same story could be used in three different problem types.'
8	2	‘I thought the additional supports [teacher-created problems] in there that it was very effective. I think it was helpful when I took one type of problem and I had the same people and items in the problem and changed the type of problem. They saw that the same story could be used in three different problem types.'
8	3	‘I saw the benefits of it [program] and I did like the way I setup to individualize.'
8	4	‘I would probably continue to use additional examples and ways to tell the different types of problems.'

Emerging Theme - Generalization

Another common theme among the special education teachers’ interview responses was generalization. The researcher coded with a letter, G, for generalization when the interviewee mentioned the following words/phrases and/or descriptions: transfer, general education, and generalize. Two of the special education teachers spoke positively about generalizing the schema-based instruction into the curriculum and/or general education classroom (see Table 10).

Table 10

Positive Interview Responses Related to Generalization

Question No.	Special Education Teacher No.	Interview Responses
2	4	‘The strategy can be used across [the] math curriculum and *Math In Focus*. Oh, look at that! This is a compare problem. This would help students generalize across the board.’
4	3	‘I saw a positive outcome with the fourth grade student. I spoke with her teacher. He came in and said oh she uses this [schema diagrams] when she does word problems. It was great to see her generalize this process.’

Table 11

Negative Interview Responses Related to Generalization

Question No.	Special Education Teacher No.	Interview Responses
4	5	‘The procedures/diagrams do not match the diagrams taught in the general education curriculum.'
4	6	‘The kids are learning different strategies in the general education classroom. The classroom teachers need to be familiar with the diagrams.'
6	5	‘The procedures do not match the procedures being taught in the general education curriculum.'
7	6	‘Learning doesn’t transfer easily to the general education classroom.'
8	5	‘I would not use it [program] at this point in time. The general education curriculum that my students are using addresses word problems using visuals like bar models.'
8	6	‘I do not think I would use it again. Like I said before, it [learning] doesn’t transfer well to the general education classroom.'

Two of the special education teachers negatively viewed the schema-based instruction generalizing into the general education curriculum and/or general education classroom (see Table 11).

Quantitative Data

Null Hypothesis #1: There is no increase in mathematical problem solving skills of students with an educational diagnosis through the use of schema-based instruction, as measured by a pre-to-post assessment.

The researcher performed a *t*-test for difference in means at a 95% confidence level between the pre and post-assessment data gathered from the schema-based instructional program. This calculation produced a *t*-test score that established a difference of means between the two samples.

Pre and Post-Assessments

At the beginning of the 2013-2014 school year, 21students participated in a pre-assessment and then completed a post-assessment toward the end of the 2013-2014 school year. Jitendra (2007) developed the pre and post-assessment for the program titled, *Solving Math Word Problems: Teaching Students with Learning Disabilities Using Schema-Based Instruction,* which included eight questions. After gathering the pre and post-assessments scored by the teachers, the researcher rescored the assessments to ensure fidelity. The researcher organized the raw data in a table and displayed the difference between the pre and post-assessment, which indicated the amount of student growth (see Table 12). The use of pseudonyms maintained anonymity for students who generated the scores, used as secondary data for purposes of this study.

Table 12

Pre and Post-Assessment Raw Data – Problem Solving

Participants	Pre-	Post-	Difference
Abe	25	63	38
Betsy	0	38	38
Charles	0	38	38
Dylan	63	100	37
Elizabeth	50	50	0
Frank	50	38	-12
George	13	38	25
Heidi	75	75	0
Isabella	25	50	25
Jazmine	0	38	38
Kim	0	28	28
Laura	88	63	-22
Manuel	0	25	25
Nanci	38	50	12
Olivia	25	25	0
Penelope	63	75	12
Quentin	0	25	25
Rasheed	25	50	25
Samantha	63	100	37
Tyson	13	50	37
Ursula	50	63	13

After displaying the raw data, the researcher calculated the means. The researcher noted an increase in mean score from pre-to-post-assessment. The pre-assessment mean of 31.7 and the post-assessment mean of 51.2 resulted in an increase of 19.5. The researcher then performed a *t*-test for difference in means between the pre and post-assessment data, which generated a *t*-test value of 2.53, then compared to the critical value of 1.68. Based on these results, the researcher concluded a statistically significant difference between the pre and post-assessment. Therefore, the researcher rejected Null Hypothesis #1, that there is no increase in mathematical problem solving skills of students with an educational diagnosis through the use of schema-based instruction, as measured by a pre-to-post assessment, and supported a significant increase in scores (see Table 13).

Table 13

T-Test of Pre and Post-Assessment

	Post	Pre
Mean	51.5238	31.7142
Variance	489.3619	796.8142
Observations	21	21
Pooled Variance	643.0880	
Hypothesized Mean Difference	0	
df	40	
t Stat	2.5312	
P(T<=t) one-tail	0.0077	
t Critical one-tail	1.6838	

Null Hypothesis #2: There is no increase in AIMSweb Math Concepts and Application (M-CAP) benchmark scores of students with an educational diagnosis through the use of schema-based instruction (fall and spring).

The researcher performed a *t*-test to determine a difference in means between the fall and spring M-CAP assessment data at a 95% confidence level. This calculation produced a *t*-test score that established no difference of means between the two samples.

Similar to the pre and post-assessment in the schema-based instructional program, students also completed the M-CAP curriculum based measurement in the fall, winter, and spring. For the purpose of this study, the researcher used scores from the fall and spring as a pre and post-assessment secondary data. M-CAP assessed problem-solving skills on concepts taught in grades two through eight. Twenty out of the 21 students took the M-CAP assessment in the fall. One student was ill when the class participated in the assessment and a make-up assessment was not provided. The researcher used national percentages, instead of raw scores to compare multiple grade levels. The raw scores for each grade level represented differing national norms, dependent on the grade level of the test-taker. The researcher displayed the national percentage for each participant on the fall and spring M-CAP assessment, and displayed student growth represented by the difference (see Table 14).

