7-2008

A Study of the Summarization of Word Problems

Tara Schwanebeck
Riverdale, NE

A Study of the Summarization of Word Problems

Tara Schwanebeck
Riverdale, NE

A Study of the Summarization of Word Problems

ABSTRACT

This action research investigates my sixth grade mathematics students' ability to solve word problems after instruction and practice using a specific word problem summarization worksheet. The worksheet was designed to break down word problems into smaller parts, helping students comprehend them and, in turn, find success that would enhance their confidence and ability to successfully solve word problems. The worksheets each had a different type of word problem, such as one-step, hidden information, or extra information. The final worksheet consisted of a mixed review of each type of word problem previously practiced in class. Using different types of data collection processes, I discovered that repeated practice using the word problem summarization worksheet improved students' attitudes toward solving word problems and also increased their ability to solve word problems successfully, as indicated by the results of a posttest. This research suggests that using the worksheet in the classroom is a way to help students find a more manageable way to organize steps in the problem solving process while also improving their abilities to successfully solve different types of word problems.

INTRODUCTION

The focus of this action research is sixth grade students' ability to successfully solve word problems. Specifically, I am focusing on having students break down word problems into steps by using a word problem summarization worksheet. I am trying to determine if this strategy helps students solve different types of word problems and if they can apply the strategy when completing homework and tests. The purpose of this action research project is to increase awareness of the steps involved when solving a word problem and then applying it to classroom practice. It is imperative that students learn the steps needed to successfully solve word problems because it is a skill that they will likely use for the remainder of their education as well as a skill that they will use as functioning citizens, whether it be part of their career, paying bills, or maintaining a home.

I am trying to find features of my students' struggles with solving word problems, specifically if reading comprehension skills play a role. If my students learn to summarize word problems, and use other strategies to help them with comprehension, or understanding of word problems, will they be able to more successfully answer word problems? These are questions that I have been asking myself since I first stepped into a classroom.

The struggle of solving word problems has been evident in my classrooms since I began teaching four years ago. It has become a major issue in my three years teaching sixth grade mathematics. The easiest way to identify that it is a problem area is from a district sixth grade assessment that I must give to each and every one of my students. This assessment has the lowest scores of all sixth grade mathematics assessments that I give, and also by all other sixth grade mathematics teachers in our district as well. Our students seem to be struggling with successfully solving word problems. This comprehension of word problems also becomes evident when

looking at other areas of academics. Reading comprehension has been identified in our school as a problem that is being addressed school wide, and is the focus of our school improvement goals. A major component of successfully solving a word problem is comprehending, or understanding, what is being asked of you within the wording.

Like many mathematics educators, I see the National Council of Teachers of Mathematics (NCTM) Principles and Standard (2000) as relevant to mathematics curricula generally. It is, therefore, important for me to look at how my action research fits into that picture. The word problem struggles that my students are facing relates to the NCTM Principles and Standards in several different areas. It relates to the "process" standards in several different ways. It is evident to me that my students are consistently struggling with some component of successfully answering word problems.

If the culprit is indeed reading comprehension, the NCTM communication process standard would address the need of my students to clearly understand and successfully answer these computational problems that are "hidden in words." The NCTM process standard of "representation" indicates that my students not only need to be successful at solving computational problems, but need to be able to apply that computation when solving other word problems as well. It is important that my students practice strategies to help them solve problems that they may encounter. In order to solve word problems successfully students must understand them, relate them to meaningful learning situations and intellectual goals, and know what processes they can use to get to correct and useful answers.

It is critical that I address this problem of practice specifically in my own classroom for the success of my students. Practicing word problems gives students an opportunity to learn the skills needed to approach and solve problems. It is also important in my own practice, not only

because I am held accountable for teaching it to students at a local, state, and national level, but because it is a skill my students will need in the seventh grade and at each grade level thereafter. It is also a skill that they will need to possess no matter what they choose as an occupation.

If there is a relationship between a student's ability to comprehend what they read and their ability to successfully solve word problems, and if that relationship can be pinpointed and directly addressed in teaching practice, it may help take some time and guesswork out of finding the cause for teachers. If students are able, at the sixth grade level, to learn the skills and strategies needed to solve word problems they can learn to apply it at higher levels of thinking. Students that can successfully solve word problems can use those skills to help them become better problem solvers as well.

