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UTILIZING TECHNOLOGY TO ENHANCE READING COMPREHENSION WITHIN MATHEMATICAL WORD PROBLEMS

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UTILIZING TECHNOLOGY TO ENHANCE READING COMPREHENSION WITHIN MATHEMATICAL WORD PROBLEMS

A Project

Presented to the

Faculty of

California State University,

San Bernardino

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

in

Education:

Instructional Technology

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by

Michele Elizabeth Conley

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ABSTRACT

Many students who are proficient with basic math facts struggle for understanding when it comes to word problems. Teachers time and time again teach and re-teach problem solving strategies in hope that their students will one day acquire all the skills necessary to become proficient in this area. Unfortunately understanding problem solving skills is not the only answer to solving word problems. There has been a significant amount of evidence linking reading comprehension to mathematical reasoning. The development of a website to assist teachers and students who are having difficulties with mathematical word problems is extremely beneficial. The website is designed with links, power points, and examples that enhance reading comprehension within mathematical word problems. Through this project, it has been determined that students who are exposed to an additional mathematical program related to breaking apart word problems show evidence of a greater understanding and mastery of solving mathematical word problems.

ACKNOWLEDGMENTS

I thank my professors for assisting me through this process and giving me the guidance I so dearly needed. To my family for the love and support you have given me throughout the years to make this all possible. Mom, I know you are looking over me in heaven, and I want you to know that because of your faith in me I was determined to go back to school and complete my masters. I love you and miss you.

DEDICATION

This project is dedicated to my mom who never gave up on me and to my oldest daughter who I know will one day be responsible for many great things.

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CHAPTER ONE

BACKGROUND

Introduction

"Mathematics textbooks and standardized test contain an increasing number of word problems that students need to solve. As students progress in their education, word problems increasingly demand greater reading skills" (Van Garderen, 2004, p.225).

Many students who are at grade level proficiency in basic math skills lack the ability to transfer their mathematical knowledge into word problems. Teachers have discovered that word problems are difficult for students to comprehend at all academic levels. The link between reading comprehension and the ability to solve word problems is becoming more and more evident every day. Students who struggle with reading comprehension but are proficient in math are finding themselves at a standstill when it comes to solving word problems. According to Mercer and Sams (2006) "an increasing amount of attention has been paid to the role of language and social interaction in the learning of mathematics". Research by Francis, Rivera, Lessaux, Kieffer, & Rivera, (2006, p.33) states "the demands for mathematical proficiency have steadily increased over the last two decades and, as a result, the ability to reason mathematically compromises one's ability to participate

fully in society" Francis, et al. (2006), goes on to say, "All children must learn to think mathematically" (p.33). In order to bridge the achievement gap in under-performing math students, and to aid all students in mathematics, a systematic approach is necessary.

Statement of the Problem

Students who are proficient in mathematics and have the ability to calculate basic and complex math problems struggle when word problems are introduced. Analyzing word problems require a combination of reading comprehension, mathematical abilities, and problem solving strategies that many students lack the ability to combine.

According to the Center on Instruction (Francis et.al., 2006), there is a common misconception about mathematics:

> It is a universal language, one that is synonymous with numbers and symbols, and a "culture-free" static body of knowledge. However the instruction of mathematical concepts and skills and the difficulties experienced by many English Language Learners (ELLs) highlights the role of academic language in mathematics. (p.34-35)

Purpose of the Project

There is a gap in achievement in students' ability to solve mathematical word problems based on their reading comprehension. Students, especially ELLs need early, explicit, and intensive instruction. Kessler, Quinn, and Hayes (1985) stress that "processing mathematics successfully rest on the ability to utilize very precise language of mathematics in doing mathematical reasoning" (p.152). The need for a program that will concentrate on students' abilities to comprehend math word problems is getting larger every day. The purpose of the project is to design and develop a website which can assist students who are having a difficult time analyzing mathematical word problem. Being able to break down word problems into small steps and utilizing the vocabulary and strategies being introduced, students will be better prepared for success in mastering word problems.

Significance of the Project

The significance of the project was to assist students who are both proficient and non-proficient in math and reading comprehension obtain the skills necessary to become more successful in solving word problems. The main emphasis for this project was analyzing mathematical word problems. By focusing on the use of academic language in the area of mathematics, ELL students will receive the support needed to understand and solve word

problems. The web site created serves as a reference tool for educators and an interactive tutorial for students.

Limitations

During the development of the project, a number of limitations were noted. These limitations are as followed:

1. The main limitation is time constraints. Teachers do not have enough time in their daily schedules to incorporate the use of technology.
2. Resource constraints constituted the second limitation. The school used in the pilot testing was a title 1 school in southern California that did not have access to a wide variety of technology or materials. The group was limited to resources made available by the school.

Definition of Terms

The following terms are defined as they apply to the project.

- English Language Learners- Students who speak a language other than English at home.

- Social Economic Status- Social economic status is based on income, family education level, parental occupation, and social status in the community.
- Scholastic Aptitude Test- A standardized test designed to measure basic critical reading, math, and writing skills.
- NAEP-National Assessment of Educational Progress
- Reciprocal teaching- Reciprocal teaching refers to an instructional activity that takes place in the form of a dialogue between teachers and students regarding segments of text. The dialogue is structured by the use of four strategies: summarizing, question generating, clarifying, and predicting. The teacher and students take turns assuming the role of teacher in leading this dialogue (Palincsar, 1986).
- Mathematical Word Problems- According to Monroe and Panchyshyn (2005), "word problems can serve as a context in which to learn mathematics concepts. Experiences with word problems can provide a meaningful bridge for connecting classroom mathematics with real-world mathematics" (p.27).
    - Problem Solving Strategies – "Problem solving is generally regarded as the most important cognitive activity in everyday and professional contexts"(Jonassen, 2000, p.63). Problem solving strategies in mathematics is a systematic approach or set of procedures needed in order to solve a math equation.