Table 14

M-CAP Fall and Spring Raw Data

Participants	Fall (National Percentage)	Spring (National Percentage)	Difference
Abe	1	18	17
Betsy	1	1	0
Charles	1	10	9
Dylan	1	8	7
Elizabeth	1	1	0
Frank	1	1	0
George	9	1	-8
Heidi	23	1	-22
Isabella	12	5	-7
Jazmine	1	1	0
Kim	1	1	0
Laura	N/A	4	N/A
Manuel	1	1	0
Nanci	7	1	-6
Olivia	5	4	-1
Penelope	2	4	2
Quentin	1	1	0
Rasheed	1	1	0
Samantha	47	70	23
Tyson	36	83	47
Ursula	71	72	1

After displaying the raw data, the researcher calculated means. The researcher noted an increase in means from the fall to spring M-CAP assessment, with a fall mean of 11.15 and a spring mean of 14.25; which indicated an increase of 3.07. The researcher then performed a *t*-test for difference in means between the pre and post-assessment data at a 95% confidence level. The *t*-test value was 0.42, then compared to the critical value of 1.68 (see Table 15). Based on these results, the researcher did not reject Null Hypothesis #2, there is no increase in AIMSweb M-CAP benchmark scores of students with an educational diagnosis through the use of schema-based instruction, when comparing fall and spring assessment data.

Table 15

T-Test between fall and spring M-CAP

	Spring (National Percentage)	Fall (National Percentage)
Mean	14.250	11.150
Variance	708.829	363.292
Observations	20.000	20.000
Pooled Variance	536.061	
Hypothesized Mean Difference	0.000	
df	38.000	
t Stat	0.423	
P(T<=t) one-tail	0.337	
t Critical one-tail	1.686	

Pre and Post-Assessment Data by Disability Category

Initially, the researcher planned to perform a *t*-test to determine a significant difference in means between pre and post-assessment data by disability category. Since the overall sample size was low, each disability category lacked enough participants to perform a *t*-test to find a difference in means. The researcher used descriptive statistics to compare the differences between the pre and post-schema-based instructional program assessment of each disability category and the mean difference of all participants (see Table 16).

The researcher also used descriptive statistics to compare the differences between the fall and spring M-CAP assessment data of each disability category and the mean difference of all participants (see Table 17).

Table 16

Disability Category Descriptive Statistics of Pre and Post-Assessment Data

Disability	Number of Participants	Pre-	Post-	Difference between Pre and Post-	Mean Difference of All Participants	Difference
Autism	12	29.25	46.08	17.08	19.9	-2.72
Learning Disability	4	41	65.75	24.75	19.9	4.95
Other Health Impairment	2	31.5	56.5	25	19.9	5.2
Intellectual Disability	2	44	62.5	18.5	19.9	-1.3
Emotional Disturbance	1	0	28	28	19.9	8.2
Language Impairment	2	56.5	62.5	6	19.9	-13.8

Table 17

Disability Category Descriptive Statistics of M-CAP

Disability	Number of Participants	Fall	Spring	Difference between Pre and Post-	Mean of All Participants	Difference
Autism	12	7.91	8.91	1	3.1	-2.1
Learning Disability	4	28.75	38.75	10	3.1	6.9
Other Health Impairment	2	4	9.5	5.5	3.1	2.4
Intellectual Disability	2	7	4.5	-2.5	3.1	-5.6
Emotional Disturbance	1	1	1	0	3.1	-3.1
Language Impairment	2	15	1	-14	3.1	-17.1

The researcher noted means of specific disabilities, autism, intellectual disability, and language impairment, were lower than the average mean of all participants on both the schema-based instructional program pre and post-assessment and the M-CAP fall and spring assessment. The researcher also noted the means of LD and OHI were higher than the average mean of all participants on both the schema-based instructional program pre and post-assessment and the M-CAP fall and spring assessment. There was only one participant in the sample with a disability of ED. The ED participant's mean was higher on the schema-based instructional program pre and post-assessment, but lower on the M-CAP fall and spring assessment.

Pre and Post-Assessment Data by Grade Spans

Initially, the researcher planned to perform a *t*-test to determine a possible statistical difference in means between participants in grades three through five and participants in grades six through eight. There were more participants in grades six through eight, n = 17, than grades three through five, n = 4. Due to the low sample size in each grade span, the researcher was unable to perform a valid *t*-test to find a statistical difference in means. The researcher used descriptive statistics to compare the differences between participants in grades three through five and participants in grades six through eight (see Table 18).

Table 18

Pre and Post-Assessment Mean by Grade Span

Grade Span	Pre-	Post	Difference
3-5	37.75	69	31.25
6-8	30.3	47.4	17.1

The researcher used descriptive statistics to compare the differences between participants in grades three through five and participants in grades six through eight for schema-based instructional program pre and post-assessment (see Table 19). The researcher noted that participants in grades three through five had a higher mean on both assessments, compared to participants in grades six through eight.

Table 19

M-CAP Mean by Grade Span

Grade Span	Fall (National Percentage)	Spring (National Percentage)	Difference
3-5	38.75	60.75	22
6-8	4.25	2.63	-1.62

General Education Teacher Perception Survey

Four general education teachers in one school completed a survey to allow the researcher to gain perceptions of the schema-based instructional program. Each teacher had at least one student who received schema-based instruction in his or her classroom. The survey consisted of three questions on a Likert scale, ranging from 1 (none) to 5 (always). The researcher's intent was to determine whether significant difference in means existed by performing a *Chi-Square* test. However, since the number of general education teachers available to complete the survey was low, the researcher was unable to perform the test. The researcher used descriptive statistics to analyze the survey results.

From the general education teachers' responses, the researcher calculated the mean for each question, based on the 1-to-5, none-to-always Likert scale. The first two questions focused on the schema-based strategy while the third question asked the teacher about the students' confidence when solving math word problems. Survey questions #1 and #2 averaged a 2.75 response rating, leaning toward the middle, between 'rarely' and ‘some.’ The third question averaged a 3.25 response rating, leaning toward the middle between ‘some’ and ‘frequently.’