To be able to determine if a student's reading ability contributes to any student's success or failure at solving word problems would be invaluable information to use in my classroom. One reality I face is that I have many students reading well below grade level. Another is that the most challenging component of my curriculum is how to teach students to successfully solve word problems. In a perfect world, students would be able to read a word problem, comprehend it, know what strategy to apply, know what operation to use, and know how to appropriately label the answer. This is a lot to ask of students. There can be many steps to solving a word problem and many strategies to choose from when selecting how to solve it. In a mythically ideal classroom, there exists a fast and extremely efficient way to teach each and every student how to be successful at each and every component of successfully solving word problems. Until this becomes a reality teachers must continue to strive to help our students in ways that we know best. We can also continue monitor, adjust, and experiment to find new and better strategies to help them cope.

I try to address word problems in my classroom by teaching each strategy and practicing each strategy. We look at the problem to decide if there is extra information, hidden information, and how many steps it will take to solve the problem. Then, for each problem we address the appropriate operation to use and why. Throughout the year we list key words indicating each operation, such as more than, fewer than, per, and total. I also have students write and solve their own word problems. I have decided to change this for my action research project and to include important steps all on one worksheet. If a student can learn the habit to read closely and interpret the text of word problem, break it down into the important steps, and summarize and communicate what the problem is asking of her or him, I consider this a pedagogical achievement. By breaking each problem down and summarizing it, this requires reading comprehension and addresses the piece with which my students seem to struggle.

For this action research project, I had students practice problems using a word problem summarization worksheet for each word problem they attempt. This breaks down the word problems into steps useful in finding the required information. Students address the facts of the words problem, what they need to know to solve the word problem, what operation they will use, the key word that indicates that operation, the computation or number sentence within the word problem, the solution, and finally the label. They also check their solution to see if their answer is reasonable. I believe that if students practice and apply this, they will be able to successfully solve many different types of word problems.

MY INQUIRY PURPOSE

I realize that it is my responsibility to educate the students who enter my classroom and help them grow into productive citizens, regardless of what path they may choose for their future. It is my responsibility to equip each individual with the skills needed to perform at the

next grade level as well as to function successfully in this world. It is important for researchers and teachers to understand the complexities and hardships that students encounter when dealing with word problems. If we only focus on the solution, we may be missing an important piece of the puzzle.

My research addresses the steps involved in solving word problems. It is in the steps that it becomes apparent to me that with which students are struggling. This is important to know because it allows me to pinpoint, for each individual student, what feature of the process and the mathematics gives him or her the most difficulty. If all steps except, for example, the computation is correct, then it will be vital to emphasize that to the student as an area of focus. Or, alternatively, if a student continues to use incorrect labels, it is obvious on his or her word problem summarization worksheet. I then bring that to the student's attention as an area of focus.

Year after year, I continue to see student frustration with word problems in my own classroom and at a district level. Confidence levels will be critical in persuading struggling students that they can successfully solve word problems. If students think they are good at working word problems and experience some success, I believe they will put forth more effort. Any classroom teacher who has struggling students strives to help those students become successful. As a teacher, a goal for every student that enters the classroom is success. In my research I am attempting a strategy that I think will promote success for students specifically dealing with word problems.

WHAT THE LITERATURE HAS TO SAY

The research on word problems has many themes. I will focus on the following themes: the different types of word problems that researchers have studied, student comprehension of

word problems, students' perceptions and attitudes toward solving word problems, and instructional techniques that have been researched in regards to teaching students how to solve word problems. Other themes were discussed in the research, but I will not address them as they do not specifically pertain to my action research project. One of them was word problems in regards to student completion of homework. Another theme was student problem solving. In this paper I am not discussing problem solving, I am looking specifically at word problems, sometimes referred to as story problems.

