Using a Visual Word Problem Solving Strategy to Improve Mathematical Understanding for Students With Learning Disabilities

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FACULTY APPROVAL

Using a Visual Word Problem Solving Strategy to Improve Mathematical Understanding for Students With Learning Disabilities

Approved for the Faculty

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ABSTRACT

The purpose of this project was to determine if a visual strategy for solving mathematical word story problems would better benefit students with learning disabilities than one that does not utilize a visual support. To accomplish this, a review of selected literature was conducted. Additionally, essential data was obtained and analyzed through an experimental pretest-posttest design. Data slightly supported the position that learning disabled students who use a visual strategy will show greater improvement in solving mathematical word story problems than those who do not use a visual strategy. In this study, a visual strategy is defined as a learning tool, which utilizes graphic or visually oriented supports to help accomplish a task. Unfortunately, the statistical analysis did not support the hypothesis on a significant level.

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CHAPTER 1

Introduction

Background for the Project

Students with learning disabilities (LD) face challenges to learning every day. Some may have significant difficulties in math, reading, or writing, while others might be impaired in all three areas. General and special education teachers work diligently to accommodate, modify, and adapt curriculum material so as to work with students at their instructional level. Moreover, they employ research-based strategies, aimed at specific skills and/or deficits to educate students.

Mathematics has been proven to be a difficult subject for both disabled and nondisabled individuals. Basic calculations such as addition, subtraction, multiplication, and division have been drilled into students' minds on a daily basis. The more students practice with rote calculations, repetition begins to become embedded into memory. However, problem solving using word story problems does not, as each problem is different. Story problems usually tell a story and ask the reader to solve for the unknown. Students with LD may not only be unable to read the material, but may lack the skills necessary to comprehend what the question is asking them to perform. Visual supports may be the key to building understanding in a word problem solving situation.

Visual supports have primarily been applied to students with autism spectrum disorders (ASD) for a variety of different purposes. They aid in expressive/receptive language, transitions, and behavioral interventions. Furthermore, students have been shown to increase understanding of academic concepts and greater memory recall. The applicability of visual supports to LD students and mathematical problem solving is an area of enormous interest to educators

Statement of the Problem

Students with LD participate in mathematics courses throughout their school career. They are served in any number of classroom settings such as general education, resource rooms, or self-contained classrooms depending on their least restrictive environment (LRE) placement. Problem solving is often an area of deficit for these students and visual supports may provide a way for students to learn and retain the skills necessary to solve them.

Purpose of the Project

The purpose of this study was to determine if a visual strategy for solving mathematical word story problems would better benefit LD students than one that does not use a visual support. A review of selected literature focused on three essential areas: challenges faced by students with LD, difficulties these students have when solving mathematical word problems, and the value of visual support strategies. During the course of the study, initial data was recorded and then

statistically analyzed against the final outcomes of the project to determine the significance of the strategy used.

Delimitations

Kirkwood Elementary School is one of four elementary schools in the Toppenish School District. There are 474 students enrolled in grades K-5. Kirkwood Elementary employs 26 full-time teachers, four of which are special education teachers serving a high population of special needs students (19.6% of the student population). Free and/or reduced priced meals are provided to 100% of the student population.

Toppenish School District, located in Toppenish, Washington, is a small city in the Lower Yakima Valley, which resides within the boundaries of the Yakama Nation Indian Reservation. The local economy is a plethora of agricultural industry, family owned businesses, Native American enterprises, government support agencies, and educational service resources. City moral is high and a great deal of pride is taken in the upkeep and maintenance of city murals, landmarks, and cultural centers. Despite its location within the Yakama Nation Indian Reservation, there are not only large populations of Native American families, but high numbers of Hispanic families who make Toppenish their home as well.

Fourteen students participated in this study. Eleven were in 2nd grade and three were in 3rd grade. The ages of students ranged from 7 to 9 years old. Of the

14 students involved, 12 were boys and two were girls. Ethnographic data shows the student population to be either Native American (29%) or Hispanic (71%). Disability categories for students include LD (10 students), intellectual disabilities (three students), and ASD (one student).

Students participating in this study were randomly assigned to one of two strategy groups – one that was word-based and the other visual-based. Students received strategy instruction in the resource room 25 minutes per day over a three-week period of time. Materials used in this study were strategy cards and a test from Unit 3 of the *Investigations* 1st grade mathematics curriculum.

Assumptions

A main assumption in this research study is that visually supported math strategies will help LD students to better solve mathematical word story problems. When designing the experimental study, the two groups of participating students were assumed to be of similar socioeconomic backgrounds, ethnic makeup, and cognitive abilities. Both instructors (teacher and paraeducator) were well prepared and knowledgeable of the strategies involved to deliver quality instruction and teach students. A further assumption was that the students were highly motivated and put forth their best effort in learning their specific strategy and applying it. All students had access to high quality, supportive, and research-based materials/instruction throughout the course of the project.

Hypothesis

Learning disabled students who use a visual strategy will show greater improvement in solving mathematical word story problems than those who do not use a visual strategy. A visual strategy is defined as a learning tool, which utilizes graphic or visually oriented supports to help accomplish a task.

Null Hypothesis

Learning disabled students who use a visual strategy will not show greater improvement in solving mathematical word story problems than those who do not use a visual strategy.