After examining the mean for each response, the researcher analyzed the percentage of each response by category, to each question. All participant responses ranged between ‘rarely’ (2) and ‘frequently’ (4) (see Table 20).

Table 20

Percentages of General Education Teacher Survey Responses

	None	Rarely	Some	Frequently	Always	Total Respondents
Q1	0	50	25	25	0	4
Q2	0	50	25	25	0	4
Q3	0	0	75	25	0	4

Two out of the four general education teachers responded to the statement at the end of the survey, ‘Describe the effectiveness of the schema-based instruction’ (see Table 21).

Table 21

Specific Responses from General Education Teacher Survey

General Education Teacher No.	Survey Responses
1	‘Student was a bit more willing to work through problems and discuss how/why to solve a problem a particular way.'
2	‘My student that received schema-based strategy instruction has become much better at organizing and solving word problems. I have noticed more attention to detail when solving problems. My student takes more time to work through word problems and has more to share when we discuss solving strategies as a class or in small groups.'

Student Surveys

Null Hypothesis #3: Students will negatively perceive the use of schema-based instruction, as measured by a Likert-scale survey.

The researcher performed an ANOVA test to determine potential difference in means between student survey responses of ‘yes,’ ‘some,’ and ‘no.’ The ANOVA was able to inform the researcher if there were differences among the three groups; however it did not identify which group (‘yes,’ ‘some,’ or ‘no’) was significantly different from another. In order for the researcher to determine a significant difference between comparisons of the three groups individually, a test for difference in means was then performed on ‘yes’ and ‘some’ and also on ‘yes’ and ‘no.’ This calculation produced a *t*-test value that established the difference of means between two groups

Every student participant completed a student perception survey, which consisted of five positive statements on a Likert scale. The Likert scale ranged from 1 (no) to 3 (yes). Nineteen participants completed the survey, and all participants completed questions #1 to #4, while only nine completed the last question. All students could not answer question #5, since only nine participants mastered ‘compare problems’ by the time the school year ended (see Table 22).

Table 22

Student Survey Percentages and Completion Rate by Question

	NO	SOME	YES	Total # of Respondents
Q1	0	42	58	19
Q2	11	31	58	19
Q3	32	36	32	19
Q4	21	21	58	19
Q5	22	56	22	9

From the survey data, the researcher applied an ANOVA and determined whether there was a difference in means between the three groups (see Table 23).

Table 23

ANOVA Summary

Groups	*Count*	*Sum*	*Average*	*Variance*
NO	5	86	17.2	147.7
SOME	5	186	37.2	169.7
YES	5	228	45.6	300.8

The *F*-test ratio was 5.165, described by Bluman (2010) as large and the *p*-value was 0.0240 described by Bluman as small. The researcher determined the amount of variance was larger between groups than within groups In addition, the *F*-test ratio of 5.165 was larger the *F*-critical value of 3.885 and the *p*-value of 0.0240 was smaller than the α-value of 0.05; therefore the researcher rejected the null hypothesis, and the data supported that a significant difference existed between the groups. The null hypothesis, students will negatively perceive the effectiveness of schema-based instruction, as measured by a Likert-scale survey, was rejected (see Table 24).

Table 24

Student Survey Analysis

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2128.5	2	1064.3	5.16	0.0240	3.8852
Within Groups	2472.8	12	206.1			
Total	4601.3	14				

From data provided for the ANOVA, the researcher then analyzed for a difference between groups (‘yes’ and ‘some’ or ‘yes’ and ‘no’) by applying a *t*-test for difference in mean. Since the *t*-test value of 0.866 was less than the *t*-critical value of 1.860, no significant difference existed between those who responded ‘yes’ and ‘some;’ the researcher did not reject the null hypothesis that students will negatively perceive the effectiveness of schema-based instruction, as measured by a Likert-scale survey (see Table 25).

Table 25

T-Test between Yes and Some

	YES	SOME
Mean	45.6	37.2
Variance	300.8	169.7
Observations	5	5
Pooled Variance	235.25	
Hypothesized Mean Difference	0	
df	8	
t Stat	0.8659	
P(T<=t) one-tail	0.2058	
t Critical one-tail	1.8595	

The researcher performed a *t*-test for difference in means to determine a possible significance between the 'yes' and 'no' group of respondents. Since the *t*-test value of 2.999 was larger than the *t*-critical value of 1.860, there was a significant difference between the 'yes' and 'no' group of respondents, and the 'yes' percentage of 45.6% was larger than the 'no' percentage of 17.2%.

Table 26

T-test between Yes and No

	YES	NO
Mean	45.6	17.2
Variance	300.8	147.7
Observations	5	5
Pooled Variance	224.25	
Hypothesized Mean Difference	0	
df	8	
t Stat	2.9986	
P(T<=t) one-tail	0.0085	
t Critical one-tail	1.8595	

Therefore, the researcher did reject the Null Hypothesis #3 that students will negatively perceive the effectiveness of schema-based instruction, as measured by a Likert-scale survey, and data supported a non-negative, or positive, perception of schema-based instruction in the classroom by students (see Table 26).

Summary

This data analysis supported the use of schema-based instruction with students with an educational disability, based on qualitative data gathered from interviews and quantitative data from the pre and post-schema-based program assessment, and reinforced the then-current literature presented in Chapter Two. However, M-CAP assessment data did not demonstrate the same amount of growth as the schema-based program assessment. In addition, the analysis also displayed discrepancies in special education and general education teachers' overall perceptions of the schema-based instructional program. Data analysis discussion and reflection are discussed in Chapter Five.

