

Modifications in Teaching Mathematical Concepts through Problem Solving for Elementary
Grade Students including Students with Learning Disabilities

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Abstract

The purpose of this study was to survey teacher opinion on whether strategies for modifications in teaching mathematical concepts through problem solving are effective for elementary grade students including students with learning disabilities. The measurement tool was a questionnaire consisting of 11 multiple-choice responses. The data were collected from the participants and analyzed for their response to questions on the benefits of using strategies and their effectiveness in teaching mathematics in their classrooms. Research in this area should continue as there is evidence that problem solving strategies are effective in solving mathematical word problems for students with mathematics difficulties and learning disabilities.

CHAPTER I

INTRODUCTION

Mathematics word problems are challenging for many students, especially students with disabilities. Recent studies have shown the benefits of teaching strategies in the classroom for solving mathematical word problems. Word problems require students to process and discriminate between known and unknown information. To develop a solution plan, students use working memory and draw upon prior knowledge. Many students with disabilities have deficits in both areas. Additionally, students with learning disabilities as well as English Language Learners have difficulties understanding the ambiguities and complexities of the language used in word problems and struggle with segregating language that is superficial and language that is important to solving word problems (Jitendra, Sczesniak, Griffin, & Deatline-Buchman, 2007).

Overview

The Common Core State Standards were initiated in 2009 and mandated instruction using higher order thinking skills. It has long been recognized that standards for teaching mathematics must change and must involve more problem solving to be relevant to the skills necessary in the 21st century. In 1995, the National Council of Teachers of Mathematics (NCTM) established a set of eight standards for teaching mathematics to students (Van De Walle, Karp, & Bay-Williams, 2019). Ultimately known as the Common Core State Standards for Mathematics (CCSS-M), these standards answered a need for teaching mathematics with greater depth of understanding and increased proficiency.

One of the areas of the CCSS-M is making sense of problems and perseveres in solving them. Problem solving is a means of fostering creative ideas in mathematics, reasoning towards a solution and using strategies to solve them. Students are encouraged to find and use a variety

of strategies as well as their own solutions. Students select how they solve a problem, rather than apply standard procedures that assume all word problems can be solved in the same manner. Strategies present options and allow students to devise and take ownership of their own strategy solution.

Statement of Problem

The purpose of this study is to examine how teaching strategies for solving mathematics word problems are effective in the classroom. Because CCSS-M is relatively new to teaching, state curriculums are still evolving. Today's mathematics teachers are facilitators who encourage, question and scaffold rather than provide instruction on standardized procedures. This study attempts to show how teachers rank the use of problem solving strategies and how they judge their effectiveness in the classroom.

CHAPTER II

REVIEW OF THE LITERATURE

The purpose of this literature review is to examine how teaching through strategies may help students solve mathematical words problems, including students with disabilities. Section one discusses how students struggle with word problems in mathematics (including special needs students). Section two describes the strategies for teaching how to solve word problems in mathematics. Section three focuses on how teacher knowledge and attitudes affect how strategies are implemented in the classroom.

Overview

Teaching through strategies offers a mechanism for dissecting, analyzing and evaluating potential solutions to mathematical word problems. Research has shown that using strategies increases students' ability to analyze, evaluate, apply, understand and remember solutions. In the past, traditional teaching methods used keywords to determine which procedure to use to solve the problem. Recent research, however, has shown that keywords are misleading and not often present in the word problem (Jitendra, et al., 2007). Routinely searching for keywords does not promote an understanding of mathematical word problems, explore problem structure or use reasoning to come to a fully understood solution that the student can replicate.

Explicit instruction in how to use a strategy is necessary to help students understand the reasoning behind their solution. Strategy instruction helps students recognize structure relationships within the word problem and provides an opportunity to develop different solutions. Since the 1990s, research studies have investigated the effectiveness of various strategies (Griffin & Jitendra, 2009). Most examine how students can isolate and evaluate the components of a problem or its structure using reasoning skills. A common approach throughout

the research is structure, i.e., what has changed in the problem, what has been grouped together and what is being compared. This structure can indicate the type of problem and the corresponding mathematical operation (Swanson, Orosco, & Lussier, 2014).

Other strategies dissect word problems into their individual components using verbal and visual cues to determine what the problem is asking the student to do. Looking at the structure of word problems helps students to attend to relevant information and discard the superficial. Griffin and Jitendra (2009) determined that teaching strategies that help students to disregard irrelevant information improves their ability to process information efficiently and unburdens their working memory, areas where students with special needs struggle.