Significance of the Project

Educators are constantly searching for strategies that will benefit students with LD. Should findings from this study show greater understanding in the solving of mathematical word story problems, other teachers may begin to implement this strategy into their classroom. Visual math strategies would not only be useful to students with LD, but might help those with other disabilities as well. Individualized Education Plans (IEPs) could also include information on the use of visual strategies under student classroom and testing accommodations.

Individual schools and entire school districts may find the results of this study interesting and useful for planning math interventions for students. District math coaches or lead teachers could use this strategy and/or other visual strategies to plan, prepare, and implement research-based intervention activities for students

struggling to understand mathematical word story problems. Math workshop times might also be an area where visually supported math strategies could help struggling students to improve their skills.

If, at the conclusion of the study, there is no support for the stated hypothesis, further experiments may be planned to gather multiple data sets. This particular study yields information on just one classroom. While the strategy might not show significant growth for the students involved in this instance, other teachers/students might find success. This study is merely the first step in a long road of speculation, experimentation, and analysis.

Procedure

The participants for this study were 2nd and 3rd grade students attending Kirkwood Elementary School. Fourteen students participated in the study and all of them received mathematics instruction in a resource room classroom daily. The majority of participants were male (12), as there were only two female students in the class. Disability categories for students included LD, intellectual disabilities (ID), and ASD.

Permission to conduct the study and use assessment data was given by the building principal (Appendix A). Students were randomly placed into two groups: one receiving instruction using a word-based strategy (Appendix B) for problem solving and one receiving instruction using a visual-based strategy (Appendix C) for problem solving. Data for this project was gathered through a

pretest of mixed addition/subtraction word story problems (Appendix D). Once the initial data had been collected, each group received instruction using their specific strategy for 25 minutes daily. Posttest results were gathered using the same testing instrument so as to compare growth between the two groups.

Definition of Terms

Specific terms used within the present study have been defined below:

Autism spectrum disorder. Disability characterized by deficits in language (expressive/receptive), social interactions, and repetitive behaviors.

Free appropriate public education. A major principal of the Individuals with Disabilities Education Act. Students with disabilities have the right to receive a free and appropriate public education that is specific to their needs, provides access to general education curriculum, and meets state standards.

Individualized education plan. Specialized plan created for students who qualify for special education services. It contains a summary of their present levels of knowledge/functioning, measurable goals/objectives, accommodation information for classroom and testing, and a summary matrix of services received (what and for how long).

Individuals with Disabilities Education Act. Federal legislative act that guaranteed rights for students with disabilities. The major principles are zero reject, identification/evaluation, free appropriate public education, least restrictive environment, procedural safeguards, and parental participation.

Intellectual disability. Disability characterized by significant impairments in cognitive functioning, adaptive, and social behaviors.

Learning disability. Disability where the individual experiences significant difficulties in specific areas of learning (reading, math, and/or writing).

Least restrictive environment. Students with disabilities are included with their general education peers as much as possible. Placements range from least (general education/resource room) to more restrictive (self-contained classroom) environments.

Visual support strategies. Graphically and/or visually oriented supports that help students to perform a variety of functions. The most common visual support is an activity schedule.

Acronyms

ASD. Autism Spectrum Disorder.

FAPE. Free Appropriate Public Education.

ID. Intellectual Disability.

IDEA. Individuals with Disabilities Education Act

IEP. Individualized Education Plan.

LD. Learning Disabled.

LRE. Least Restrictive Environment.

CHAPTER 2

Review of Selected Literature

Introduction

To support the research hypothesis, a comprehensive literature review was conducted to explore the findings of other professionals. Research was examined in three distinct areas: information on students with learning disabilities, challenges in solving mathematical word story problems, and the benefits of visual supports.

Students with learning disabilities (LD) face difficult obstacles to learning. Research-based strategies and supports are needed in order for them to benefit from instruction and retain the skills necessary to build academic knowledge. Mathematical reasoning is an area of concern for students with LD. Reasoning skills, such as those needed to solve mathematical word story problems, are becoming more desired because of their application to everyday tasks and possible vocational traits. Visual supports provide students with graphic representations of the material being studied. Research has been done to explore the capabilities that visual supports have in teaching language, prompting students to follow procedures, and increase understanding of academic concepts.

Each of these subtopics have been explored and discussed in the following pages. The literature reviewed consists mainly of peer-reviewed journal articles sought through electronic databases such as Academic Search Premier – EBSCO.

The research examined was relevant and as current as possible. Some older journals were used because of their historical precedence.

Defining Learning Disabilities, Student Challenges, & Supportive Practices

The term "learning disability" has been widely disputed and redefined many times by researchers striving to find a universal definition that encompasses the vast dimensions of this disability. In 1963, Samuel Kirk delivered a speech to academic professionals that clearly identified and defined this disability for the first time. Hammill (1990) refers to Kirk's definition:

> A learning disability refers to a retardation, disorder, or delayed development in one or more of the processes of speech, language, reading, writing, arithmetic, or other school subjects resulting from a psychological handicap caused by a possible cerebral dysfunction and/or emotional or behavioral disturbances. It is not the result of mental retardation, sensory deprivation, or cultural and instructional factors. (p. 75)

Kirk's definition explains that individuals suffering from a learning disability are hindered by dysfunctions or disturbances stemming from their brain and/or emotional/behavioral characteristics. This type of irregularity within the individual affects their learning ability in one and/or many academic processes - consequently making it extremely difficult to learn without the aid of special education services.