CHAPTER TWO

REVIEW OF THE LITERATURE

Introduction

Solving mathematical word problems is not a concept easily taught across grade levels in elementary schools. Word problems are not as simple as solving basic algorithms, but a process involving procedures and conceptual thinking. Students who are at grade level proficiency in basic math skills lack the ability to transfer their knowledge into solving word problems. The link between reading comprehension and solving mathematical word problems is becoming more prolific every day.

The literature reviewed discussed the links between word meanings, the language barrier, and reading comprehension to solving mathematical word problems. There were several models presented on how to bridge the barrier between reading comprehension and solving mathematical word problems. The use of technology was a strong tool in assisting the cause. There are many benefits in using technology to lessen the gap as well as challenges.

Issues to Enhance Reading Comprehension within Word Problems

Problems in Word Problems

Research has noticed the importance of language in student performance on content area assessments such as math. “Nationally children perform 10% to 30% worse on mathematical word problems compared to math problems presented in numeric form” (Abedi & Lord, 2001, p.219). Through one study conducted by Jamal Abedi and Carol Lord (2001), it was found that students who were English Language Learners (ELLs) scored lower on math test than those students who were proficient English speakers. There were also differences in math performances based on socioeconomic status (SES) but not gender. ELL students score lower on standardized math achievement test in elementary schools, Scholastic Aptitude Test in the high schools, and the quantitative and analytical sections of the Graduate Record Exam compared to non ELL students.

For many people, especially English Learners, interpreting word problems is a difficult concept. Kintsh and Greeno’s (1985) model of understanding and solving word arithmetic problems indicates that part of the knowledge people need for solving word problems include the ability to use words such as *all, more*, and *less* in task -specific ways. Kintsch and Greeno (1985) also made the important assumption that students should treat words such as *have, give, all, more, and less*, in a special task specific way. The

assumption is significant in Kintsch's and Greeno's (1985) model because having the knowledge to treat these words in a task specific way will help in determining what information within the problem should be included or excluded, what information should be inferred, and how to construct the problem. Fuchs (2008), states that "although word problems require correct calculation for solutions, they differ from calculation problems because of the addition of linguistic information". She goes on to say that "a word problem requires students to construct a problem model by identifying what information is missing, determining the number sentence that incorporates the given and missing information, and deriving the calculation problem for finding the missing information" (p.155-156).

In general, students are not explicitly taught how to interpret certain words in specific ways. In school, mathematical procedures are taught without the direct instruction of specific terminology causing many students to fall short when it comes to solving word problems. If students are not taught explicitly what a word or phrase means when applying it to a specific problem or situation, then how can they be expected to adequately solve the problem?

According to Sovik (1999), "when arithmetical word problems are concerned, not only arithmetical knowledge but all kinds of linguistic, conceptual and situational knowledge are involved in the understanding of the problems" (p.3). When students do not linguistically understand what a problem is asking for, it is nearly impossible for them to choose the correct

strategy to solve it. Sovik goes on to say that “past research seems to have indicated that text problems are found difficult not always because of a faulty knowledge of arithmetic, but rather because of the way the problem is presented linguistically” (p.5-6) . In order for a student to be an effective math word problem solver, the learner should first be able to understand the purpose of the problem.

Effective Strategies to Teach Small Groups

Reciprocal teaching is a research based strategy supported by many reading specialist for developing comprehension skills. “Reciprocal teaching is an instructional approach designed to increase students’ reading comprehension at all grade levels and in all subject areas. Students are taught cognitive strategies that help them construct meaning from text and simultaneously monitor their reading comprehension” (Blazer & Miami-Dade County Public Schools, 2007, p.1). In reading, reciprocal teaching is student centered and involves students making predictions, questioning ideas, seeking clarification, and summarizing content (Pressley, 2002). According to Van Garderen (2004), Palinscar’s reciprocal teaching model can be modified for developing reading comprehension within mathematical word problems. The four major components of a modified method would include questioning,

clarifying, summarizing, and planning. Students would be divided into small groups with different roles to break down mathematical word problems. Salend (2001) suggest that students be provided with a student created math dictionary to assist in the understanding of math terminology. Modification can be created to enhance the learning of all students within the small groups. Van Garderen (2004), suggest that incorporating reciprocal teaching in reading mathematical word problems can be improved through specific instructional activities such as:

- Identifying the purpose of reciprocal teaching and why each strategy is important.
- Provide explicit instruction about what each strategy is and how to carry out each of the strategies.
- Modeling the use of the strategies by the teacher.
- Providing repeated opportunities to practice the use of the strategies with the teacher's
- Having the student's model and explain the use of each strategy
- Highlighting to the students when and where the strategy can be applied and making apparent how different students might apply the strategies in different ways to the same content (p. 224).

While reciprocal teaching has proven to be an effective method of instruction, there are issues to consider when implementing it in the classroom. According to Blazer (2007), educators should consider "the grade levels and

types of students most likely to benefit from reciprocal teaching instruction, optimum group size, appropriate number and length of reciprocal teaching sessions, and types of text to select for reciprocal teaching instruction" (p.11).

Technology Tools to Support Instruction

Advantages and Challenges of Using Technology

Integrating technology into the classroom is essential at every age level. Technology, as one resource, can play a significant role in fostering students' thinking about content and concepts (Wepner, 1992). According to McDonald and Hannafin (2003), many researchers, administrators, teachers, and parents advocate using technology to improve and increase student learning and motivation. When computer technology is aligned to standards based instruction, it can have a positive effect. Papert (1980) believed that computers could enable students to take control of their own learning. Chan and Ahern (1999) believed that by using the web, teachers can create individualized instruction to motivate students to help them achieve their full potential. A study conducted by Kulik and Kulik and associates (1985) determined that computer based instruction significantly improved the achievement levels of elementary students. Another study by Swenson and Anderson (1982) implies

that through implementing computer based instruction, students will be more motivated and will develop positive attitudes towards learning.