Strategy instruction for students with learning disabilities provides a mechanism to overcome limits in working memory and processing speed and adapt ways to increase higher order thinking skills. For these students, instruction must be explicit with ample time to practice. Also, it must incorporate verbal, visual and, when necessary tactile (manipulatives) tools to allow students to visualize solutions (Bouck & Park, 2018).

In addition to answering the need to incorporate the eight CCSS-M standards for mathematical practice, teaching strategies promotes conceptual understanding and motivates students to use reasoning to make sense of the problem. Kiuvara and Witzel (2014) state that the CCSS-M mandates teaching not just mathematics but mathematics combined with reasoning. They further state that instruction must encompass higher order thinking skills in order to use and explain word problem solving effectively.

Strategies for Mathematical Word Problems

Teaching strategies for solving word problems have existed since 1946. George Polya's four-step model (understand the problem, devise a plan, carry out the plan, look back and reflect)

is still a standard in many mathematics textbooks and is considered traditional mathematics instruction for word problems (Jitendra, Dupuis, Rodriguez, Zaslofsky, Slater, Cozine-Corroy & Church, 2013). However, recent studies have shown that this model does not promote higher order problem-solving skills nor is it an effective strategy for students who have difficulties with mathematics or have learning disabilities (Kiuhara & Witzel, 2014).

Direct Instruction Problem Solving Strategy

Direct instruction is the step sequence originally developed by Polya to solve word problems. Students build on prior knowledge to understand the problem, choose a strategy and make a plan, execute the plan, and check the work. Wilson and Sindelar (1991) contend that lack of direct instruction rather than learning deficits is the cause for students who struggle with solving mathematical word problems. They conducted a study comparing strategy teaching to teaching the Polya sequence in solving addition and subtraction word problems. Groups of three to five students in nine elementary schools received strategy only instruction, sequence only instruction and a combination of strategy plus sequence instruction. Students in the strategy plus sequence group scored higher than the other two groups indicating a combined approach is more effective than a single strategy.

Schema Based Instruction (SBI) Strategy

Schema based strategies use diagrams or graphs to assess the elements of a problem and determine a solution. In SBI, students follow a sequence for identifying the problem by type, representing it in a meaningful graphic and selecting an appropriate plan to solve the problem. Recent studies (Jitendra et al., 2013; Jitendra, Nelson, Pulles, Kiss, & Houseworth, 2016) have shown demonstrated improvements in student word problem proficiency using SBI, especially students with disabilities. In their 2007 journal article, Jitendra et al. describe a 1996

intervention effort using the SBI instruction method with three third and fourth grade students who have learning disabilities or are failing in mathematics. In that study, students showed an increase in the number of word problems answered correctly using the SBI strategy. Jitendra, et al. (2007) conducted a follow-on study with a larger sample of 109 third grade students with mathematics difficulties. Instruction covered different types of problem structure or type (what has changed, what is grouped together, or what is compared). The model was designed to identify the structure of the problem and allow the student to disregard irrelevant information and map the resulting schema to a solution. Using SBI, students were more successful in analyzing the text, constructing diagrams that showed relationships within the problem and solving it. Because of their success, students also were motivated to use SBI after the study ended and were able to continually improve their skills through practice.

Real-Life Problem-Solving Strategy

CCSS-M standards require that mathematics instruction must relate to real life problems. Fuchs, L. Fuchs, D., Finelli, Courey & et al. (2006) state that word problems must be linked to real world situations in order to be relatable and in order to provide skills that are transferable to the real world. Using schema, Fuchs et al. (2006) focused on teaching students a logical sequence of steps within the schema type (change, group, compare) while disregarding unnecessary features. In a study with third graders, her team used a schema broadening approach, wherein students were taught to analyze a problem by its familiar parts. Once superficial features like the introductory story and certain vocabulary were eliminated from word problems, students recognize the familiar structures (change, group, compare) and performed the associated operation. By identifying information that is familiar and relatable, students were able to make connections to what they already know to solve the problem. Using this approach,

the study saw significant improvement in the word problem solving ability of students with mathematics difficulties.

The complexities of solving word problems involves understanding vocabulary, analyzing what is important and what is relevant, retaining information in working memory and accessing higher order thinking. Using tools is a valuable way to assist students with disabilities who struggle with these aspects of problem solving. In a 2013 study, Wilson describes using the math frame, a tool that helps students use strategies, particularly for word problems involving multiple steps. The math frame is a visual representation that breaks down the steps for each component part of the problem. As students use the tool, they begin to process information using questioning and higher order thinking skills. It also provides a written summary of students' reasoning and understanding as they work through the steps of solving the word problem.