Types of Word Problems

There are many strategies used when solving word problems, dependent on the type of word problem that one is trying to solve. Typically students are taught strategies one at a time for specific types of problems, for example, working backwards, guess and check methods, finding a pattern, drawing a diagram, and so on. This can both benefit and hinder student performance. It may benefit students because when they know that they are working on one specific strategy, they know exactly what strategy to use. It may be a hindrance for students when teachers intersperse strategies together on an assignment because they may have a difficult time deciphering when to use what strategy. This is especially true when the student does not fully comprehend the word problem and/or the strategy to use. Another problem for students could lie in the calculation of the word problem. It is then difficult for teachers to determine the barrier for students who are trying to successfully solve the word problem.

Word problems, like many other mathematical concepts, can be solved in a variety of different ways using multiple strategies. Montague and Applegate (2000), both university professors, did a study on 54 students of different ability levels to determine their perceptions of very easy to very difficult word problems; the pair then had the students solve the problems

while being timed. Montague and Applegate found that gifted students or students with higher ability used more strategies and representations when solving word problems than lower functioning students. Their strategies for solving the word problems were also more complex than those students of lower ability. They also discovered that higher ability students, when given a more difficult problem, were more persistent in solving the problem.

Verschaffel, Corte, and Vierstraete (1999), from the University of Leuven, Belgium, did a study on 99 fifth graders and 100 sixth graders with differing socioeconomic backgrounds. One of the factors they looked at with word problems is how they were interpreted. They called these 1+ or 1- problems because the student had to interpret the correct answer based on the wording of the question. Some of the factors students had to consider were more abstract. For example, "John's best time to run the 100 m is 17 seconds. How long will it take him to run 1 km?" (p. 226). One might consider the fact that John could not maintain a constant speed throughout a longer run. Another example would be "There are 450 soldiers to be bussed to their training site. Each bus can hold 36 soldiers. How many busses are needed?" (p. 226). Exact calculation of the word problem does not yield an answer that the authors are looking for, in this case students need to round the exact answer to the next larger whole number.

These types of word problems are difficult for children because after finding an exact calculation, they must interpret that answer to make sense and fit the word problem. Verschaffel, Corte, and Vierstraete (1999) also note that these word problems can be ambiguous, adding another level of complexity for the student who is solving it. Also, if given as an assignment, students may recognize the ambiguity in one word problem and try to manipulate each answer as they did the last, though at times it may not be needed. This can leave struggling students unsuccessful and frustrated. Research about the different types of word problems leads one to

believe that students can be successful at solving word problems. There are many variables to consider when teaching word problems, such as the degree of difficulty due to factors such as the number of steps, the strategies involved, the wording of the problem, and the students interpretation of the problem.

Comprehension of Word Problems

There are many students who report to mathematics classes each day reading below grade level. Many of them seem to enjoy mathematics because they struggle reading and perceive mathematics to be a subject with little reading and writing. Word problems are an obstacle to those students and they feel frustrated in their attempts to solve them. It is difficult to assess whether or not the students are unsuccessful due to the lack of comprehension while reading the problem, or to the mathematical skills involved in finding the solution.

Computation and comprehension of word problems are both critical in the success of solving word problems. From Fordham University, Robinowitz and Woolley (1995) did a study to try to determine if computation and comprehension were tied together or if only one or the other played a role in student success. Their subjects were 78 undergraduate students from the University of Chicago. When students who are struggling focus on the computation and numbers from the problem, they may miss out on what the word problem is really asking. This study found that there is no interaction between computation and calculation when solving word problems. The researchers found that with an increase in the size of the problem, only the difficulty level of the problem goes up, but the understanding of the numbers involved and the way to manipulate them does not.

After administering a test to 450 students from seven elementary schools to determine if there is a pattern to students thinking and ways of solving word problems, Christou and

Philippou (1998), from the University of Cyprus, determined that if students cannot solve easier word problems, such as one step problems, then they will not be able to solve more difficult word problems. "The fact that pupils were unable to solve a higher level problem unless they could solve problems of the preceding level seems to provide compelling evidence that the levels, as identified, might generate a hierarchy of thinking" (p. 438). This reveals that students must be able to understand the problem and then must know how to calculate it in order to successfully solve it. Reading comprehension, then, plays a major role in a student's ability to successfully solve word problems.