Kirk's identification of "learning disabled" individuals was precipitated by the concerns that parents had for their children. Parents and guardians of children living with a learning disability felt that they had been "inappropriately identified and placed in classrooms for children with mental retardation, or, were struggling within general education classrooms" (Vaughn, Gersten, & Chard, 2000, p. 99). These students had continually undergone scrutiny and other prejudices against them due to factors beyond their control.

Prior to the authorization of the Individuals with Disabilities Education Act (IDEA), students with disabilities were not allowed to attend public schools and were believed to be unable to learn. Students with LD had their challenges too, but due to the almost "invisible" nature of their disability, were able to take advantage of public education. When IDEA was passed, all students, regardless of their disability, had the right to a free and appropriate public education (FAPE). "For students with LD, who were already provided education within the general education system when IDEA was enacted (1977), special needs would now be identified and specialized treatment would be provided" (Vaughn & Linan-Thompson, 2003, p. 140).

Students with LD face constant obstacles to learning. Besides the obvious delays in development of academic skills, these students also experience social/emotional conflict, which impacts their self-concept, affect/emotions, perceptions, communication, and social behavior (Bryan, Burstein, & Ergul,

2004). Bear, Kortering, and Braziel (2006) conducted a study to examine differences among students with learning disabilities who complete high school and those who do not complete high school. At the conclusion of the project, they did not find significant differences in the areas explored, however, they did suspect, based on their data, that "the key to school completion…may not be the academic skill level possessed by these students per se, but each student's *application* of such skills (e.g., motivation to complete schoolwork and homework, to attend classes, to avoid suspensions)" (Bear, Kortering, & Braziel, 2006, p. 297). Students' self-concept of themselves will impact their learning and motivation to strive for success. Instruction and practice in building self-esteem, emotional/behavioral control, and motivation/effort, paired with specific and specially designed classroom activities will help to prepare students for achievement.

Vaughn, Gersten, and Chard (2000) express in their article, "The Underlying Message in LD Intervention Research: Findings from Research Synthesis," that "considerable progress in designing, implementing, and evaluating effective interventions for students with LD has been the hallmark of the last 2 decades in special education" (p. 100). Instruction and interventions to help students with LD have been developed, researched, and practiced for many years. Of the many in practice, the most effective are those that employ the following components:

1. Control of task difficulty – Differentiating content to make difficult tasks achievable and simple tasks more challenging (as needed per individual).
2. Teaching students in small interactive groups – Small groups of six students or less when teaching concepts.
3. Directed response questioning – Teaching students to ask themselves questions while they read and/or problem solve. (Vaughn, Gersten, & Chard, 2000)

Students in learning environments that take advantage of such methods/settings will have a better chance of benefitting from the academic tasks being done.

Students with LD may struggle in reading, writing, math, and/or a combination of all three. Mathematics especially can be very difficult to learn. Das and Janzen (2004) explain that, "many areas of the brain contribute to the successful learning and application of math skills" (p. 203). Moreover, that "students who begin school with a solid understanding of basic math concepts are likely to achieve greater levels of math competency in their lives, than those who have difficulty with math in the early years" (Das & Janzen, 2004, p. 203). It is therefore imperative that educators help students with LD to gain the math skills necessary to lead them into adulthood.

Learning Disabled Students' Difficulties Solving Mathematical Word Problems

"All students, including those often overlooked in mathematics education – students with learning disabilities – will require problem-solving skills to

navigate the demands of the 21st century" (Gallagher-Landi, 2001, p. 13). Problem solving skills are important, not only for math, but for real world applications as well. People utilize these skills daily in their jobs, home, and when working with other people. As the world continues to advance technologically, problem-solving skills will be needed now more than ever before. One way that schools help to stimulate these skills is through the practice of mathematical word problems.

"Students with learning disabilities often experience difficulties with mathematical word problem solving that may be compounded by problems in reading, computation, or both" (Jitendra, Hoff, & Beck, 1999, p. 50). Students with LD may struggle in one academic area or many. Mathematical word problems not only incorporate skills required to perform calculations, but they require one to read, comprehend information, visualize, estimate, and think abstractly. Students may also "exhibit problems such as attention deficits, memory problems, auditory-processing difficulties…and information-processing deficits that contribute to poor problem solving" (Gallagher-Landi, 2001, p. 14). It's no wonder that students with learning disabilities find these types of problems difficult – they may not have the skills necessary to perform these complex functions. However, it's not impossible for these students to learn how to attack word problems. Fleischner, Nuzum, and Marzola (1987) state that "positive

attitude[s] towards problem solving and appropriate cognitive style also have been shown to be associated with good problem solving performance" (p. 214).