Model-Based Strategies

Model-based strategies are characterized by teacher-directed instruction using conceptual, visual and tactile models and manipulatives. Using manipulatives, such as Cuisenaire rods, cubes and sticks, in mathematics instruction has been a common practice for students with and without disabilities. In February 2018, Bouck and Park conducted a comprehensive literature survey of studies that examined the use of manipulative for students with learning disabilities. They reviewed 36 studies on manipulatives and found that the most successful instance was their use with the concrete-representation-abstract (CRA) approach. Models and manipulative are most effective for moving students from the concrete (models and manipulatives) to the abstract (algorithms) in solving word problems.

Self-Regulated Strategy

Originally developed by Graham and Harris in 2003 (as cited in Montague, 2008), self-regulation consists of six states of instruction, accessing prior knowledge, discussing a strategy, modeling with think alouds, memorizing the steps, scaffolding as needed and monitoring progress. Bishara (2016) investigated the impact of self-regulated study versus traditional teaching. Forty students, nine to 10 years old in four classrooms participated in the study, all with learning disabilities. Two classrooms used the self-regulated approach while the other two used the traditional, teacher presentation approach. In the self-regulated approach, students had the flexibility to develop their own strategies. Through open-ended questions, they identified important facts in the problem, made connections and evaluated relationships, and organize their ideas. Traditional, teacher-directed instruction was procedurally based and focuses on algorithm application. Students using the self-regulated approach scored significantly higher in posttests than the students taught with the traditional method.

In a review of the literature, Kihara and Witzel (2014) describe how Self-Regulated Strategy Development (SRSD) promotes mathematical reasoning and complements content knowledge. SRSD uses the same reasoning and logical steps as SBI, focusing on structure and building upon, and understanding, what is familiar. SRSD leads students through the six stages to independent performance. More scaffolding is present through the initial stages until students are able to work independently.

Research has shown that teaching strategies in the general education classroom with students of varying abilities, including students with mathematics difficulties and learning disabilities, has improved performance on mathematical word problems. Griffin and Jitendra (2009) conducted a study to compare SBI and general strategy instruction (GSI, i.e. Polya's

method) in a third-grade inclusive classroom. Results over a period of 18 weeks, showed improvements in students' word problem performance using both strategies. Similar to the 2007 study, Griffin and Jitendra (2009) again found that students developed a positive attitude towards both strategies and were motivated to continue using them beyond the original study.

In their 2014 study, Kiuvara and Witzel noted that students have difficulties with mathematics because they also have difficulties in reading, vocabulary, information processing and limited working memory, all of which are essential in understanding and solving word problems. For students with learning disabilities, these difficulties create greater challenges when working with strategies. Garderen (2007) had success in a recent study with three students in the eighth grade who had learning disabilities. Students were instructed how to draw diagrams to solve one and two-step word problems. Prior to the study, the students did not use diagrams nor did they know how to draw them. Their pre-test diagrams were pictures rather than schema. During post-testing, however, student drawings were more structural and schematically related to the word problem. Significantly, students were able to draw schematic diagrams for all posttest problems, which aided in solving the problem.

Role of Technology

Technology has an ever-increasing role in instruction for all academic subjects. Technology needs to be innovative and focus on making strategies easy to use, fun and convenient for students. Yang, Chang, Cheng and Chan (2016) worked with a group of students in Taiwan to incorporate technology into how they strategize to solve word problems. Using PC tablets, students generated mathematics structures and solutions along with explanations and shared them with other classmates. The technology uses a Sketch Board for creating the

mathematics strategy and solution and a Sharing Zone, which made it easy for students to display their solutions for discussion with peers.

Teacher Knowledge and Attitudes About Teaching Strategies

Equally important to using strategies with students is the teacher's ability to explicitly teach strategies and foster mathematics discussion. Factors that affect student outcomes using strategies in the classroom are teacher self-efficacy, attitudes and beliefs towards mathematics and their assessment of their ability to engage students in mathematics activities and discourse. Carney, Brendefur, Thiede, Hughes and Sutton (2014) examined elementary grade teacher knowledge and beliefs. Participants in the study completed a professional development course on teaching alternative solutions for solving mathematical problems. The course emphasized instruction that aligns with CCSS-M standards and that engages students in mathematical reasoning wherein they can select their own strategy for a solution. The research showed that the course was instrumental in improving teacher self-confidence and changing their beliefs on what students can achieve through CCSS-M standards-based mathematics instruction. Participants felt better prepared to implement CCSS-M standards in their classrooms. The study supports the need for professional development that enhances teacher knowledge, strengthens their beliefs and attitudes towards CCSS-M, and increases the likelihood that they will guide their students toward a positive experience in mathematics instruction.