Chapter Five: Discussion and Reflection

Introduction

As mentioned in the literature review, numerous studies conducted by Jitendra and associates (1996, 1998, 2002, 2007, 2010, 2011) indicated positive academic results of schema-based instruction on students with a wide variety of disabilities, and noted schema-based instruction helped close the achievement gap and teach students with an educational disability to solve mathematical word problems (Adams et al., 2007; Church et al., 2013; Deatline-Buchmann et al., 2005; Fang et al., 2015; Fede et al., 2013; Griffin & Jitendra, 2009; Jitendra et al., 2002; Jitendra et al., 1998; Jitendra et al., 2010; Jitendra & Hoff, 1996; Rockwell et al., 2011). The purpose of this study was to measure student achievement on mathematical problem solving skills for students in grades three through eight, previously identified with an educational disability, after schema-based instruction. The researcher measured student achievement by using both a pre and post-assessment and M-CAP benchmark scores on mathematical problem solving. In addition, the researcher was interested in gathering special and general education teachers' and students' perceptions of schema-based instruction through surveys and interviews.

The researcher analyzed data from a pre and post-schema-based instructional program assessment and M-CAP benchmark scores. The researcher performed a *t*-test for difference in means on both sets of assessments. On the schema-based instructional program assessment, the researcher discovered a statistically significant difference. However, there was not a statistically significant difference when analyzing the secondary data, M-CAP benchmark scores. The researcher then disaggregated the assessment scores by disability category and also by grade span. The researcher noted the mean scores of participants with autism, intellectual disability, and language impairment were lower than the average mean scores of all participants on both the schema-based instructional program pre and post-assessment and the M-CAP fall and spring assessment. The researcher also noted the mean scores of students with LDs and OHIs were higher than the average mean of all participants on both the schema-based instructional program pre and post-assessment and the M-CAP fall and spring assessment. The researcher concluded participants in grades three through had a higher difference in mean scores on both assessments, compared to participants in grades six through eight.

The researcher also analyzed data gathered in interview responses and surveys by all the participants in the study. After coding the six special education teachers' interview responses, several themes emerged: organization, routine or structure, language, individualization, and generalization. The researcher also analyzed student survey data and determined a significant difference between the mean ratings of the 'yes' and 'no' survey prompt answers. Finally, the researcher analyzed the four general education teachers' survey results and found two questions leaned to the negative direction, related to schema-based instruction. The third question on problem solving leaned to the positive direction, when calculating the mean rating response.

Research Questions

RQ1: How do special education teachers perceive the implementation of schema-based instruction?

RQ2: How do special education teachers perceive schema-based instruction and student achievement?

RQ3: How do general education teachers perceive schema-based instruction and student achievement?

Hypotheses

H1: There is an increase in mathematical problem solving skills of students with an educational diagnosis through the use of schema-based instruction, as measured by a pre-to-post assessment.

H2: There is an increase in AIMSweb Math Concepts and Application (M-CAP) benchmark scores of students with an educational diagnosis through the use of schema-based instruction.

H3: Students will positively perceive the schema-based instruction, as measured by a Likert-scale survey.

Discussion of Findings

Research Question 1. How do special education teachers perceive the implementation of schema-based instruction?

When analyzing the special education teacher interview responses, several themes emerged, related to the implementation process: individualization, organization, language, and routine or structures. The majority of special education teachers needed to modify or individualize instruction to meet the needs of all students. As part of special education, each child received an IEP (Project IDEAL, 2013). In the researchers' experience, an individualized plan for students with an educational disability appeared 'logical.' A common way to individualize instruction was by creating word problems to match student interest or background knowledge and to ensure students mastered each problem type. The special education teachers also noted the organization of the program;

specifically the scripts the program provided. Jitendra (2007) intended the scripts not to be read verbatim, but to be used as a guide for expected teacher and student language. The language of the materials appeared too wordy for some of the students. Therefore, special education teachers attempted to minimize the wordiness to meet students' needs.

The special education teachers also discussed the routine or structure of the program. Implementation required repetition of the tools, including the FOPS checklist and the schema diagrams. Some special education teachers stressed the importance of consistently providing these tools, especially in the beginning, until students demonstrated mastery. Jitendra (2007) discussed the importance of providing the tools in the beginning and slowly fading the use of the tools as student's demonstrated mastery of the material.

Research Question #2. How do special education teachers perceive the schema-based instruction and student achievement?

When analyzing the special education teacher interview responses, several themes emerged, related to student achievement after using schema-based instruction: organization, language, and generalization. The majority of special education teachers perceived the schema-based instructional program helped students organize how to solve mathematical word problems. The special education teachers perceived that the FOPS checklist and schema diagrams also helped students organize during problem solving. As stated in the research, students who struggled with mathematical problem solving required a way to organize the word problem for greater understanding. Once the problem was organized, students had a better chance of solving the problem correctly (Fede, 2010; Jitendra, 2007; r4 Education Solutions, 2010).

The special education teachers noted the theme of language, as related to the schema-based instruction and student achievement. Two special education teachers reported students who struggled in the area of language had a difficult time when using schema-based instruction. Special education teachers also shared students who were language impaired struggled with this program, due to the wordiness of the program, including the FOPS checklist and the schema diagrams. Therefore, the special education teachers perceived student achievement would decrease for students who struggled in the area of language.

The special education teachers also discussed the theme of generalization related to student achievement after the use of the schema-based instructional program. Two special education teachers perceived the program as having a positive outcome on student achievement as students were able to generalize mathematical problem solving skills in a general education classroom/curriculum; two other special education teachers perceived the program as ineffective related to student achievement, because students were unable to generalize the skills/strategies from the program. Two of the special education teachers perceived the program/strategies were easily transferrable into the general education classroom. One teacher discussed how the different diagrams appeared helpful when solving word problems found within the district curricular materials. The other teacher heard from one of the students' general education teachers, diagrams were also used in the classroom when solving mathematical word problems.