Changing attitudes about mathematical problem solving will take a lot of effort and instruction in strategies that work. Schools have fallen short in teaching mathematics to students with LD. "Special education typically has focused on arithmetic computation rather than higher-order skills such as reasoning and problem solving" (Xin, Jitendra, & Deatline-Buchman, 2005, p. 181). There is a trend to focus more on teaching students to do calculations rather than engage in higher level thinking, which is required in order to problem solve. In addition, teachers who do teach story problem solving, only instruct students on how to pick out key words/concepts, which lead to a calculation, and then to their final answer:

> One commonly used instructional approach is the "key word" strategy, in which students are taught key words that cue them as to what operation to use in solving problems. For example, students learn that *altogether* indicates the use of the addition operation, whereas *left* indicates subtraction. Similarly, the word *times* calls for multiplication, and *among* indicates the need to divide. (Xin, Jitendra, & Deatline-Buchman, 2005, p. 181)

Strategies such as this one only scratch the surface level of the process, abandoning deeper meanings and analysis of the problem. Furthermore, they

leave students with elementary strategies to approach problems that require more thought and skill. Students with LD use "less developed strategies than typically achieving children, such as counting and occasionally modeling" (Jimenez-Gonzalez & Garcia-Espinel, 2002, p. 119).

Calculation skills are needed in order to solve word problems. Number sense and knowledge of operations (addition, subtraction, multiplication, and division) are essential to providing an overall answer, but students who have a true understanding of problem solving will be able to apply these skills in different settings. Jitendra, DiPipi, & Perron-Jones (2002) explain:

> Mathematical problem-solving instruction should not only emphasize conceptual knowledge of the operations but also facilitate a highly integrated understanding of the operations and the many different but related meanings these operations take on in real contexts. (p. 24)

Problem solving strategies should extend beyond the classroom and be applicable to real life situations. One way that educators have attempted to do this is through schema strategy instruction.

"The schema strategy is seen as a viable approach for teaching students with learning disabilities to solve addition and subtraction word problems" (Jitendra, DiPipi, & Perron-Jones, 2002, p. 25). A schema strategy and/or schema-based instruction is an effective way to teach students with learning disabilities how to solve word problems. In this type of instruction, students are

specifically taught how to organize the information and put it into a schema (structure) so that they categorize it to determine the best way to solve the problem. Many researchers have conducted studies on the benefits of schema-based instruction with learning disabled students. Xin (2007) explains that, "successful problem solvers seek and find underlying structural information (e.g., problem schemata), whereas unsuccessful problem solvers tend to focus on the surface features of problems" (p. 347). This organizational structure makes the problem clear and gives students with learning disabilities an extra tool to use in solving problems. The following guidelines, as cited by Jitendra, Hoff, and Beck (1999), are supportive of teaching word problem solving using a schema strategy:

- Teach prerequisite skills to a criterion level to master the task to be learned (i.e., identifying the different problem schemata).
- Introduce schema strategy instruction by providing explicit modeling, demonstrations, and explanations using several examples.
- Teach generalizable rules for determining the operation to use in solving word problems.
- Use frequent student exchanges to check student understanding of strategy steps and provide corrective feedback.
- Provide guided practice (i.e., mediated scaffolded instruction) in terms of presenting schemata diagrams as students learn to apply the strategy. Eventually, reduce the amount of scaffolding as students attain mastery

and have students generate diagrams to map information in word problems prior to solving them.

- Provide systematic and varied practice to help students retain and transfer learned skills.
- Use frequent measures (weekly tests) of student performance on word-problem-solving tasks to monitor progress.
- Systematically assess for maintenance and generalization of the strategy. (p. 63)

Diagrams have been proven to be especially helpful to students with LD. Schema-based instruction centers around the idea of organization and diagrams are a great way to put everything into perspective. Van Garderen (2007) explains that diagrams "can be used to help unpack the structure of a problem and thus lay the foundation for its solution, simplify a complex situation, and make abstract concepts more concrete" (p. 540). Diagramming information acts as a visual support for students with LD and could make word problems less frightening. However, despite their benefit, little research has been done on "representation strategies (e.g., paraphrasing and visualizing) to solve mathematical word problems. Generally, students with LD use representation processes infrequently, if at all" (Van Garderen, 2007, p. 540).

Benefits of Visual Supports

"Visual supports are pictorial and graphic stimuli that enhance comprehension and learning in individuals who may otherwise struggle with communication" (Arthur-Kelly, Sigafoos, Green, Mathisen, & Arthur-Kelly, 2009, p. 1475). They can be used in a variety of different ways to support individuals in their daily needs. Visual supports can indicate choices available to an individual, graphically demonstrate step-by-step procedures, signal transitions, aid in expressive language, and reduce anxiety – causing fewer behavioral outbursts in students with ASD (Arthur-Kelly et. al, 2009).

Research in the area of visual supports has predominately been with students with ASD. Students with ASD have trouble with expressive/receptive language, as well as impaired social skills and repetitive behaviors. Visual supports have been proven to increase understanding for these individuals and assist in transitioning, positive behavioral intervention/supports, and communication skills. The functionality and benefits associated with visual supports may not only help students with ASD, but LD students as well.

Students with LD often exhibit problems related to learning and memory. Johnston, Nelson, Evans, and Palazolo (2003) explain in their research that visual supports enhance a number of skills and processes, which include increases in expressive/receptive language and greater memory recall. Furthermore, "visual supports can attract and hold attention, thus enabling [a] student to focus on the

message, reduce anxiety, make abstract concepts more concrete, help prompt the student, and help the student to express his or her thoughts" (Rao & Gagie, 2006, p. 31).