Teacher Self-Efficacy

Teacher self-efficacy can be defined as confidence in one's ability to conclude a task successfully and influence successful outcomes for students (Hill, 2010; Carney et al., 2014;

Giles & Bendolph, 2016). A teacher's belief that he or she can explicitly teach a strategy, evaluate its implementation, reason towards a solution and invite discussion affects student attitudes towards mathematics and ultimately their success. Giles and Bendolph (2016) address teacher self-efficacy in relation to student outcomes. They surveyed 41 preservice teachers who were previously enrolled in a mathematics methods course. They found that participants were confident in both their personal beliefs about their ability to teach mathematics and their expectations of successful student outcomes. The researchers attribute these positive attitudes to the training, which was aligned with CCSS-M standards and encouraged mathematics reflection and discussion.

Teacher Knowledge

In 2010, the NCTM published a study on the need to assess teacher mathematics knowledge (Hill, 2010). Teacher knowledge varies from school to school. There is ongoing debate over what constitutes what type and how much knowledge is necessary to effectively teach mathematics. There are questions about whether professional development programs should include mathematics content or focus more on teaching methods for analyzing, using strategies, interpreting solutions and diagnosing problem areas. Through a survey of teachers in 1,090 randomly selected schools, Hill (2010) found that participants had less difficulty with content and more difficulty in teaching standards-based mathematical methods and higher-level thinking skills. The strongest correlation existed between mathematical knowledge and years of experience. This can be expected as teachers become more familiar with grade level content and curriculum requirements.

A teacher's ability to draw upon his or her own skills with confidence influences student attitude and motivation to achieve. Not dissimilar to other content areas such as science, mathematics instruction is more effective if the teacher is mathematically astute and can explain solutions, foster student analysis and encourage thoughtful discussion. In a large-scale study of elementary mathematics curricula in 110 schools, Agodini and Harris (2016) evaluated the effects of three classroom characteristics in relation to teacher knowledge, attitude, and the need to differentiate their classroom instruction in four curricula. They found that the impact of teacher knowledge and attitude varied across the different curricula suggesting that schools have choices for implementing a curriculum that best meets the needs of the students and the expertise of the teachers. In this study, one standards-based and one tradition curriculum achieved successful teaching outcomes.

Teacher Attitudes and Beliefs

Many adults, including teachers, feel that they are inadequate when it comes to understanding mathematics. However, a teacher's belief that he or she can be effective in providing content accurately and thoroughly can impact student motivation and achievement. Attitudes towards mathematics instruction affect how students value mathematics, become confident problem solvers, learn to reason through analysis and communicate math solutions. Although the extent of teacher knowledge has shown to be a factor in fostering a mathematic learning environment (Carney et al., 2014), an ability to analyze errors, use multiple strategies, evaluate potential directions, diagnose errors and explain solutions is more directly in accord with CCSS-M standards. Additionally, teachers whose instructional methods align with strategy-based learning are able to foster a creative math environment (Agodini & Harris, 2016).

Attitudes and beliefs influence a teacher's self-efficacy and confidence in his or her ability to create a mathematics-focused classroom where questioning and discussions are encouraged.

Conclusion

This review of literature has shown that various cognitive processes can be tapped teaching strategies with all students. Using strategies not only increases word problem solving proficiency but also has been shown to foster student participation and enthusiasm. Improvement can also be seen in their willingness to struggle and persevere. Students who participate actively with a strategy are more apt to retain knowledge.

Successful use of strategies in the classroom is affected by teacher knowledge, attitudes and beliefs. Although mathematical knowledge is a valuable asset, skills in methods that facilitate student analysis, evaluation and problem solving are critical to learning, applying and retaining mathematics skills. It is important that a teacher be able to communicate with students to interpret, explain and respond to student inquiry as well as to diagnose errors in problem solving rationale. To achieve these ends, methods courses rather than content knowledge may be a better path towards achieving professional development goals for mathematics instruction (Carney et al., 2014; Agodini & Harris, 2016). Teachers whose classrooms reflect a mathematically challenging environment that encourages discussion and inspires student to analyze, inquire, interpret and formulate solutions through sound strategies are most likely to achieve successful outcomes.

CHAPTER III

METHODS

The purpose of this study is to examine the teacher's perspective on the impact of teaching strategies on students working with mathematical word problems. A review of the literature explored strategies that improved student performance in solving mathematical word problems and the impact of teacher knowledge and attitude on successfully implementing strategies in the classroom.