Generalizing strategies across settings was vital when students were learning a new skill. If generalization occurred, student achievement improved. Two other special education teachers perceived students' level of difficulty related to generalizing skills/strategies, when using the schema-based instructional program. Students became confused on which strategy to follow, since the schema-based instructional program was different than what was taught in the students' general education classrooms. Students with a disability needed consistency across the school day, especially when strategies were presented in a specific area(s) of deficit. The two teachers stressed an inability of students to transfer strategies (diagrams and FOPS checklist) into other word problems not in the program. Both teachers decided not to use this program in the future.

Research Question #3. How do general education teachers perceive schema-based instruction and student achievement?

Four general education teachers completed a survey to share perceptions of schema-based instruction and student achievement. The survey consisted of three questions with the responses using a Likert scale from 1-to-5, none-to-always. The first two questions directly asked the teacher about the schema-based strategy, while the third question asked the teacher about the students' confidence when solving math word problems. The responses to the first two questions related to the schema-based strategy leaned to the negative direction. The general education teachers did negatively view the schema-based instructional program, as helping students solve mathematical word problems in their classrooms. During the 2013-2014 school year, the district where the study was conducted implemented a new mathematical curricular program called *Math In Focus*, based on the Singapore math curriculum. This program stressed the concrete-pictorial-abstract instructional (CPA) process and used bar models (visual depictions) to teach methods to solve mathematical word problems (Cavendish, 2013). While learning to implement this program, the general education teachers had difficulty stressing the schema-based instructional strategies, while also stressing the strategies taught in the students' everyday curriculum. In addition, the researcher did not personally discuss the schema-based program with the general education teachers. The two special education teachers were responsible for communicating with the general education teachers and helping them to understand the strategies (FOPS checklist, schema diagrams, etc.) that each student learned, in order for students to generalize specific skills.

While the first two questions specifically addressed the schema-based strategies and leaned to the negative direction, the third question related to students' confidence when solving mathematical word problems leaned to the positive direction. The third question did not directly relate to the schema-based instruction. Therefore, since the first two questions leaned to the negative direction, the researcher concluded that the general education teachers' perception of an increase in students' confidence level from the third question could not be linked to the schema-based instructional program. As stated above, the special education and general education teachers exposed students to multiple ways to solve mathematical word problems. The schema-based strategies and the strategies taught in the *Math In Focus* both assisted students in increasing their confidence levels.

Hypothesis #1. There is an increase in mathematical problem solving skills of students with an educational diagnosis through the use of schema-based instruction, as measured by a pre-to-post assessment.

The analysis of the schema-based instructional program pre and post-assessment data support Hypothesis #1. The analysis did support an increase in the mathematical problem solving skills of students with a diagnosed educational disability through the use of schema-based instruction. Most students (19 out of 21) increased their mathematical problem solving skills, as measured by this assessment. The schema-based instructional program had many best practices/strategies in the area of mathematics and in the area of supporting students with disabilities: the pictorial and abstract part of the CPA instruction process, a checklist with a mnemonic strategy, graphic organizers (schema diagrams), use of a reading comprehension strategy of retelling in one's own words, use of a think-aloud strategy, cooperative learning, and word problems with real world application. Along with the best practices/strategies, the program provided teachers with a detailed script. This detailed script provided teachers with a tool to ask appropriate questions and provided a means to elicit responses from students. The script included exemplary student responses to provide teachers with a tool for prompting student responses and encouraging growth towards mastery. In addition, the researcher believed the author, Jitendra (2007), organized the program in a logical manner and was practical for teacher use. The researcher concluded the use of the best practices/strategies and an organized, detailed program aided in the increase of mathematical problem solving skills in students with a disability.

Hypothesis #2: There is an increase in AIMSweb Math Concepts and Application (M-CAP) benchmark scores of students with an educational diagnosis through the use of schema-based instruction.

The analysis of the AIMSweb M-CAP assessment data did not support the Hypothesis #2. Student data did not show an increase in mathematical problem solving skills, based on the secondary data, M-CAP national percentages. The researcher believed this occurred since M-CAP assessed more than just mathematical problem solving skills in word problems; it also assessed problem solving skills in the following non-word problem domains for grades three through eight: number sense, number and operations, patterns and relationships, measurement, geometry, and data and probability. The questions in these non-word problem domains revealed schema-based instruction did not increase a student's overall ability to solve problems that were not word problems. This study only directly examined if a student's mathematical word problem solving increased. The schema-based instructional program was supplemental to a student's regular mathematical curricular materials.

Another reason for the lack of growth on the M-CAP benchmark assessment was this tool assessed students on grade-level standards. Students who received specialized instruction in the area of math from a special education teacher may not understand grade-level concepts in the domains of number sense, measurement, and geometry. The schema-based instructional program and assessment remediated and assessed skills on a student's individual instructional level. Students in the general education classroom mastered addition and subtraction word problems and generally worked on mastering more complex skills. The students in this study had not mastered these basic skills included in the study, because the students lacked foundational mathematical problem-solving skills.

Hypothesis #3: Students will positively perceive schema-based instruction, as measured by a Likert-scale survey.

The analysis of the student survey data did support the Hypothesis # 3, students would positively perceive schema-based instruction, as measured by a Likert-scale survey. The analysis supported student's positively perceived schema-based instruction due to the significant difference between the 'yes' and 'no' groups. Since most students demonstrated growth on their pre and post-schema-based instructional assessments, the researcher believed the students developed greater confidence in an ability to succeed.

The researcher analyzed the participants' student survey responses by question, to determine which statements the students answered more frequently as 'yes.' The students rated statement #1 (The diagrams helped me solve word problems) and statement #2 (The FOPS checklist helped me solve math word problems) more frequently in the 'yes' category, with few or no responses in the 'no' category. The first two questions specifically targeted the strategies used in the schema-based instruction program, including the visual diagrams and checklist. Both strategies were 'best practice' in the area of mathematics for helping all students, especially students who struggled in problem solving. Questions #3, #4, and #5 related to the three different addition/subtraction problem types (change, group, and compare) and had a higher student selection of 'no' than the questions #1 and #2. Teachers directly taught these diagrams in the program so students could differentiate between the three schema diagrams to solve a wide variety of mathematical word problems. Being able to distinguish between the three diagrams was a difficult task for the students. The researcher believed the students rated questions #3, #4, and #5 not as positively as questions #1 and #2, because the students struggled with the skills.