One of the more useful modes of visually supported material is an activity schedule. Activity schedules are usually presented using pictures that have been organized to show a sequence. Students using an activity schedule can see what they are supposed to do now, as well as what is coming up next. Schedules give students structure within their day. Breitfelder (2008) elaborates:

> Most students need structure in their environment in order to be successful. As teachers, it is our job to do what is best for students and one way to help ensure success is by implementing visuals to structure their environment. (p. 4)

Rao and Gagie (2006) further stress the functionality and usefulness of visual supports in their work by listing their findings:

> [Visual supports] are part of everyone's communication system…They can attract and hold a student's attention…enable the student to focus on the message and reduce anxiety…make abstract concepts more concrete for the student… help the student express his or her thoughts. (p. 26)

Little research has been done on other uses of visuals supports with students. Future research and experimentation continues to be done to find additional outlets for its use.

Summary

Students with LD have unique learning needs. Many of these students struggle with reading, writing, math, or possibly all three. This is further compounded by deficits in memory and a lack of self-concept. A critical area of difficulty in math has to do with word story problems. Students struggle to make sense of these problems, but have to in order to meet the demands of future employment/daily living. However, visual supports may shed some light on the issue of problem solving, using graphic representation to increase student understanding, organize information, and have greater memory recall.

CHAPTER 3

Methodology and Treatment of Data

Introduction

The purpose of this study was to determine if a visual strategy for solving mathematical word story problems would better benefit learning disabled students than one that does not utilize a visual support. To accomplish this purpose, a review of selected literature was conducted to research information surrounding the present study topic. Furthermore, an experimental pretest-posttest research design was used to view growth that students made while participating in their respective strategy groups.

Fourteen 2nd and 3rd grade resource room students were randomly assigned to one of two strategy groups – one that was word-based and the other visual-based. Students received strategy instruction in the resource room 25 minutes per day over a three-week period of time. At the conclusion of the project, a final posttest was taken and results from all assessments were analyzed to decide which strategy method showed greater student growth.

Methodology

Permission to conduct the study and use anonymous student pretest-posttest results was given by the school building principal (Appendix A). This project utilized an experimental research method, which consisted of "…selecting and defining a problem, selecting participants and measuring instruments,

preparing a research plan, executing procedures, analyzing the data, and formulating conclusions" (Gay, Mills, & Airasian, 2009, p. 240). Students were randomly placed into one of two groups. The experimental group used the visual-based STAR strategy method (Appendix C), while the control group practiced using the word-based STAR (Appendix B) strategy method of solving story problems. At the end of the study, results were used to determine which strategy showed more significant growth.

Participants

Fourteen students participated in this study – 11 were in 2nd grade and three were in 3rd grade. Ages ranged from 7 to 9 years old. Of the 14 students involved, 12 were boys and two were girls. Ethnographic data would indicate this student population to be either Native American (29%) or Hispanic (71%). All students received daily instruction in mathematics in the resource room to benefit from specialized instruction. Disability categories for students include learning disabilities (10 students), intellectual disabilities (three students), and autism spectrum disorder (one student). Students with intellectual disabilities and autism spectrum disorder were included in the study so as to test the hypothesis on the greatest number of students. These students received instruction in the same time period block as all students with learning disabilities on a daily basis. To exclude these students, would mean denying them beneficial mathematics instruction.

Instruments

Kirkwood Elementary uses the *Investigations* mathematics curriculum. A curriculum-based assessment from the 1st grade version was used to gather numerical data. The same assessment was used throughout the study to measure growth between the groups. *Investigations* is published by Pearson Education and has gone through multiple measures to insure that its assessments are both reliable and valid.

Design

A pretest-posttest research design was used to gather data for this study. All students were initially assessed using a curriculum-based assessment that focused on addition and subtraction story problems. Pretest data was recorded and students were then instructed in their relative strategies. The same assessment was administered again at the end of the study.

Procedure

Approval to conduct the study and use results was given by the school building principal (Appendix A). A curriculum-based measure was administered to all students to obtain initial pretest data. The assessment used was called "Challenging Story Problems" from Unit 3 of the 1st grade *Investigations* mathematics curriculum (Appendix D). After scores were recorded, students were then randomly assigned to one of two groups. Both groups used the STAR word problem method. However, one group was instructed using a word-based

version of the strategy (steps written out on the strategy card) and the other a visual-based version of the strategy (steps illustrated with pictures on the strategy card). Students in both groups received strategy instruction in the resource room 25 minutes per day over a three-week period of time. Instruction was provided by the classroom teacher and paraeducator. The final posttest was administered at the end of the three weeks to all students. Results from both the pretest and posttest assessments were formatted into a table to compare scores.

Treatment of the Data

Data was statistically analyzed using the *t* test for independent samples. Scores from the pretest and posttest were analyzed using the STAT PAK, a computerized program for statistical calculations.

Summary

The experimental pretest-posttest research design laid the foundation in determining if a visual-based strategy was beneficial to students solving word problems. Fourteen students participated in the study. Students were of either Native American or Hispanic background and both male and female students were included. The majority of the class had LD, but students with ID and ASD participated as well. All students received strategy instruction daily for 25 minutes over a three-week period. Scores for statistical analysis were gained through curriculum-based assessment and treated using the *t* test for independent samples.