Though research has supported the idea that there are many advantages to using technology in the classroom, there are many challenges that must be overcome in order for technology to be truly effective. According to Tirupalavanam and Middleton (2006) schools that service a large number of ELL students and those that service families at or below the poverty level usually have fewer resources. They go onto say "there is considerable evidence that second language learners generally have less access to technology-enriched instruction than native English speakers" (p.102). In General, schools that service a high number of English Language Learners and students from low income families direct their monetary budgets on other areas of academics that do not include enhancing technology. In addition, families of low income students do not have the means to support technology learning at home.

Software Programs that Support Learning

Many programs have been developed which incorporate technology to assist students in their comprehension of math skills. Programs like Brainpop, Accelerated math, Star math, Study Island, and First in Math are valuable tools in student learning. These programs engage students in learning and provide

helpful feedback in analyzing students' abilities but do not provide specific guidelines for solving math word problems.

BrainPOP is an interactive math program. It targets all academic subject areas though the use of interactive videos. (brainpop.com, 2014).

Study Island is designed to help students master concepts specified in California's Content Standards. It is a web-based program geared to target learners at all academic levels. (studyisland.com, 2008.)

Accelerated Math provides the repeated practice of the core math curriculum. It gives teachers automatic feedback for individualize instruction (renlearn.com, 2008).

STAR Math assists teachers in determining the math level of students. It helps measure individual and class growth. Students are able to complete math assessments in a timely manner and teachers are able to get precise and dependable scores immediately (renlearn.com, 2008).

First in math is a computer based program designed to supplement curriculum. It assists students with fundamental math skills through interactive games and activities that focus on fluency while also promoting math reasoning and critical thinking skills. (firstinmath.com, 2014).

Each of the software programs described above provides unique characteristics that help make math instruction meaningful. When used appropriately, the software programs will employ students to become independent learners. Accelerated math and STAR math encourages students

to monitor their academic progress. Each program can be used as a very powerful teaching tool within the classroom, however if they are not used appropriately, they can take away from instruction. Software programs are meant to supplement the core curriculum. Without proper planning and implementation, the programs are not a valid use of instructional time.

Accessibility Issues and Principals

World Wide Web

The use of technology in the classroom is essential for the learning of all students in today's world. According to the Department of Education (2006), Internet access in instructional rooms grew from 8% in 1995, to 77% in 2000, and 94% in 2005. As students move into postsecondary education, the role of technology grows (Hoffman, 2005). Creating accessibility for all learners has been a challenge.

> For all learners to fully utilize the Internet and web-based materials, a website will need to grant equal access to all its users. Although students may have preferred learning styles and needs that require adaptations, utilizing a range of processes will appeal and apply to more students than a single process that may excludes large populations of learners (Optiz, 2002, p.3).

PowerPoint and other Presentations

Creating universally effective and accessible learning materials start with an accessibility diagnosis of the software, website, or learning application to determine problems and define solutions (Hoffman, 2005).

Table 1. Accessibility Requirements for the Web

Accessibility challenge	Potential Solution
Create text equivalent to graphic images	A text equivalent for every non-text element shall be provided (e.g. via “alt” or “longdesc,” or in element content).
Provide audio equivalent to visual presentation	Equivalent alternatives for any multimedia presentation shall be synchronized with the presentation.
Assist those with color blindness	Web pages shall be designed so that all information conveyed with color is also available without color, for example, from context or markup.
Provide alternative ways to select links from a server-side image map	Redundant text links shall be provided for each active region of a server-side image map.
Assist in making image maps understandable without visual representation	Client-side image maps shall be provided instead of server-side image maps excepts where the regions cannot be defined with an available geometric shape.
Assist in the understanding of tabular information	Row and column headers shall be identified for data tables. Markup shall be used to associate data cells and header cells for data tables that have two or more logical levels of row or column headers.
Create ease of site navigation	Frames shall be titled with text that facilitates frame identification and navigation.
Avoid excessive screen flickering, which might induce seizures	Pages shall be designed to avoid causing the screen to flicker by using a frequency greater than 2Hz and lower than 55Hz.
Avoid overuse of graphics, especially for content that is updated regularly.	Provide a text only page, with equivalent information or functionality. The content of the text-only page shall be updated whenever the primary page changes.
Make enhancements created with scripting language accessible to screen	When pages use scripting languages to display content or to create interface

readers.	elements, the information provided by the script shall be identified with functional text that can be read by assistive technologies.
Provide applet instructions to allow downloading for all types of learners.	When a web page requires that an applet, plug in, or other application be present or the client system to interpret the page content, the page must provide a link to plug in or applet that complies with 51194.21(a) through (l).
Provide a mechanism for learners with visual disabilities to complete forms	When electronic forms are designed to be completed online, the form shall allow people using assistive technology to assess the information, field elements, and functionality required for completion and submission of the form, including all directions and cues.
Enhance Website navigations	A method shall be provided that permits users to skip repetitive navigations links.
Allow self-paced manipulation of site for learners with motor difficulties	When a timed response is required, the user shall be alerted and given sufficient time to indicate more time required.

(See table 1, excerpted from Hoffman, 2005, p.173).