Disability Categories

Since the overall sample was low, the researcher used descriptive statistics to compare the difference between the pre and post-assessment of each disability category and the mean difference of all participants. The researcher analyzed the mean scores of students with autism, intellectual disability, and language impairment, lower than the average mean of all participants on both the schema-based instructional program pre and post-assessment and the M-CAP fall and spring assessment. The literature review supported students with autism, an intellectual disability, or a language impairment struggled with language concepts (Fede et al., 2013; Rockwell et al., 2011). One of the emergent sub-themes from the special education teachers' responses was the difficulty of the schema-based instruction for students with low language. The teachers described how the script and/or materials were too difficult for students who struggled in this area. The pre and post-assessment data for the disability categories of students who struggled in the area of language complemented the theme from the special education teachers' responses that students with low language struggled with schema-based instruction, leading the researcher to conclude schema-based instruction was difficult for students who struggled in the area of language.

The researcher also noted the mean of students with an LD and OHI were higher than the average mean of all participants on both the schema-based instructional program pre and post-assessment and the M-CAP fall and spring assessment. The literature review supported this result; students with an LD or OHI benefitted from strategies like the visual schema diagrams and the FOPS checklist presented in the schema-based instructional program (Jitendra, 2007). The researcher also found these six students had an average IQ, as stated in the special education eligibility report.

Grade Span

Since the sample size was low, the researcher used descriptive statistics to compare the differences between participants in grades three through five and participants in grades six through eight. The researcher noted that participants in grades three through five had a higher difference in mean on both assessments compared to participants in grades six through eight. The students in grades three through five spent more of the school day in the general education classroom than the students in grades six through eight. Therefore, the IEP teams of the students in grade three through five decided these students were capable of grasping grade level concepts, while receiving remediation in the area of mathematics from the special education teachers. In addition, all students received instruction in the schema-based instructional program in addition and subtraction word problems; more appropriate for students in three through five. Teachers taught the students in grades six through eight multiple ways to solve addition and subtraction word problems. Jitendra (2007) stated older students might have greater difficulty learning the schema-based instruction, because of an exposure to multiple ways to solve a mathematical word problem. The students in grades six through eight also struggled repeatedly with solving word problems during elementary years. The researcher believed secondary teachers (6-12) had high expectations for students to learn the content while elementary teachers (K-5) had high expectations for students to fully understand and to fully apply the concepts taught. The researcher concluded schema-based instruction might have come easier for elementary teachers than secondary teachers, due to an expectation of conceptual versus content understanding.

Recommendations for Future Studies

This mixed-method study supported the use of schema-based instruction, especially when using Jitendra's (2007) program, *Solving Math Word Problems: Teaching Students with Learning Disabilities Using Schema-Based Instruction*, for students with an educational disability. The researcher discovered commonalities between this study and previous studies involving schema-based instruction conducted by other researchers (see Table 17). These previous studies assisted the researcher in developing this study and in determining recommendations for future studies in the area of mathematical problem solving using schema-based instruction (see Appendix D).

The researcher recommends, in future studies, a larger sample size of students with an educational disability and which received specialized instruction in the area of mathematical problem solving, for statistical analysis to occur. An increase in the number of participants would allow for generalization of the results; an increase the number of participants would also better reflect the population as a whole. A larger participant population would have allowed the researcher to determine the significant differences with greater clarity.

The researcher had hoped to determine a significant difference in the areas of disability categories and grade span based on the pre and post-assessment data. Due to the low number of participants, the researcher used descriptive statistics. The researcher recommends an increase in the number of participants in both of these areas, to promote better generalization of the study to the larger population for future studies and to provide educators with specific selection criteria. If the findings supported using schema-based instruction with students with an intellectual disability, an educator could select schema-based instruction. However, if there were more students with an intellectual disability in this study and the researcher found schema-based instruction was not beneficial, then an educator would be advised not to use schema-based instruction and to find another research-based intervention.

The researcher believed additional information would have improved this study; specifically: this study could have included a maintenance mathematical problem solving assessment to determine if the students were able to maintain the skills gained from the schema-based instruction. Students who struggled with memory retention when learning a new strategy like schema-based instruction needed to retain the skills or strategies taught by the educators. Since retention was very important, the researcher should have interviewed general education teachers who participated in the study. Additional qualitative information would have provided the researcher insight into students generalizing strategies into the general education classroom. Students with a disability, specifically autism, struggled with generalizing skills across environments.

The researcher also recommends conducting a comparison study between the schema-based instruction approach and the general-strategy instruction approach presented in the district's curricular materials, *Math in Focus*. The *Math in Focus* curricular materials based on the Singapore math approach utilized a visual representation of bar models for students to solve mathematical word problems. By doing a comparison study, the researcher could make additional recommendations to the district regarding the use of both approaches with students who received special education services.

Additionally, the researcher recommends including general education students in the study. By including general education students, the study would have added to the growing body of literature supporting the use of schema-based instruction with students in the general education environment. Including general education students would have allowed the researcher to make additional recommendations to the researched district about mathematical problem solving approaches.

The researcher recommends a different instructional approach for students with an intellectual disability or a language impairment, since the means of specific disabilities, intellectual disability and language impairment, were lower than the average mean of all participants on both the schema-based instructional program pre and post-assessment and the M-CAP fall and spring assessment. Additionally, the theme of language emerged from the special education teachers' responses related to the wordiness of the program, and students with low language struggled with the schema-based instructional program. Furthermore, the previous studies discussed in Chapter Two did not include participants with a language impairment or an intellectual disability. With no previous studies, the researcher added to the body of literature on the use of schema-based instruction with students with an intellectual disability or a language impairment; the researcher recommends further studies investigate the use of schema-based instruction on students with an intellectual disability or a language impairment.