Design

This study was descriptive using a survey comprised of 11 multiple-choice questions. The questions were intended to elicit teacher opinion on the value of teaching strategies to their students in solving mathematical word problems. The survey also sought to gather data on teacher confidence in teaching math strategies in order to meet the eight standards of mathematical practice.

Participants

The survey was conducted with 27 graduate students at Goucher College currently enrolled in Masters Programs in Education and nine teachers at a suburban Baltimore high school. Of those respondents, 28% has five or less years of experience teaching, 42% had 6-10 years in teaching, 25% had 11-20 years' experience and 5% had over 20 years' experience as teachers. Of those surveyed, 16 currently teach elementary grade students, two are middle school teachers, and 17 teach high school. One participant teaches pre-school. Seven participants teach special education and 29 are regular education teachers. All of the respondents were currently teaching in the State of Maryland.

Instrument

This survey sought to gain teacher experience and opinion on the effectiveness of strategy instruction in the classroom, not only in terms of student performance but also gains in student enthusiasm and continued use of strategies for problem solving in school. The instrument used in the study was a questionnaire. The questionnaire was composed of 11 multiple-choice questions. Questions required a single response and were a combination of Likert, rating and multiple-choice responses. Rating scale questions asked respondent to rate the goals of instruction and the likelihood of student response to strategy instruction; the Likert scale items fell into two categories: the effectiveness of the strategy instruction on the students and the respondent's opinion of, and success in, their teaching methods in this area. There were no open-ended questions used during the survey. There was one comment field at the end of the questionnaire for providing optional comments.

Procedure

Thirty-six questionnaires were distributed to two classes in the 2019 spring semester at Goucher College and to teachers in a large high school in suburban Baltimore. Participants completed the survey independently. After respondents finished the questionnaire, it was collected immediately. All information obtained in the surveys was anonymously reported. The surveys did not collect any personal information or information that could be attributable.

CHAPTER IV
RESULTS

The purpose of this study was to examine teacher assessment of using strategies to teach students how to solve mathematical word problems and how effective strategy instruction is in their classrooms. Thirty-six participants (regular and special educators) completed an 11-question survey in Spring 2019 at Goucher College and at a high school in suburban Baltimore. The responses to the survey were tabulated and calculated as shown in Tables 1, 2 and 3.

Teacher Perspective of the Goals of Strategy Instruction

Table 1 tabulates the results for questions related to how teachers use strategies in the classroom to help students solve mathematics word problems. Seventy-eight percent of the participants responded that using a strategy is most important in mathematics instruction. While regular educators responded in the majority (81%), special educators were split evenly between using a strategy and following a set of procedures as the most important aspect of mathematics instruction. Significantly, 13% of regular educators also felt that following procedures rather than using a strategy is most important in teaching mathematics.

Table 1. Results for Questions on How Teachers use Strategies in their Classrooms

Questionnaire	Regular Educator		Special Educator		Total	
	N	%	N	%	N	%
1. Which of the following in terms of the goal of mathematics instruction is most important in your classroom?						
Getting the right answer	2	6%	0	--	2	6%
Using a strategy	26	81%	2	50%	28	78%
Following correct procedures	4	13%	2	50%	6	17%
2. Which best describes how you teach students to solve mathematical word problems?						
Sequence and Steps	10	31%	2	50%	12	33%

Questionnaire	Regular Educator		Special Educator		Total	
	N	%	N	%	N	%
Keywords	9	28%	2	50%	11	31%
Patterns	3	9%	0	--	3	8%
Predicting	1	3%	0	--	1	3%
Estimating	2	6%	0	--	2	6%
Algorithms	1	3%	0	--	1	3%
Problem Structure Analysis	6	19%	0	--	6	1%
3. What would you say is the best approach for scaffolding instruction for mathematics?						
Verbal cues	1	3%	0	--	1	3%
Visual-graphics-solution mapping	12	38%	2	50%	14	39%
Using models/manipulatives	15	47%	2	50%	17	47%
Using tools, such as a calculator	2	6%	0	--	2	6%
Providing extended work time	2	6%	0	--	2	6%
4. What resonates most with your students during instruction?	2					
Relating math to popular literature	3	9%	0	--	3	8%
Math games	14	44%	3	75%	17	47%
Prior Knowledge	12	38%	0	--	12	33%
Technology	3	9%	1	25%	4	11%

Overall 33% of participants use sequence and steps; 31% use keywords. Less than 25% use other methods, such as patterns, predicting, and estimating. Nineteen percent of regular educators use problem structural analysis in their classrooms. Special educators responded that they use either sequence and steps or keywords.