"People now have the tools to create presentations that use sophisticated graphics and text with vivid color, interesting animations, detailed charts and personalized templates. Our students should know how to use this new communication technology" (Shackelford, 2007, p.3). As teachers become more familiar with using the web as an instructional medium, interest including rich, interactive media also increases (Hoffman, 2005). Microsoft's PowerPoint presentation software has become a widely used tool for teachers to supplement instruction. Hoffman (2005) points out several general guidelines that can enhance the accessibility of PowerPoint presentations:

- Customize timing of animations.
- Simplified screen graphics.
- Text transcripts for any embedded media objects

- Color

Shackelford (2007) recommends that before a person prepares their power point presentation they should:

- Create a template or master slide for the presentation.
- Develop a summary of the information that you want to present.
- Effectively use pictures, clip art, text wrapping, animation, etc. to produce a quality presentation.
- Check the presentation to insure it has the necessary content
- Edit and revise the presentation for grammar, spelling, and language.

Shackelford (2007) suggest that the presenter also identify the following prior to creating their power point presentation:

- The intended audience.
- Where the presentation will be given.
- The equipment needed for the presentation
- The purpose of the presentation.
- The desired affect of the presentation.

The use of technology in the classroom is increasing everyday. Educators are becoming more familiar with the tools readily available to them via the internet and are now becoming more active participants in the creating

of supplemental materials. The need for universal guidelines is important in helping meet the needs of all learners.

Instructional Design Processes

Instructional design is a systematic process in which educators design, develop, and deliver lessons that will meet the needs of all learners. According to Fardanesh (2006, p.2),

> "instructional design is conducted when a set of activities and procedures are organized prior to instruction to achieve a set of knowledge, skills, and attitudes; therefore instructional design could be defined as prescribing and forecasting optimal instructional methods for achieving desired changes in knowledge, skills, and attitudes of designated students".

Fardanesh (2006), goes on to say that "there are two main theoretical approaches in the field of instructional design; the systematic approach; and the constructivist approach" (p.2)

The systematic approach has two commonly used instructional design models; the ADDIE model and the Dick and Carey model.

The ADDIE model is used for general purposes. This approach provides educators with useful, clearly defined stages for the effective implementation of instruction. The ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model provides a conceptual model for instruction. "The purpose of a conceptual model is to help students learn the value of the systematic

process for developing instruction. One of the values of the systematic approach is identifying what is to be learned, exploring teaching options, assessing learning, and evaluating the overall instruction and student learning" (Magliaro and Shambaugh 2006, p.88).

The Dick and Carey Model follow a behaviorist approach between the instructional material and the learning of the materials. According to AKBULUT (2007),

> "the Dick and Carey model consist of the following ten components: assessing needs to identify goals, conducting instructional analysis, analyzing the learners and contexts, writing performance objectives, developing assessment instruments, developing instructional strategy, developing and selecting instructional materials, designing and conducting the formative evaluation of instruction, revising instruction, and conducting summative evaluation." (p. 2)

Rapid Prototyping: An Alternative Instructional Design Strategy, (Tripp & Bicheymeyer, 1990) evaluates why prototyping may be appropriate for instructional systems design. Rapid prototyping, has been supported as an alternate instructional design strategy because it solves the effectiveness problems related to traditional software design methods while increasing achievement.

There have been several attempts to model the design process. Traditional models of the design process are condensed to three stages:

analysis, synthesis, and evaluation. Broadbent (1973) points out that these models do not specifically define a design process but a decision sequence. The method of software design that has been widely approved is rapid prototyping. Rapid software prototyping has been defined by Lantz as a "system development methodology based on building and using a model of a system for designing, implementing, testing, and installing the system" (Tripp & Bichelmeyer, 1999, p.35).

Rapid prototyping is appropriate for instructional design because it allows for the flexibility needed when dealing with the process of instruction.

The constructivist approach to teaching and learning is based on the combination of a division of research within cognitive psychology and social psychology. The basic idea is that an individual learner must actively build knowledge and skills and that information exist within these concepts rather than an outside environment. The advocates of constructivism all agree that it is the individual's processing of stimuli from the environment and the resulting cognitive structures that produce adaptive behavior. Crandall, Dale, Rhodes, and Spanos (1985) state that "language skills-particularly the reading skills needed to comprehend mathematics text and word problems and the listening skills required to understand and follow an instructor's presentation of a problem's solution – are the vehicles through which students learn and apply math concepts and skills" (p.130).

A major problem that the advocates are finding is that making a connection between thinking and behavior has proven to be misleading. One reason for this is that factors such as situation variables, emotions and consequences all play an important role in adaptive behavior.

Instructional designers attempt to design learning resources based on their research. Designers select learning methods and approaches based on several different learning theories and observations. Mather and Chiodo (1994), state that “it is important to evaluate the methods teachers are using to teach students in general and to evaluate the methods used in the process of teaching mathematics in particular” (p.1). When you have acceptance of a specific viewpoint, you have a different starting point to build a design. Constructivists suggest that educators first consider the knowledge and experiences that students bring with them to the learning task, and then build a design that will allow the students to expand and develop this knowledge. Behaviorists suggest that educators should first decide what knowledge or skill the students should acquire then develop a design that will lead to it. The major issue is whether to start with a design that is taught step-by-step as the behaviorists suggests or to start with the student’s knowledge and understanding of a particular concept and fill in the gaps as suggested by the constructivist.

Van Gog, et al., (2005), found the following:

> most researchers agree that ideally, instruction for complex skill learning should center on authentic tasks, should be adaptive to the individual learner's needs and capacity, and should support and motivate learners in acquiring the ability to plan, monitor, and evaluate their own learning process. (p.73)

The challenge in creating an effective design is to develop instruction that meets the criteria listed above as well as follow the guidelines set forth by both constructivist and behaviorist.

Summary

The literature important to the project was presented in Chapter Two. Research has found that there is a significant gap in achievement between reading comprehension and solving mathematical word problems. From English Language Learners to proficient English speakers, the language of math is one of its own. Technology is a tool that can bridge the gap between reading and math. Using different programs, following guidelines, and researching all available resources is the start to enabling students to becoming more successful in solving math word problems.