CHAPTER 4

Analysis of the Data

Introduction

The aim of this research study was to determine if a visual-based strategy for solving mathematical word story problems would better benefit learning disabled students than one that does not utilize a visual support. Students with learning disabilities participate in mathematics courses, which teach problem solving skills. Mathematical word story problems are often an area of deficit for these students and visual supports may provide a way for them to better understand and build the skills required to work through them.

Description of the Environment

Kirkwood Elementary School is one of four elementary schools in the Toppenish School District. Toppenish is a small city in the lower Yakima Valley that resides on the Yakama Nation Indian Reservation. The local economy is comprised of agricultural land, family owned businesses, Native American enterprises, government support agencies, and educational service resources.

An experimental pretest-posttest research method was used in this study. Fourteen 2nd and 3rd grade resource room students were randomly assigned to two different groups. Both groups were instructed on how to use the STAR word problem method. One group used a word-based strategy while the other used a visual-based strategy. Students in both groups received strategy instruction in the

resource room 25 minutes per day over a three-week period of time that was provided by the classroom teacher and paraeducator.

Hypothesis

Learning disabled students who use a visual strategy will show greater improvement in solving mathematical word story problems than those who do not use a visual strategy.

Null Hypothesis

Learning disabled students who use a visual strategy will not show greater improvement in solving mathematical word story problems than those who do not use a visual strategy.

Results of the Study

At the conclusion of this experimental study, results were analyzed using the *t* test for independent samples. For group A (non-visual group), a *t*-value of 0.93 with 12 degrees of freedom was obtained. For group B (visual group), a *t*-value of 1.21 with 12 degrees of freedom was found. Neither *t*-value score was significant at the .05 level (Table 1). Based on this information, the null hypothesis, learning disabled students who use a visual strategy will not show greater improvement in solving mathematical word story problems than those who do not use a visual strategy, was confirmed. The hypothesis, learning disabled students who use a visual strategy will show greater improvement in

solving mathematical word story problems than those who do not use a visual strategy, was not supported.

Table 1: T-values for Group A (non-visual) and Group B (visual)

Group	*t*-value	DF	Significant at .05 (1.782)
A	0.93	12	No
B	1.21	12	No

The pretest and posttest results, as well as individual student growth points, are illustrated in Table 2. While the hypothesis was not supported in this study, group B (visual) did show a little more improvement than group A (non-visual). However, it was not a significant amount of growth. This holds educational relevance, but it is not significantly supported statistically.

Table 2: Summary of Scores from the Pretest to the Posttest on Mathematical Word Story Problems.

Group/Student	Pretest	Posttest	Pre-Post Gain
A1	23	22	-1
A2	13	16	+3
A3	20	19	-1
A4	23	23	+0
A5	17	23	+6
A6	23	24	+1
A7	12	18	+6
B1	13	11	-2
B2	21	24	+3
B3	19	22	+3
B4	18	21	+3
B5	14	21	+7
B6	24	23	-1
B7	10	18	+8

Final Score Improvement (+) or (-): Indicates Improved (+) and Diminished (-) Performance on the test.

When a constant value of +3 (Table 3) was used to remove negative scores for analysis, the growth points measured 32 for group A (non-visual) and 39 for group B (visual). Group B growth scores were seven points higher than that of group A. In this study, group B (visual) had slightly more growth than group A on the test. However, it was not a significant amount of growth.

Table 3: Summary of Scores showing Constant Value of +3.

Group/ Student	Pretest	Posttest	Pre-Post Gain	Constant Value	Total
A1	23	22	-1	+3	2
A2	13	16	+3	+3	6
A3	20	19	-1	+3	2
A4	23	23	+0	+3	3
A5	17	23	+6	+3	9
A6	23	24	+1	+3	4
A7	12	18	+6	+3	9
				Total	**35-3=32**
B1	13	11	-2	+3	1
B2	21	24	+3	+3	6
B3	19	22	+3	+3	6
B4	18	21	+3	+3	6
B5	14	21	+7	+3	10
B6	24	23	-1	+3	2
B7	10	18	+8	+3	11
				Total	**42-3=39**

Findings

When group A (non-visual) and group B (visual) were compared, test scores for group B were slightly higher than that of group A. Despite the limited number of findings, the null hypothesis, learning disabled students who use a

visual strategy will not show greater improvement in solving mathematical word story problems than those who do not use a visual strategy, was accepted.

Discussion

The present study contains information that can be used to further investigate the use of visual support strategies in mathematics instruction for students with learning disabilities. The data did show a small increase in test scores when visual strategies were used to teach mathematical word story problems to students. This would be a beneficial practice to further develop.

Based upon the preceding analysis of data, it may be recommended that students use visual-based strategies when learning to perform mathematical word story problems. As previously mentioned in Chapter 2, Vaughn, Gersten, and Chard (2000) have explored many strategies for instruction and intervention to help students with LD build mathematical reasoning skills. Visual-based math strategies employ aspects of these, which have been proven to be most beneficial to this population of learners. This includes: differentiating content (using visual supports to build understand out of information that may have previously been too difficult), teaching in small groups (smaller teacher to student ratios provide more support for the students in using the strategy), and most importantly, using directed response questioning (utilizing the visual strategy as a guide to walk through the problem and have students ask themselves questions about what they're reading, seeing, and doing).