Forty-seven percent of the participants feel the best approach to scaffolding instruction is to use models or manipulatives; 39% use mapping to graphically portray solutions. Special educators are split between the two approaches. Few respondents use tools or give students extended work time (6%).

Educators felt that math games resonate the most with their students (47%). Over twice as many special educators than regular educators answered that their students respond to technology. Among the special educators, 75% stated that their students relate most to visual or graphic mapping and using models and manipulatives.

Student Response to Strategy Instruction

Table 2 shows participant response to how student react to instruction on how to use strategies to solve mathematics word problems. In the regular education classroom, participants felt that students give up easily before they can solve the problem. Special educators see formulating a plan on how to solve the problem as the most significant struggle, with some (25%) responding that students are unable to read the problem. All participants felt that students are mostly disinterested during strategy instruction. Only 28 % of regular educators said their students are engaged and only 3% said they are enthusiastic.

Table 2. Results for Questions on Student Attitudes Towards Strategy Instruction

Questionnaire	Regular Educator		Special Educator		Total	
	N	%	N	%	N	%
5. What would you say your students struggle with the most in solving word problems?						
Can't read the problem	6	19%	1	25%	7	19%
Can't formulate a plan or strategy	9	28%	3	75%	12	33%
Give up easily	15	47%	0	--	15	42%
Can't get the right answer	2	6%	0	--	2	6%
6. How would you rank student response to learning problem solving strategies?						
Enthusiastic	1	3%	0	--	1	3%
Engaged	9	28%	0	--	9	25%
Frustrated	9	28%	1	25%	10	28%
Disinterested	13	41%	3	75%	16	44%
7. What area of improvements is most important from						

Questionnaire	Regular Educator		Special Educator		Total	
	N	%	N	%	N	%
a strategy instruction point of view?						
Increased performance	2	6%	0	--	2	6%
Interest and attitude	7	22%	1	25%	8	22%
Willingness to persevere	23	72%	3	75%	26	72%
8. How effective would you say strategy instruction is effective for students with learning disabilities?						
Extremely effective	6	18%	2	50%	8	23%
Somewhat effective	14	45%	2	50%	16	46%
Neutral	9	29%	0	--	9	26%
Not effective	2	6%	0	--	2	6%

The most important area for improvement for both regular and special educators is the students' willingness to persevere. This assessment aligns with their response to Question 5 where they stated students give up easily. Interest and attitude were important with 22% of regular educators and 25% of special educators.

Overall, the majority of participants agreed that strategy instruction for students with disabilities is somewhat effective (46%). Fifty percent of special educators felt that strategy instruction was extremely effective while the remaining 50% felt they were somewhat effective. Only 6% of participants felt that they were not effective.

Teacher Motivation and Attitudes

The remaining three questions on the survey addressed teacher beliefs about their effectiveness in teaching strategies for solving mathematics word problems. Table 3 tabulates their responses.

Table 3. Results for Questions on Teacher Attitudes and Beliefs about Strategy Instruction in Their Classroom

Questionnaire	Regular Educator		Special Educator		Total	
	N	%	N	%	N	%
9. How would you rank the ease of teaching students to solve mathematics word problems?						
Extremely difficult	3	9%	0	8%	3	8%
Somewhat difficult	21	66%	3	75%	24	67%
Neutral	6	19%	1	25%	7	19%
Somewhat easy	2	6%	0	--	2	6%
Extremely easy	0	0	0	--	0	--
10. Which approach or strategy have you found most successful?						
Memorizing procedures	3	9%	0	--	3	8%
Using connection tasks	8	25%	1	25%	9	25%
Using schemas or diagrams	5	16%	1	25%	6	17%
Using models/manipulatives	16	50%	2	50%	18	50%
11. How successful do you think strategy instruction is in your classroom?						
Extremely effective	4	13%	2	50%	6	17%
Somewhat effective	23	72%	1	25%	24	67%
Neutral	5	16%	1	25%	6	17%
Not effective	0	0	0	--	0	--

In response to the question on the ease of teaching strategies, participants were either neutral or found teaching strategies somewhat difficult. Sixty-six percent of regular educators and 75% of special educators found strategy instruction somewhat difficult with their students. Only 6% of regular educators found it somewhat easy while 9% found it extremely difficult.