Franke and Kazemi (2001) discuss how research regarding Cognitively Guided Instruction (CGI) affects the teaching and learning of mathematics. They observed and analyzed how first grade teachers, who were well versed in CGI, presented material to their students over time as they understood more about how their students learned. Their discussion is very similar to that of Christou and Philippou (1998). Franke and Kazemi (2001) discuss that students have to have an understanding of what they are doing currently and then apply it as they gain new knowledge. When applied to word problems, students have to be able to comprehend what the problem is asking of them. If students comprehend, they can then apply what they have learned to unfamiliar problems. However, if students do not learn with understanding, or comprehend the task, each new problem is unfamiliar and isolated from all others. They will only be successful if given direction on that very type of problem for each problem they attempt.

When looking specifically at reading comprehension and how it affects a students ability to solve word problems I found contradicting research. Franke and Kazemi (2001) and also Christou and Philippou (1998) both indicate that when solving word problems, students must understand what the word problem that they are reading in order to successfully solve it. From

their articles I would say that they think that the comprehension and calculation of word problems go hand in hand. Robinowitz and Woolley (1995) found otherwise. However, these researchers did suggest there could be factors in their study that one would want to further evaluate for validity. With my research I am attempting to help students reading comprehension by summarizing the word problems. In doing so, I hope that I find improved comprehension of word problems leads to greater success in doing correct calculations, therefore increasing student performance.

Students' Perceptions and Attitudes Toward Word Problems

It seems as if students' success or failure is sometimes dependent on their persistence and attitudes toward the task. When researching word problems, perceptions and attitudes became an emerging theme. In my research, I will be interviewing students and also having them fill out a survey on their perception and attitudes of word problems. Research that I found, in general, discussed that higher ability students have a more positive feeling toward word problems and lower ability students are more negative, as one may have assumed, when measuring their success.

In a presentation at Cordell University that was adapted into an article, Peterson (1991) discusses the perception that many students may have. He suggests that some students believe that mathematics is "an unchanging body of knowledge that must be painstakingly and painfully passed on from generation to generation" (p. 37). He also discusses that many parents feel that mathematics was an intimidating course for them and pass this belief to their children. Franke and Kazemi (2001) discuss the fact that learners must be responsible for acquiring knowledge and making it their own. I think if they can do this they can overcome the perception that Peterson discusses.

Other than parental views, students may also be affected by the view of their classroom teacher and how he or she feels about word problems as discussed by Franke and Carey (1997). They interviewed 36 first graders and analyzed their perceptions of mathematics in problem solving environments. They looked at two different schools with different demographics, but all students came from CGI classrooms. When given different types of problems the researchers found that student perceptions of success did not depend on speed or accuracy when they are in a problem solving environment. Franke and Carey (1997) recognized that there could be many different strategies when solving problems and that student discussion was an indicator of success. In this particular article, the problem that the students completed and the interviewers analyzed were word problems, that these researchers referred to as problem solving.

Some of the students from Franke and Carey (1997) believed that the teacher was the one person who determined the correctness of their answers, but most students believed that they were the ones who could determine the correctness of their answers. This indicates that in an environment where students are immersed in answering word problems and discussing their solutions with other students, the role of the teacher is to be a facilitator and the responsibility shifts toward the student. This is a change from what many would consider a typical classroom with typical perceptions.

Wildmon, Skinner, McCurdy, and Sims (1991) from Mississippi State University looked at student perceptions of word problems with a focus toward how they felt about the difficulty level of their homework. For their research, they had 76 high school students complete two assignments. Along with the assignment was a survey of which assignment was the easiest, which assignment took the shortest amount of time, and which took the least amount of effort. Each assignment had the same number of word problems on it that were at the same level of

difficulty. The difference was that one assignment had extra, easier word problems scattered throughout. The findings indicated that most students preferred the longer assignment with easier problems dispersed in it. Their findings suggest that student attitudes toward assignments could be improved by adding additional, easier word problems even though it makes the assignment longer and more time consuming.