Today's students have access to a wide range of technological tools that allow them to use websites that will enhance their overall understanding of

basic math concepts. Through effective instructional design methods and learning theories, learners are able to take advantage of the multitude of resources that will assist in their overall understanding of math concepts.

CHAPTER THREE

PROJECT DESIGN PROCESSES

Introduction

Chapter Three documents the steps used in developing the project. Specifically, the design and development of a website that can be used by both teachers and students to improve the success rate of solving mathematical word problems.

Analysis

The significance of the project was to create a website that would assist students who are both proficient and non-proficient in math and reading comprehension obtain the skills necessary to become more successful in solving word problems. The main emphasis for this project was analyzing mathematical word problems. By focusing on the use of academic language in the area of mathematics, ELL students received the support needed to understand and solve word problems. The website created served as a reference tool for educators and an interactive tutorial for students.

Objective of the Study

The objective was to create a website that would serve as reference tool for educators to assist students in the area of mathematics, specifically on solving word problems. The needs of teachers would be assessed at the beginning of the study through a brief survey and evaluation will be administered at the end of the project through both a survey and interview.

Hypothesis

Teachers are in need of an additional tool, a math website, to assist students who are both proficient and non-proficient in math and reading comprehension obtain the skills necessary to become more successful in solving word problems.

Methodology

Participants had access to the website in order to navigate, utilize, and evaluate its effectiveness in teaching reading comprehension within math. Prior to accessing the website, a needs assessment survey was administered. Following the review of the site, an evaluation survey and interview were conducted.

Data Collection

Data collection was both qualitative and quantitative. Data was collected through the use of confidential surveys and voluntary interviews. The needs assessment survey consisted of 11 questions, and the website evaluation

survey consisted of 11 questions. Hard copy surveys were distributed to all participants. Interviews were conducted at Morris Elementary School in Rialto California in room B-4 and only took approximately 10-15 minutes per participant. Interview questions were open-ended questions, such as:

- What was your overall opinion of this website?
- What benefits did you see?
- What areas needed improvement?
- What information do you suggest be added to enhance this website?
- Is this website beneficial in teaching students how to solve mathematical word problems?
- Do you see your students using this website regularly?

Data Analysis

Data was analyzed through the use of frequency charts, tables, and graphs. Interview responses were coded to find emerging common themes. The survey results were not linked to the interview responses.

Dissemination

The website information was disseminated among colleagues via the internet and paper notices.

Participants

The learners for this project are third, fourth, and fifth grade elementary school teachers. The teachers range in experience from 10 years to over 30 years of teaching experience. The elementary school in which the teachers work at is located in southern California. The elementary school has approximately 697 students with 85.9% being English Language Learners. There are 3 third grade teachers, 3 fourth grade teachers, 3 fifth grade teachers, and one Resource Specialist (RSP) teacher participating in this study. All 10 teachers are No Child Left Behind (NCLB) compliant and have English Language Learners (ELL) with CELDT (California English Language Development Test) Levels ranging from 3 to 5. (Level 1 being beginning, level 2 early intermediate, level 3 intermediate, level 4 early advance, level 5 advance.)

Needs Assessment

The majority of teachers participating in this study have been teaching for over 15 years. The teachers use technology on a daily basis for managerial duties. The teachers incorporate the use of technology for students daily. Teachers do have daily access to the internet.

Instructional Technology

All teachers participating in this study have daily access to five dell desktop computers. Students are instructed to use the computers to take accelerated reading test, access Study Island and Ticket to Read, First in

Math, and to access BrainPoP. Teachers are beginning to use internet based programs to support mathematics and to teach problem solving strategies. The main usage of technology for math is by using First in Math.

General Teaching Preference

This group of teachers mainly teaches mathematics in a whole group setting rather than in small groups. Most of the learners in their classes are visual learners and need to see step by step instructions in orders fully understand a concept. The teachers prefer students using whiteboards during whole class instruction. For Accelerated Math, the students are put into small groups depending on the math objective they are working on and are able to collaborate in order to find a better way to solve a problem. Several students are hands-on learners and need to use manipulatives in order to work out a problem. Overall, the teachers use direct instruction for every lesson in mathematics.

Instructional Goals

In addition to developing stronger math students, teachers will develop strategies that will help students become successful in all academic areas as evident in the California Standardized Test (CST). According to the California Department of Education Mathematic Contents Standards for public schools 4th and 5th grade students should master the following standard addressing word problems:

Mathematical Reasoning

1.0 Students make decisions about how to approach problems:

1.1 Analyze problems by identifying relationships, distinguishing relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.

1.2 Determine when and how to break a problem into simpler parts.

Context Analysis

The idea of the learning environment for this school is one in which all students feel safe to participate, communicate, and interact. There are several different mathematic programs being used in this school on a regular basis, so flexibility is a must. On a daily basis, students are involved in using Accelerated Math, the district adopted math program, and Study Island. Study Island is a program bought by the school to help increase student achievement on the California Standardized Testing (CST's). Study Island is a leading provider of web-based state assessment preparation programs and standards based learning programs. With this program, the teachers are able to give direct instruction on a specific math standard and then the students are able to take a test on the computer (as long as they have internet connection) in the same format as the CST's. This is different than Accelerated Math in that the question format is identical to the SBAC. Accelerated math is a Renaissance program that allows the teacher to differentiate instruction for each student.

Accelerated math gives students individualized practice for a math objective they are working and allows the students to work at their own pace. For the district adopted text book, *Scott Foresman*, the district has established both a pacing guide to follow and has created chapter test to be administered regularly. The idea of this is to prepare the students for the Smarter Balanced Assessment Consortium (SBAC).

Design

Teachers are in need of an additional tool, a math website, to assist students who are both proficient and non-proficient in math and reading comprehension obtain the skills necessary to become more successful in solving word problems. The objective was to create a website that serves as this tool.