Factors that may have contributed to the support of the null hypothesis might be the number of students in the sample. A larger sample of 50-100 participants would have given more accurate information on the type of strategy that is most beneficial for a larger number of students (word-based vs. visual-based). While both groups were chosen at random, they may not have been completely similar in terms of ability level. Some of the group A students scored well on the pretest, leaving little room for improvement on the posttest.

Further limitations might be the inclusion of students with intellectual disabilities and autism spectrum disorder in the sample. These students do have challenges to learning, but their responses to the strategy and instruction could have been better or worse than those of the students with learning disabilities. Furthermore, there is a greater amount of research, which proves students with autism learn better with visual supports. Finally, this research study was conducted at the end of the school year, after students had already received instruction using other problem solving strategies. Future researchers might take these limitations into account and further clarify the benefits of using visual strategies in mathematical problem solving.

Summary

This chapter provided introductory information on the research project, a description of the environment, the hypothesis, results of the study, findings, and discussion. However, at the conclusion of the project, the statistical analysis did

not support the hypothesis. Data from this study slightly supports the statement that students who use a visual strategy in solving mathematical word story problems, will show greater improvement than those who do not. The use of visual-based math strategies could be recommended for use with students with LD, as they can incorporate best practices in instruction and intervention.

Limitations to the study may have led to the acceptance of the null hypothesis. The sample population was very small, with only 14 students participating in the study. Group A and B, while randomized, were not equivalent in terms of ability levels. Student pretest scores in group A were a bit higher than those in group B, leaving little room for growth. The inclusion of students with disabilities other than LD could have impacted the results as well. Especially since one of the students had autism and research already proves that visual strategies are more successful with this group of individuals. Moreover, those students could have been using other strategies taught to them throughout the school year.

CHAPTER 5

Summary, Conclusions, and Recommendations

Introduction

The purpose of this experimental study was to determine if visual strategies for solving mathematical word story problems would yield greater improvement results for learning disabled students than those strategies that do not use a visual support. Students with learning disabilities participate in mathematics courses, where reasoning skills present a direct challenge. Problem solving skills are difficult for these students and visual support strategies could help them to learn and retain the skills necessary to solve them.

Summary

The parameters of this research project were explained extensively in Chapter 1, citing specific information relative to the problem, background information, statement of the hypothesis, delimitations, assumptions, and significance of the research topic. An extensive review of literature was done to explore the findings of other professionals in three distinct areas: information on students with learning disabilities, challenges in solving mathematical word story problems, and the benefits of visual supports. This information helped to support the research problem that students with learning disabilities have problem solving difficulties. It also supported the need for and implementation of strategies that have proven beneficial. Visual support strategies have been proven to be very

effective for students with autism. It was therefore predicted that they may also work for students with learning disabilities as well.

This experiment utilized a pretest-posttest research design. The assessment used to collect initial information was called "Challenging Story Problems" from Unit 3 of the 1st grade *Investigations* mathematics curriculum. Pretest data was recorded and students were then instructed in their relative strategies (visual and non-visual). The same assessment was then administered again at the end of the three-week strategy instruction time.

Upon conclusion of the study, the data did show a slight increase in test scores when visual strategies were used to teach mathematical word story problems to students. However, the *t*-value score was not significant, supporting the null hypothesis that learning disabled students who use a visual strategy will not show greater improvement in solving mathematical word story problems than those who do not use a visual strategy. The hypothesis was not supported and therefore rejected.

Conclusions

Information gained from the comprehensive review of literature and the results of the research study draw a number of conclusions. Students with learning disabilities do require specific strategies targeted at skill deficits. Visual support strategies have helped to provide students with more concrete representations of mathematical ideas. Students performing poorly on

mathematical problem solving tests can improve their scores with the use of visual math strategies. However, further research is still needed to assess the effectiveness of visual supports and their application to mathematics instruction for students with learning disabilities.

The research hypothesis, learning disabled students who use a visual strategy will show greater improvement in solving mathematical word story problems than those who do not use a visual strategy, was not supported. Limitations may have led to the acceptance of the null hypothesis. However, despite the rejection, there was slightly more improvement shown in the group who used the visual strategy for mathematical word problem solving than the one that did not.

Recommendations

Recommendations can be made to educators based upon the data collected in this project. First, special and general education teachers should try to use as many visual strategies as possible to help accommodate students in their classrooms that may be struggling with mathematical concepts. There is a trend in education, presently, where districts are beginning to train staff in the implementation of GLAD (Guided Language Acquisition Development). Many GLAD components are centered around visual supports and educators may try to incorporate these more frequently, helping to address the deficits of students with disabilities.

A great deal of literature has been published on the topic of mathematical reasoning. Research suggests that students receive a great deal of teaching and practice related to calculation while reasoning skills are seldom addressed. Students need repetitive practice with tasks such as thinking aloud and explaining what they did to solve a problem. Students with disabilities, whether it be ASD or LD, have difficulties expressing their knowledge of mathematical procedures. Educators should teach more skills related to mathematical reasoning rather than focusing primarily on calculation instruction.

Lastly, teachers should receive further training and be given time to create visual outlines and/or strategies for students. Much of the research having to do with visual supports has come from professionals working with students who have ASD. Strategies that work effectively with ASD students also work well with LD, ID, and general education students too. Visual supports allow students to see what it is that they need to do and help guide them there. They also allow for independence in completing tasks, as students can see the breakdown in a series of steps.