Although Wildmon, Skinner, McCurdy, and Sims (1991) do not know the exact reasoning for the results in this study, one can look at student perceptions and attitudes. Overall, student perceptions indicate that even though the assignment had more word problems, if there are easier problems dispersed in it a student is more likely to complete the homework. The student's attitudes when solving the easier problems become more positive toward the homework as well.

It is apparent that when students perceive something to be easier they are more likely to feel success and have a positive attitude toward it, as Franke and Carey (1997), and also Wildmon, Skinner, McCurdy, and Sims (1991) have indicated in their research. For my research, students will be summarizing word problems and breaking them down into more manageable pieces. In doing so, if they can perceive this as an easy task and find success, then their perceptions and attitude toward word problems will likely become more positive.

Students' Struggles When Attempting Word Problems

Word problems have many components; it is often difficult to analyze what part of it a student may struggle with. When students begin a word problem, first they must comprehend what they have read. Then the student must somehow model the problem to interpret how to manipulate the numbers. The calculations typically have to be precise and then the student must choose the correct label that fits the problem. With all of these steps to consider, it becomes

obvious why some students may struggle. Researchers have indicated specific reasons as to why students may have a difficult time successfully answering word problems.

Verschaffel and Corte (1997) chose three classes of children who were between the ages of ten and twelve. One experimental group was taught using realistic modeling of word problems and the two control groups followed the regular mathematics curriculum. They determined through the control group that students could develop a disposition toward more realistic mathematical modeling. The authors comment that these real world problems should permeate a mathematical curriculum as students begin their education. According to the results of the study, students should be immersed in interpreting real world problems in order to practice the basic computational components of mathematics.

As Verschaffel and Corte (1997) believe that students should be immersed in solving word problems from a young age, Li (1990) has found that younger children may have a more difficult time creating a mental image in order to help them with the problem than an older child. Therefore, during the early stages in their education concrete modeling may help them to be more successful. Li tested forty, six and seven year olds using one step addition and subtraction word problems. He created his word problems with and without surplus information. His findings showed that students correctly solved fewer of the word problems with unnecessary information than those that did not have extra information. He comments that even the slightest change in a word problem could affect how the students would perform when answering it.

Sovik, Frostrad, and Heggberget (1999) add to this idea with their research. They are professors at the Norwegian University of Science and Technology with the Department of Education. In their article they commented that not only arithmetic knowledge is vital, a student must also have conceptual, linguistic, and situational knowledge to understand a word problem.

One specific component that can make a word problem even more difficult for a student is the way that it is expressed linguistically.

In the study completed by Sovik, Frostrad, and Heggberget (1999), they specifically looked at four groups of fourth graders with different ability levels in reading and mathematics and examined the strategies they used in solving word problems. Their findings reveal similarities in the deductive strategies used between those students who are good at both reading and mathematics, and those who are good at mathematics but not reading. There are also similarities in the other two groups, those who are poor at mathematics but good at reading, and the group that was poor at both, they used more procedural strategies when solving the problems. The final find from their research was that each student's IQ was a strong predictor of the strategies that the students would choose when solving word problems. This again indicates that the lower ability students in mathematics have fewer and less developed strategies for solving word problems.

There is even more research to expand the previous findings. Gonzalez and Espinel (2002), professor and assistant professor at the University of La Laguna, Canary Islands, Spain, did a study on 148 students who were between seven and nine years old. They first tested students who were verified in special education. Secondly, those who struggled but were not identified as special education students they labeled as the Garden Variety (GV) students. Lastly, they tested those who were typical achieving students. Both of the lower groups of students used less developed strategies when solving word problems. These students had to refer to the most basic strategies such as counting up, where they use their fingers to do the computation.

There are many components to solving a word problem. The research I read has similarities. For example, the lower ability students have less developed strategies and therefore

have a more difficult time solving word problems than their typical achieving peers. The

summarization worksheet that I will be using to conduct my research has each student break

down each word problem. I think that this will give my struggling students an opportunity for

success. I realize that it will probably be easier for some of my students than others.

Instructional Techniques When Teaching Word Problems

Peterson (1991) sees the world of mathematics evolving from a static, unchanging

subject, into a subject in which the focus lies more in applications allowing mathematics to be

more accessible to outsiders. From the research that I read, the overall feel of how mathematics

is best taught to students was similar to that of Peterson's. Many researchers did not comment on

how to teach using applications, but commented on the fact that in the past, mathematics has

been a subject based more on arithmetic practice and less on worldly applications.