The design of this website involved creating PowerPoint presentations and tutorials for solving word problems, as well as researching various websites to incorporate as links within the website. Based on information gathered from the analysis of this project, it was determined that incorporating PowerPoints into the website was the best media outlet. Through PowerPoint presentations, learning objectives and goals were clearly stated, student-centered activities were easily implemented, and participant evaluations and feedback was quickly obtained.

Through the use of Rapid Prototyping, the ease of development in a web environment permitted design and development to occur at the same time.

Development

The development of this website involved creating a storyboard to outline the structure of the website. The storyboard included a flowchart consisting of links for problem solving strategies such as draw a picture, make a graph, and making a list. The next link consisted of interactive tutorials where one would be able to access sites such as brain pop and Study Island. The third main component consisted of problem solving tutorials with step by step guides on how to break down word problems.

Each PowerPoint followed the guidelines recommended in the literature review:

- Customize timing of animations.
- Simplified screen graphics.
- Color

The graphics and timing were appropriate for student usage. Navigation through the website was designed to be kid friendly and easily accessible to younger learners.

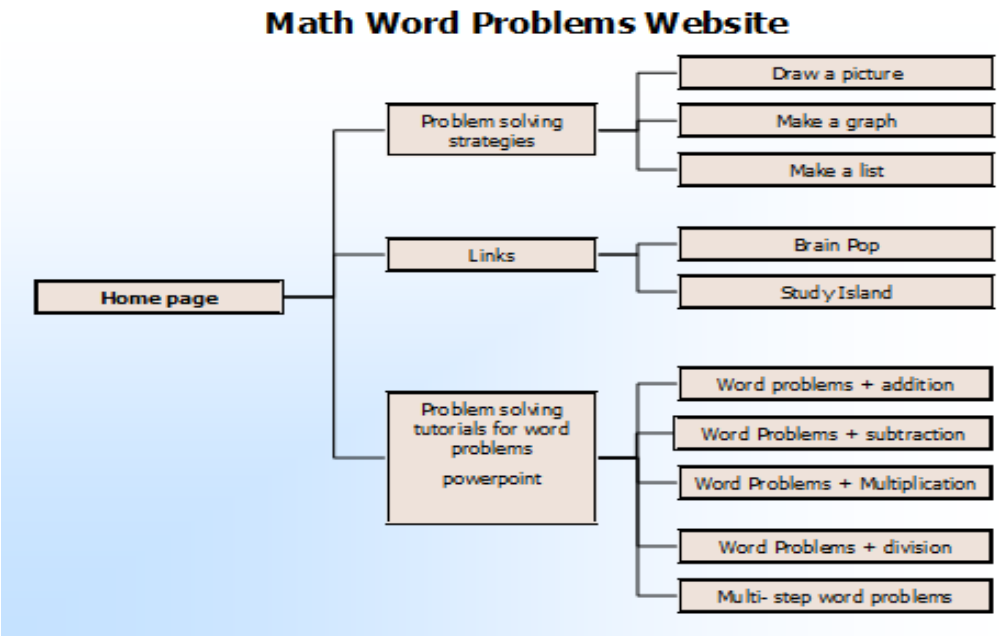

Figure 1: Math Word Problems Website

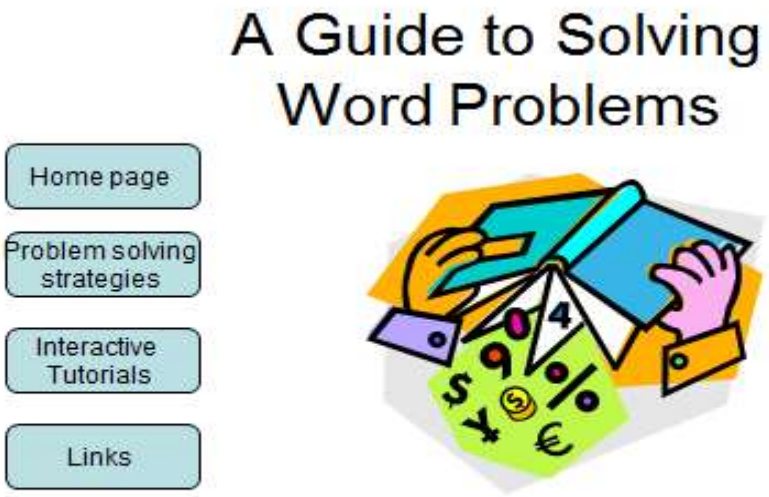

Figure 2: A Guide to Solving Word Problems

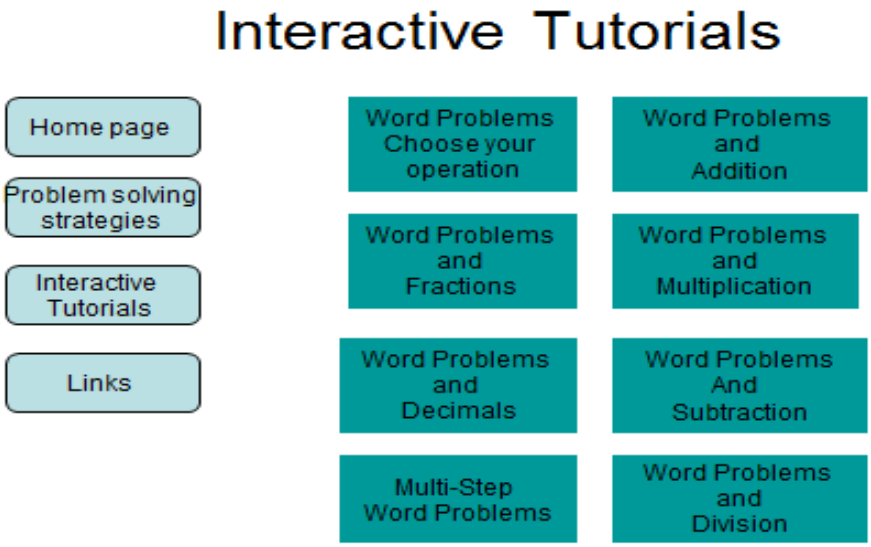

Figure 3: Interactive Tutorials

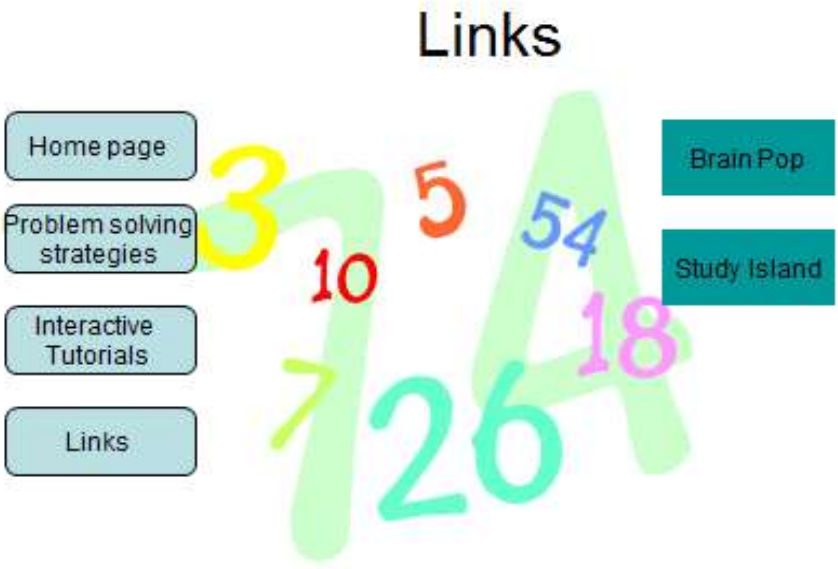

Figure 4: Links

Participants had access to the website in order to navigate, utilize, and evaluate its effectiveness in teaching reading comprehension within math. Following the review of the site, an evaluation survey and interview was conducted.

Delivery Environment

Teachers were given access to the mathematics website where they were able to scroll around and access several different math problem solving strategy tutorials. The math web site also linked users to several different math websites.

General Outcomes

Teachers anticipated that their students would increase their ability to solve word problems as evident on the SBAC, district benchmark tests, and study island. Students would improve their test scores by at least one level (i.e. below basic to basic, basic to proficient, proficient to advance, etc.).

Assessment Strategies

. In order to assess the effectiveness of the website, teachers were to give students an accelerated math test containing three to five word problems for each of the basic arithmetic operations. Students were to complete the test as an individual assignment with a passing grade being 80% or higher in accuracy for each operation. The power point presentations were used as informal assessment. Study Island which is a standards based software

program was utilized as an assessment to determine the proficiency level for each student. In order to score proficient or advance on Study Island, students needed to have score 70% or higher in solving word problems for each arithmetic operation.

Content Organization