Fang et al., in 2015, conducted a study utilizing a simplified schema-based instructional approach with second grade students. The researcher recommends the simplified schema-based instructional approach, or a version of the simplified schema-based instructional approach, with students diagnosed with an intellectual disability or a language impairment as an alternative approach, due to the shortened routine with less memorization and less language. Again, the researcher would caution the future researcher, related to the small sample size of students diagnosed with an intellectual disability and a language impairment making it difficult to generalize the results of the study.

During the 2013-2014 school year, the elementary schools in the district adopted new mathematical, curricular materials tied to the CCSS. When adopting new curricular materials, additional training and time was utilized in preparing both general and special education teachers. The researcher would not recommend conducting a study with additional training in the same subject at a school then-currently going through a materials adoption.

Recommendations for District

The researcher had several recommendations for the district for the continued use of the schema-based instructional program. Originally, the researcher recommended educators utilize schema-based instruction with students with an education disability that impaired their mathematical problem solving abilities. The researcher would caution the district to add this program to the list of successful interventions for special education teachers to select, based on the needs of the students. The researcher disagreed educators should use this program with every student and this schema-based instructional program should not be the primary curricular material implemented for any student. The schema-based instructional program only covered mathematical word problems and did not cover all the other grade-level standards (e.g., place value, fractions, geometry, etc.) The researcher stresses schema-based instruction was a tool for an educator's toolbox to utilize when a student was not making adequate progress with solving mathematical word problems.

For this program to lead to increased academic outcomes in the researched district, additional training would need to occur with both special and general education teachers and include training similar to that provided to special education teachers in this study; specifically understanding of word problem schemas. Teachers needed fluency in the identification of appropriate schematic diagrams for all problem types. Having teachers fluent in the schematic diagrams for all problems types would increase an educator's confidence when teaching students how to approach a mathematical word problem. As coaching was available to the participants if a question or concern arose while teaching schema-based instruction, the researcher believes job-embedded coaching would have increased the participants' confidence when delivering the schema-based instructional program. The researcher recommends if the district chose to continue the use of the schema-based instructional program job-embedded coaching along with initial training be a requirement.

During the 2013-2014 school year, the elementary school in this study adopted new curricular materials that taught mathematical problem solving using methods different from that of schema-based instruction. The researcher would caution the teachers and district in simultaneously teaching students multiple ways to solve mathematical word problems. The students who did not benefit from the new curricular adoption approach could benefit from the schema-based instructional program. However, educators would need to reinforce and generalize the schema-based instruction in the general education classroom for the students to successfully use the strategies across multiple settings.

Recommendations to Improve Schema-Based Instructional Program

After analyzing the data, the researcher had several recommendations to improve the schema-based instructional program titled, *Solving Math Word Problems: Teaching Students with Learning Disabilities Using Schema-Based Instruction,* by Jitendra (2007), if another edition were written. Five-out-of-the-six special education teachers discussed the need to create additional problems in order for their students to master each schema. The researcher recommends that multiple worksheets or additional problems for each schema be added to the program, as supplemental materials. As noted in the literature, some students would benefit from repetition (Dombeck et al., 2013) and the additional worksheets/problems would allow teachers the ability to provide additional practice on an as-needed basis to ensure student understanding.

The researcher also endorses the suggestion from teachers in this study that suggests implementers of this program should utilize personalized word problems. The literature noted that students who had little motivation to solve mathematical word problems benefited from personalized word problems (Hart, 1996; Technical Education Research Center, 2008). One special education teacher in this study also discussed the need to create word problems with real-world experiences to engender and sustain student interest in solving the problem. This recommendation would be placed either in the beginning of the program as another way to engage students who struggle or throughout the program in the teacher-directed script.

As noted in the researcher's recommendation to the district, the special education and general education teachers needed additional training to effectively implement schema-based instruction. This program offered no materials specifically labeled for teacher training. The program described schema-based instruction and how to utilize the program in the beginning. However, specific materials designed to support the implementation of the program in classroom instruction would have benefitted the educators and created a more uniform implementation of the program. Specific training materials could include videos depicting lessons utilizing schema-based instruction and a visual presentation when training future implementers on how to effectively implement this instruction.

Generalization was a common theme when the researcher coded the special education teachers' interview responses. In order to help students generalize their recently taught skills in the schema-based instructional program, the researcher recommends the program add a parent connections page. The parent connections page would thoroughly describe the schema-based strategies utilized in the program and how parents could best support their children in transferring these skills. As two special education teachers noted that generalization was difficult and students had difficulty utilizing this instruction in their general education classroom, the parent connections page could also be given to the general education teachers as a resource of methods to encourage students to use their recently-taught strategies.

The researcher also recommends a list of other instructional approaches that could be utilized to assist students who are struggling to understand the schema-based instructional strategies taught in Jitendra's (2007) program. As noted in recommendations for future studies, the researcher recommended that a modified or simplified schema-based instructional approach (Fang et al., 2015) be used with students with an intellectual disability or a language impairment. The researcher recommends a modified or simplified schema-based instructional approach (Fang et al., 2015) would be specifically listed as an option for teachers to use with struggling students. As noted in the literature review, the concrete-representational (pictorial)-abstract (CRA) process was a successful way to teach mathematical, conceptual understanding (Hudson & Miller, 2006; Korn, 2014; Sousa, 2008). Jitendra's (2007) schema-based instructional program had the representational and abstract portion of the CRA process. The researcher recommends the program incorporate the concrete stage; thereby, encouraging implementers to use hands-on materials to assist students in learning the strategies incorporated into the schema-based instructional program. Again, this suggestion to use concrete materials when students are not grasping the concept could be incorporated into the beginning of the program or this could be incorporated into the teacher-directed script specifically outlining when and how to utilize the concrete stage.