People become teachers because they enjoy working with children and watching them grow. Teachers always have their students' best interests at heart and use research-based instructional strategies to help them learn. Visual support strategies and their application to math is a great area to explore. Students will

enjoy seeing what they're learning and may also develop better understandings of academic concepts through the use of visual mediums.

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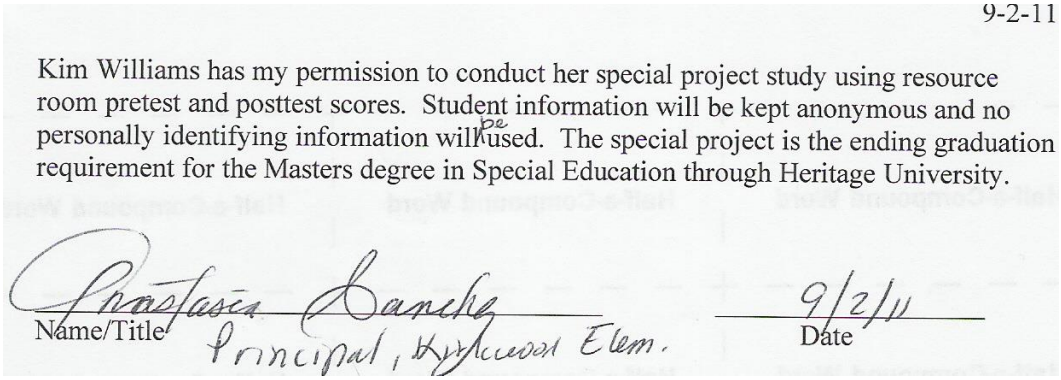
APPENDIX A: Permission



9-2-11

Kim Williams has my permission to conduct her special project study using resource room pretest and posttest scores. Student information will be kept anonymous and no personally identifying information will be used. The special project is the ending graduation requirement for the Masters degree in Special Education through Heritage University.

Anastasia Sanchez — 9/2/11

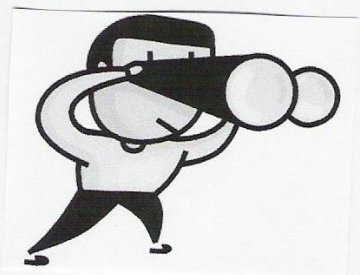
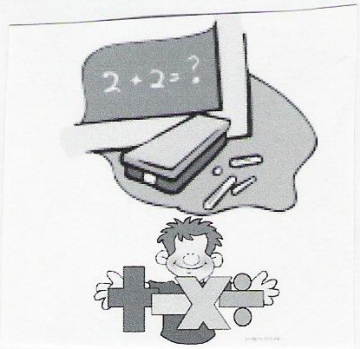
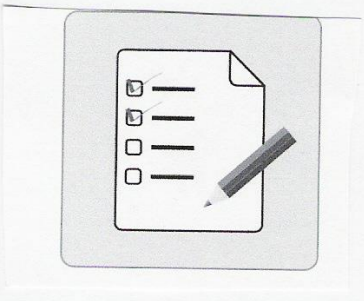
Name/Title Principal, Hyde Wood Elem. — Date

APPENDIX B: Word-Based Strategy Card

STAR Word Problem Strategy	
S	Search the word problem & write down the **facts**.
T	Translate the words into an **equation** and identify the **operation**.
A	**Answer** the problem and **show your work** in solving the problem.
R	Review/check your answer.

APPENDIX C: Visual-Based Strategy Card

STAR Word Problem Strategy

S **Search the Problem & Write Down the Facts**	
T **Translate the Words into an Equation & Identify the Operation**	
A **Answer the Problem & Show Your Work**	
R **Review the Answer**	

APPENDIX D: Pretest-Posttest Assessment

Name Date

Solving Story Problems

Challenging Story Problems

(page 1 of 3)

Solve the problems. Show your work.

1. Max and Rosa picked cherries.
They ate 18 cherries for lunch.
Rosa ate 6 more cherries after lunch.
How many cherries did Max and Rosa eat?

2. There were 4 children on the bus.
At the next stop, 13 more got on.
Then 6 more children got on.
How many children were on the bus?

Name Date

Solving Story Problems

Challenging Story Problems

(page 2 of 3)

Solve the problems. Show your work.

3. Rosa had 11 stamps.
Her father gave her 12 more.
Now how many stamps does
Rosa have?

4. Rosa had 21 balloons.
She gave 3 of them away.
Now how many balloons does
Rosa have?

Name Date

Solving Story Problems

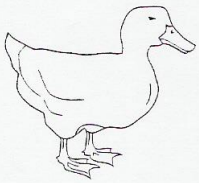
Challenging Story Problems

(page 3 of 3)

Solve the problems. Show your work.

5. Max had 19 pennies. He spent 15 pennies. Now how many pennies does he have?

6. Max's mom saw 23 ducks. 13 ducks flew away. How many ducks were left?



Name Date

Solving Story Problems

Assessment: How Many Books?

Solve the problem. Show your work.

Our class library has 8 books about frogs.
Mr. B gave us 5 more.
How many books about frogs do we have now?