The website was designed using feature from Dream Weaver. The design contains a homepage introducing the website. Within the homepage, there are links to problem solving strategies, interactive tutorials, and problem solving tutorials. The website contains PowerPoint presentations that may be viewed as Html or through a PowerPoint viewer. Several links to outside resources that focus on mathematics are accessible through this website. The guidelines for the website are structured to follow the recommendations of Hoffman (2005).Special attention has been made to meet the accessibility requirements for the web.

Content Sources

The content in which all lessons were derived from were based on the California State Content Standards. Materials had been obtained from the school district's adopted textbook series *Scott Foresman*. The majority of handouts and worksheets have been digitally created by Accelerated Math.

Testing and Improvements

Prior to implementation of the website, various tests were conducted. The website was evaluated using criteria established in the design section. Non-participants were given access to the website in order to make suggestions and improvements.

Implementation

In order for other teachers to implement the program a brief tutorial of the prototype was administered at grade level meetings. Teachers were given instructions as to how to navigate through the website as well as information pertaining to the tutorials and PowerPoints. Teachers were also advised to utilize the program in a small group setting that focused on reciprocal teaching.

The teachers introduced the website to students using small group, direct instruction. A modified approach of reciprocal teaching utilizing the following four components: clarifying, questioning, summarizing, and planning were used in the delivery of instruction. The use of reciprocal teaching in solving mathematical word problems allowed all students to work collaboratively in a student-centered learning environment. Students had the opportunity to change leadership roles within the group allowing them to feel comfortable among their peers. Through reciprocal teaching members of the

group were able to read the word problem, ask for clarification on vocabulary words and/or phrases, and use questioning strategies to solve key components of the problems. Once the key concepts were identified and all terms were clarified, students were then able to summarize the problem and devise a plan to solve it.

The use of reciprocal teaching gave all members of the group an opportunity to share their own thoughts and ideas. The structure was able to be modified to meets the needs of all students in the group. The use of academic language was emphasized throughout all lessons.

Evaluation

Evaluations were conducted through anonymous surveys and one-on-one interviews. The teachers expressed their appreciation of the word problem presentations through the brief one-on-one interviews. What was noticed by the majority of teachers was that the timing of specific animations in the PowerPoints were to slow. The students waited too long for the advancement of slides. This required a modification in the timing of the animations and slide transitions. Another thing that was noticed was that the questions were a bit remedial for some grade levels. This was done purposely in order for the concept to be taught without overextending the students' brains.

The teachers who implemented this program within their own classrooms returned with positive feedback. The navigation was simple allowing them to focus on the concepts. Several teachers began using the program through whole class instruction while a few teachers followed the suggestion of incorporating small group instruction utilizing reciprocal teaching strategies. The response was all positive with ideas to expand the tutorials to higher level concepts.