Conclusion

Students with an educational disability faced a diverse set of challenges in different areas in education and benefited from using evidence-based or research-based interventions (Graham et al., 2013; Hagaman et al., 2013; Forbringer & Fuchs, 2014). In this study, the researcher analyzed quantitative and qualitative data including pre and post-assessment data from the schema-based instructional program, M-CAP data, student survey data, special education teacher interview responses, and general education teacher survey responses, to determine to what extent Jitendra's (2007) schema-based instructional program would benefit students who struggled with mathematical problem solving. As evident in this study and as noted in the then-current literature, the program titled, *Solving Math Word Problems: Teaching Students with Learning Disabilities Using*

Schema-Based Instruction, by Jitendra (2007) was a research-based intervention that helped to develop mathematical problem-solving skills for students who struggled. After analysis of the results of this study and the demonstrated success of the program with students with diverse educational disabilities, the researcher recommended that special education teachers add schema-based instruction to the list of successful interventions from which to select, based on the needs of their students, in order to help all students achieve a greater level of proficiency in mathematical problem solving.

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Appendix A

Special Education Teacher Interview Questions

1. What do you believe are the key components of this program?
2. Describe the implementation process for this program.
3. What skills did your students gain from this program?
4. Describe the effectiveness of the schema diagrams.
5. Describe the effectiveness of the FOPS checklist.
6. Describe the overall effectiveness of this program.
7. Describe your overall perception of this program.
8. Would you implement this program again? Explain.

Appendix B

General Education Teacher Survey

Schema-Based Strategy Survey

(General Education Teacher)

Please answer the statements below.

1. My student(s) used the schema-based strategy when solving math word problems.

Always Frequently Some Rarely None

2. The schema-based strategy helped my student(s) solve math word problems.

Always Frequently Some Rarely None

3. My student(s) is more confident when solving math word problems now compared to the beginning of the school year.

Always Frequently Some Rarely None

4.

Describe the effectiveness of schema-based instruction:

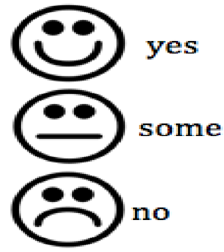
____

____

____

____

Appendix C



Student Survey (3rd-5th Grades)

Circle the correct choice below.

1. The diagrams helped me solve math word problems.

---

2. The FOPS checklist helped me solve math word problems.

---

3. Change problems are easy for me to solve.

---

4. Group problems are easy for me to solve.

---

5. Compare problems are easy for me to solve.

Student Survey (6th-8th Grades)

Circle the correct choice below.

1. The diagrams helped me solve math word problems.

Yes Some No

---

2. The FOPS checklist helped me solve math word problems.

Yes Some No

---

3. Change problems are easy for me to solve.

Yes Some No

---

4. Group problems are easy for me to solve.

Yes Some No

5. Compare problems are easy for me to solve.

Yes Some No

Appendix D

Schema-Based Instruction Comparison Studies

Researchers	DiPipi & Jitendra	Griffin & Jitendra	Deatline-Buchmann, Jitendra & Xin	Hoff & Jitendra	Bhat, Gardill, Griffin, Jitendra, McGoey, & Riley	Fede, Pierce, Matthews, & Wells
Year	2002	2009	2005	1996	1998	2010
# of Participants	4	60	22	3	34	32
Grade	8th	3rd	Middle	Elementary	Elementary	5th
General Ed. Or Special Ed.	Special Ed.	Both	Both	Special Ed.	Both	Both
Disability	LD	LD	LD & ED	LD	LD & ED	LD & AU
Majority of Day in Special Education	No	No	No	No	No	No
Student Growth in Problem Solving	Yes	Yes	Yes	Yes	Yes	Yes
Students Perceived SBI Worked	Yes	N/A	N/A	Yes	N/A	Yes
Teachers Perceived SBI Worked	Yes	N/A	N/A	N/A	N/A	N/A
Ability to Generalize SBI	Yes	Yes	Yes	Yes	Yes	N/A

Researchers	Church, Corroy, Huang, Kanive, Jitendra, Rodriguez, & Zaslofsky	Griffin, Jones, & Rockwell	George, Jitendra, Price, & Sood	Casner	Fang, Hartsell, Herron, Mohn, & Zhou	Adams, Griffin, Haria, Kaduvettoor, Leh, & Jitendra
Year	2013	2011	2010	2013	2015	2007
# of Participants	136	1	2	21	4	88
Grade	3rd	4th	4th & 5th	4th-8th	2nd	3rd
General Ed. Or Special Ed.	Both	Special Ed.	Special Ed.	Special Ed.	Gen. Ed.	Both
Disability	NS	AU	ED	AU, ED, ID, LD, LI, & OHI	N/A	LD
Majority of Day in Special Education	No	No	Yes	Both	N/A	No
Student Growth in Problem Solving	Yes	Yes	Yes	Yes	Yes	Yes
Students Perceived SBI Worked	N/A	N/A	N/A	Yes	N/A	N/A
Teachers Perceived SBI Worked	N/A	N/A	N/A	Mixed	N/A	N/A

Ability to Generalize SBI	N/A	Yes	Yes	N/A	Yes	Yes

Vitae

Education

Educational Doctorate Degree in Educational Administration (Expected December 2016)
Lindenwood University

Educational Specialist Degree in Educational Administration (Spring 2012)
Lindenwood University

Master of Arts Degree in School Administration (Spring 2008)
Lindenwood University

Bachelor of Science Degree in Special Education (Fall 2005)
Fontbonne University

Certifications

Elementary Principal (K-8)
Special Education Administrator (K-12)
Elementary Education (1-6)
Special Education: Mild-Moderate Disabilities, Cross-Categorical (K-12)
Severe Developmental Disabilities (Birth-21)

Professional Experience

Elementary Principal	July 2014- Present
Special Education Area Coordinator	July 2011- June 2014
Special Education Administrative Intern	August 2009-June 2011
Literacy Leader	August 2008-June 2011
Special Education Teacher	December 2005-June 2009
Applied Behavioral Analysis Paraprofessional	June 2002-July 2005