The participants believed that the majority of their students respond most to using models and manipulatives, which aligns with how they scaffold (Question 3). A much lower percentage

use connection tasks (25% of respondents) while 17% use schemas or diagrams and only 8% use memorization.

On the question regarding their own success with strategy instruction, 72% of regular educators and 25% of special educators felt that their instruction was somewhat effective. Half of special educators felt that they were extremely effective with only 13% of regular educators in agreement. No participants answered negatively to this question.

In summary, participants use some form of a strategy in their instruction for solving mathematics word problems (Table 1). Participants' assessment of student response to strategy instruction ranges from engaged to disinterested with most participants ranking their instruction as somewhat effective. Participants felt that students give up easily and that willingness to persevere is the most important improvement to be gained from strategy instruction (Table 2). The majority of participants also felt that their instruction on strategies was somewhat effective. Conversely, they found teaching students to solve math problems to be somewhat difficult (Table 3).

CHAPTER V

DISCUSSION

This study surveyed educator opinion on teaching mathematics strategies to students for solving word problems, including students with learning disabilities. The study surveyed 36 teachers in the Baltimore, Maryland metropolitan area who are regular and special educators and who completed a multi-choice questionnaire. Through a questionnaire, the study examined how teachers implement strategies in their classroom and how they feel strategies affect student performance.

Implications of the Results

According to the results of this study, most educators in regular and special education mathematics instruction use a strategy. The majority uses the sequence and steps strategy, which reflects a more traditional approach to teaching mathematics. A significant percentage also uses keywords, a strategy which research has shown is not always reliable when trying to solve word problems (Jitendra et al., 2007). Although all responded that their instruction was effective, they also responded that teaching students to solve mathematics word problems is not easy. A high percentage also responded that students are disinterested and frustrated when learning a strategy during mathematics instruction.

This overall response indicates that some of the strategies that have been shown to provide greater understanding and increased enthusiasm among students, including students with disabilities (e.g., Jitendra, et al., 2007), are not implemented by the teachers in this survey. Only 18% of teachers surveyed found any strategy instruction effective for students with learning disabilities.

Theoretical Consequences

Overall, the survey did not support the high rate of success of strategy instruction achieved in past research studies. Lack of effective instruction can lead to fewer opportunities to use higher order thinking skills necessary for success in mathematics. The theoretical consequences for students are voids in their understanding of mathematics as well as their motivation to be successful mathematics learners.

Threats to Validity

There are multiple threats to validity in this study. As a survey, the validity of the results is subject to the clarity of each question, the perception of the respondents and the interpretation of the researcher. There was no subsequent discussion and very few comments noted on the questionnaires that would add clarity to their answers. The sample size was small and represented a population attending one college and teaching at one high school in the State of Maryland. The results, in most cases, are the opinions of teachers within a sample population that has a wide range of teaching experience between one and 20 years.

The widely diverse demographics of the survey participants themselves pose threats to the validity of the survey results. The experience of the participants and the grade level (elementary, middle and high school) they teach can yield different perceptions of the usefulness of strategies to their student population. Students in early elementary classroom with little experience in the traditional approach to learning word problem solving may respond more enthusiastically to strategy instruction than high school students with many years of experience with traditional approaches.

Connections to Previous Studies

Numerous research studies described in Chapter II, cite successful trials with students who are explicitly taught strategies to help them solve word problems. In some cases, a combination of strategies yielded improved performance with students including students with disabilities (Griffin & Jitendra, 2009). Yet the survey results indicate that most of the respondents felt they are only somewhat successful. Researchers also recognize the debate on how best to prepare teachers for implementing strategies to achieve the objectives of the CCSS-M standards. Carney, et al. (2014) describes the impact of providing preservice teachers a course that is more directed towards teaching how to foster higher order thinking skills (i.e., evaluate, analyze, interpret) in solving mathematic word problems rather than providing instruction in content material.

The response that students are frustrated and disinterested when learning math strategies is disconcerting. Most of the past research for this study has shown that students respond positively to strategy instruction, are engaged and are more likely to persevere until they use a strategy successfully to solve problems. Furthermore, strategies have been shown to promote higher order thinking skills.

Implications for Future Research

The responses provided by teachers raises interesting questions for what constitutes the necessary tools to teach mathematics strategies and to encourage students to use higher order thinking skills in solving mathematics word problems. Although strategies vary in approach, all center on student participation through questioning and reasoning rather than teacher-directed instruction. Prior research supports student improved performance, engagement and enthusiasm to persevere until they solve the problem using their own strategy. However, the results of the

study do not correlate with prior research. In light of the CCSS-M standards and the need for instruction to incorporate higher order thinking, the effectiveness of teacher implementation of mathematics strategy in the classroom and student response should be further investigated.