When comparing American textbooks to Chinese textbooks used in classrooms, Li (2000)

made an interesting find. She constructed her study to determine the difference in expectations of

the problems found within the different textbooks. Li found that the Chinese textbooks typically

had a higher level of mathematics content and often had more problems. American textbooks, in

comparison, emphasized conceptual understanding and also varied more in problem

requirements. This finding indicates that if American teachers are teaching from textbooks,

students may be exposed to more word problems and problem solving type situations.

When teaching students to solve word problems, teachers must consider many factors.

One not often considered by teachers, is the ambiguity of the problems as indicated by Cooper

and Harries (2002). Their study gave students two realistic problems, one from a national test

and one that they adapted to encourage a more realistic response. They found that if given the

opportunity and the right word problems, young students may be more ready to think realistically than they had previously thought.

Cooper and Harries explored student responses and thoughts to the elevator problem. "The lift can carry up to 14 people. In the morning rush, 269 people want to go up in this lift. How many times must it go up?" (p. 5). The authors then questioned the students through interviews as to how realistic their answers were. The best answer, according to a typical classroom teacher, would probably be found by taking 269 divided by 14 and rounding the decimal up to arrive at an answer of 20 times. Students, however, came up with several different answers that could have worked. A few student responses were below the computational answer because realistically, if people were in a hurry, they may crowd more people than allowed in the elevator, or people may take the stairs. Other students concluded, as a typical classroom teacher might, the computational answer was found by rounding to the next whole number. Some students gave an answer larger than the computational answer because there may not be 14 people on the elevator each trip. Each of these answers could, in all likelihood occur, but in a typical classroom setting, teachers would only accept the answer that was rounded to get an answer of 20 times. Teachers need to be flexible and listen to student responses when teaching word problems.

Garderen (2004) was the researcher who I found who addressed the summarization of word problems. She used reciprocal teaching, typically used for reading comprehension, and applied it to mathematical word problems. In her classroom, she had students work in small groups and discuss each of her four steps when solving word problems. They are clarifying, questioning, summarizing, and planning. This process allowed her students to discuss their

thinking with other students. Working collaboratively also let her students see other students' thought processes.

For my action research project, students will learn a summarization strategy that breaks down each word problem into parts. This summarization strategy will have students identify key words helping them choose the correct operation, draw a representation, do the calculations, find the correct label, and check for reasonableness for each word problem. My action research is different in that I am specifically looking at a summarization strategy to increase student performance when solving word problems.

THE PURPOSE OF STUDYING WORD PROBLEM SUMMARIZATION

The purpose of my research is to determine if breaking word problems down step by step increases student success in finding correct solutions and labels for word problems. I know that many of my students are reading below grade level. Reading ability does not seem as if it would directly affect student performance in mathematics, but it stands to reason that it does if students do not comprehend what a word problem is asking. My study will force students to break down each part of a word problem increasing their comprehension creating more success when solving word problems.

I am seeking to understand the consequences of students using a summarization strategy. After practicing the summarization strategy repeatedly, I am interested in knowing whether students transfer what they learn from the summarization worksheets onto homework and tests. I will be examining the student attitudes toward solving word problems, student ability to summarize a word problem, and student success at solving word problems in seeking to answer the following research questions:

1. What does my teaching look like when I try to teach specific word problem strategies to my students for greater comprehension?

2. What will happen to my students' abilities to solve word problems if they learn to analyze them by using a reading comprehension strategy focused on summarization?

3. What type of change will I see in my students' attitudes and confidence levels toward solving word problems if I have them focus on summarizing word problems?

4. If students are able to summarize one type of word problem using summarization strategies, how will that influence their ability to solve other types of word problems, such as two step problems or problems with extra information?

ACTION RESEARCH METHODS

Ninety three students were the subjects in my study. These students are from four different sixth grade classes that I teach throughout each day, all on Team 6-4 in my building. Collectively, these four classes work at the same pace and they are not ability grouped. The only students excluded in this study are the four students who participate in the High Ability Learners mathematics class, and an additional six students who are in the special education mathematics class where they learn life skills. Of the 93 subjects, there are 46 girls and 52 boys, there are 9 students verified for special education.