Summary

The design and development of this project was to create a website that included tutorials to enhance the development of solving mathematical word problems. The website was used a supplemental teaching tool for small group instruction with students. Colleagues were invited to use the website within their own classrooms and found it very helpful with their instruction.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

Introduction

In order for other teachers to implement the program a brief tutorial of the prototype was administered at grade level meetings. Teachers were given instructions as to how to navigate through the website as well as information pertaining to the tutorials and PowerPoints. Teachers were also advised to utilize the program in a small group setting that focused on reciprocal teaching.

The teachers introduced the website to students using small group, direct instruction. A modified approach of reciprocal teaching utilizing the following four components: clarifying, questioning, summarizing, and planning were used in the delivery of instruction. The use of reciprocal teaching in solving mathematical word problems allowed all students to work collaboratively in a student-centered learning environment. Students had the opportunity to change leadership roles within the group allowing them to feel comfortable among their peers. Through reciprocal teaching members of the group were able to read the word problem, ask for clarification on vocabulary words and/or phrases, and use questioning strategies to solve key components of the problems. Once the key concepts were identified and all

terms were clarified, students were then able to summarize the problem and devise a plan to solve it.

The use of reciprocal teaching gave all members of the group an opportunity to share their own thoughts and ideas. The structure was able to be modified to meets the needs of all students in the group. The use of academic language was emphasized throughout all lessons.

Conclusions

The conclusions extracted from the project follows.

1. Reading comprehension does affect one's ability to perform well on mathematical word problems. According to Sovik (1999),"not only arithmetic knowledge but all kinds of linguistic, conceptual and situational knowledge are involved in the understanding of problems" (p.3).
2. A program that breaks down mathematical word problems into small more manageable parts incorporating specialized vocabulary words would benefit all students.
3. Teachers feel that students who actively use the web site will show a significant amount of growth on all mathematical assessments. Papert (1980) believed that computers could enable students to take control of

their own learning. Swenson and Anderson (1982) argued that the greatest educational benefit of computer assisted instruction could be increased student motivation and improved attitudes.

4. It has been determined that small group instruction utilizing a modified version of reciprocal teaching will benefit all participants as evident through chapter test, study island, and district benchmark assessments. Van Garderen (2004) suggest that effectiveness of reciprocal teaching for comprehending mathematical word problems can be enhanced by the use of specific instructional actions.

Recommendations

The recommendations resulting from the project follows.

1. It is recommended that teachers begin their year by introducing key concepts in solving mathematical word problems. Larry Bell's Math UNRAAVEL strategies and 12 powerful words are excellent tools to utilize.
2. It is recommended that teachers meet with their students at least once weekly in a small group setting to teach and re-teach strategies to solve word problems. Reciprocal teaching strategies are student centered and allow for structured collaboration among peers.

3. It is recommended that students be directed to review the concepts of solving word problems on a weekly basis. Daily and weekly review of key concepts and strategies are imperative to the overall understanding and mastery of mathematic standards.
4. It is recommended that teachers who are interested in developing a similar project to research similar web sites and programs designed to enhance mathematical reasoning.

Summary

Solving mathematical word problems are a challenge for students at every academic level. By providing an additional amount of support in solving mathematical word problems through reciprocal teaching, modified instruction, and utilizing technology, students have a greater opportunity to be successful.

APPENDIX A

IRB APPROVAL

CALIFORNIA STATE UNIVERSITY
SAN BERNARDINO

Academic Affairs
Office of Academic Research • Institutional Review Board

June 13, 2013

CSUSB INSTITUTIONAL REVIEW BOARD
Expedited Review
IRB# 12075
Status
APPROVED

Ms. Michele Conley
c/o: Prof. Eun-Ok Baek
Department of Science, Math and Technology Education
California State University, San Bernardino
5500 University Parkway
San Bernardino, California 92407

Dear Ms. Conley:

Your application to use human subjects, titled "Utilizing Technology to Enhance Reading Comprehension within Mathematical Word Problems" has been reviewed and approved by the Institutional Review Board (IRB). The attached informed consent document has been stamped and signed by the IRB chairperson. All subsequent copies used must be this officially approved version. A change in your informed consent (no matter how minor the change) requires resubmission of your protocol as amended. **Your application is approved for one year from June 13, 2013 through June 12, 2014 . One month prior to the approval end date you need to file for a renewal if you have not completed your research. See additional requirements (Items 1 – 4) of your approval below.**

Your responsibilities as the researcher/investigator reporting to the IRB Committee include the following 4 requirements as mandated by the Code of Federal Regulations 45 CFR 46 listed below. Please note that the protocol change form and renewal form are located on the IRB website under the forms menu. Failure to notify the IRB of the above may result in disciplinary action. You are required to keep copies of the informed consent forms and data for at least three years.

1) **Submit a protocol change form if any changes (no matter how minor) are made in your research prospectus/protocol for review and approval of the IRB before implemented in your research.**
2) **If any unanticipated/adverse events are experienced by subjects during your research,**
3) **Too renew your protocol one month prior to the protocols end date,**
4) **When your project has ended by emailing the IRB Coordinator/Compliance Analyst.**

The CSUSB IRB has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval notice does not replace any departmental or additional approvals which may be required.

If you have any questions regarding the IRB decision, please contact Michael Gillespie, IRB Compliance Coordinator. Mr. Michael Gillespie can be reached by phone at (909) 537-7588, by fax at (909) 537-7028, or by email at mgillesp@csusb.edu. Please include your application approval identification number (listed at the top) in all correspondence.

Best of luck with your research.

Sincerely,

Sharon Ward, Ph.D.
Institutional Review Board

SW/mg

cc: Prof. Eun-Ok Baek, Department of Science, Math and Technology Education

909.537.7588 • fax: 909.537.7028 • http://irb.csusb.edu/
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