Conclusions

From this study, it can be concluded that using mathematical strategies have been successful in teaching higher order thinking skills in solving mathematics word problems. However, the respondents to the survey were not confident that strategies were effective in every situation. A significant number responded that their students were not enthusiastic or motivated to use strategies and were frustrated and disinterested in response to learning them. Overall, the disagreement between what research shows and what is implemented in the classrooms should be investigated further.

A second area of study should address modifications needed to mathematical strategies for solving word problems to make them more accessible and effective for students with learning disabilities. In several instances during this research for this study, several strategies, notably SBI, show promise for students with learning disabilities in solving mathematical word problems.

References

- Agodini, R & Harris, B. (2016). How teacher and classroom characteristics moderate the effects of four elementary math curricula. *The Elementary School Journal*, 117(2).
- Bishara, S. (2016). Self-regulated math instructions for pupils with learning disabilities. *Cogent Education*, 3(1) (PAGES)
- Bouck, E. C., & Park, J. (2018). A systematic review of the literature on mathematics manipulatives to support students with disabilities. *Education & Treatment of Children*, 41(1), 65-106.
- Carney, M, Brendefur, J., Thiede, K, Hughes, G & Sutton, J. (2014). Statewide mathematics professional development: teacher knowledge, self-efficacy, and beliefs. *Educational Policy*, 30(4), pp. 539-572.
- Fuchs, L. S., Fuchs, D., Finelli, R., Courey, S. J., & et al. (2006). Teaching third graders about real-life mathematical problem solving: A randomized controlled study. *The Elementary School Journal*, 106(4), 311,386.
- Garderen, D. v. (2007). Teaching students with LD to use diagrams to solve mathematical word problems. *Journal of Learning Disabilities*, 40(6), 540-53.
- Giles, R., Byrd, K. & Bendolph, A. (2016). An investigation of elementary preservice teachers' self-efficacy for teaching mathematics. *Cogent Education*, 3:1160523.

- Griffin, C. C., & Jitendra, A. K. (2009). Word problem-solving instruction in inclusive third-grade mathematics classrooms. *The Journal of Educational Research, 102*(3), 187-201.
- Hill, H. (2010). The nature and predictors of elementary teachers' mathematical knowledge for teaching. *Journal for Research in Mathematics Education, 41*(5), 513-545.
- Jitendra, A. K., Dupuis, D. N., Rodriguez, M. C., Zaslofsky, A. F., Slater, S., Cozine-Corroy, K., & Church, C. (2013). A randomized controlled trial of the impact of schema-based instruction on mathematical outcomes for third-grade students with mathematics difficulties. *The Elementary School Journal, 114*(2), 252.
- Jitendra, A. K., Nelson, G., Pulles, S. M., Kiss, A. J., & Houseworth, J. (2016). Is mathematical representation of problems an evidence-based strategy for students with mathematics difficulties? *Exceptional Children, 83*(1), 8-25.
- Jitendra, A. K., Sczesniak, E., Griffin, C. C., & Deatline-Buchman, A. (2007). Mathematical word problem solving in third-grade classrooms. *The Journal of Educational Research, 100*(5), 302-328.
- Kiuhara, S. A., & Witzel, B. S. (2014). Math literacy strategies for students with learning difficulties. *Childhood Education, 90*(3), 234-238.
- Montague, M. (2008). Self-regulation strategies to improve mathematical problem solving for students with learning disabilities. *Learning Disability Quarterly, 31*(1), 37-44.

- Swanson, H. L., Orosco, M. J., & Lussier, C. M. (2014). The effects of mathematics strategy instruction for children with serious problem-solving difficulties. *Exceptional Children*, 80(2), 149-168.
- Van De Walle, J. A., Karp, K. S., Bay-Williams, J. M. (2019). *Elementary and Middle School Mathematics Teaching Developmentally*. New York, NY; Pearson.
- Wilson, C. L., & Sindelar, P. T. (1991). Direct instruction in math word problems: Students with learning disabilities. *Exceptional Children*, 57(6), 512.
- Wilson, G. L. (2013). The math frame: Reaching mathematical common core heights for students who struggle. *Teaching Exceptional Children*, 46(1), 36-46.
- Yang, E. F. Y., Chang, B., Cheng, H. N. H., & Chan, T. (2016). Improving pupils' mathematical communication abilities through computer-supported reciprocal peer tutoring. *Journal of Educational Technology & Society*, 19(3), 157-169.