During the fall semester of 2007, I administered the NCLB Word Problem Assessment as a pretest to gauge the level that my students were performing at on word problems (Appendix A). The spring semester of 2008 is when I conducted data collection. I began by giving all students a twelve statement survey (Appendix B) about solving word problems, looking specifically at their confidence levels and the processes that they use. I organized the data from

the survey by totaling the number of students that were neutral, agreed, or disagreed with each

statement.

Additionally, I interviewed six subjects using the same interview questions for each

student (Appendix C). I chose students based on what I considered to be their ability level. I

interviewed two high achieving students, two average achieving students, and two lower

achieving students, none of whom were special education students. The interviews consisted of

two parts: a section where I had each student write answers to several word problems, followed

by a question and answer session. I followed the interviews with a journal entry where I jotted

down some initial thoughts and comments regarding each interview.

As part of my data collection I also kept a weekly journal. In this journal I noted thoughts

and ideas as they presented themselves throughout the week. At the end of each week I

completed the journal by following a template that I consistently used throughout my data

collection (Appendix D). Journal entries were collected from February 11, 2008 through April

28, 2008. The journal entries include reflection questions regarding my research questions and

what my teaching looked like during the week.

The main component of my data collection was student word problem summarization

worksheets. The summarization worksheets had students break down word problems into

different steps, or boxes, that they had to complete. Here are the steps that were listed across the

top of each worksheet:

Word Problem	What are the facts? What do I need to know?	What operation is appropriate? How do you know?	Draw a picture of the problem.	Write the number sentence for this problem.	Write the solution and *label.*	Is your answer reasonable?

Students completed six of these worksheets, each including five to six word problems, throughout the months of February, March, and April. Each word problem summarization worksheet focused on a different type of word problem. There were one step word problems, word problems with extra information, word problems with hidden information, interpreting remainders word problems, multi-step word problems, and a cumulative worksheet including all of types of word problems that were previously practiced in class. Students were required to fill in each box, or step, for every word problem on the worksheets. For each word problem summarization worksheet, I kept track of every word problem and calculated how many and what percentage of my students had each one correct or incorrect. My teacher journals detailed the questions that arose and my personal comments and thoughts as students worked on these worksheets. Throughout the semester I also collected student work on tests and daily assignments regarding word problems.

To finalize my data, on April 21, 2008, I gave a post-survey to all subjects. This post-survey was identical to the pre-survey given in February with an additional five essay questions that I felt were important to ask as my data collection neared completion. They were;

1. Does using the word problem summarization boxes make solving word problems easier or difficult? Why?

2. As I make plans for my mathematics class next year, what advice would you give me about using a summarization table for word problems?

3. How do you feel when you see word problems on a test or an assignment? Why?

4. What could teachers do to help make it easier for students to solve word problems?

5. Do you think our practice in class has helped you to become more successful when solving word problem?

I categorized and quantified the responses from the post survey to compare them with the results from the pre-survey (Appendix F). I also administered NCLB word problem assessment again on April 22-23, 2008 as a post test. I then compared the NCLB pretest and posttest to evaluate student performance at the start of my data collection and the completion of my data collection. This was a vital piece of data because I used it to help me analyze student growth during my research. I found success rates for each word problem at the start of my research and compared it to student success rates at the completion of my research to indicate student growth.

The last step for my data collection was to interview the same six students as I had originally interviewed at the start of my research. For the post interview, I did not have students solve any word problems but I focused on some lingering questions that I had. It consisted of 5 questions about word problems (Appendix G). I completed this the week of April 21, 2008.

WHAT I UNCOVERED

My data collection and action research work revolved around my four research questions. Those four questions looked directly at students' ability to solve word problems, their attitudes toward word problems, their ability to apply strategies to various types of word problems, and the way that my teaching would be affected as I strove toward student success when attempting word problems. I was surprised at some of my findings along the way, but much of what occurred in my classroom is what I expected would happen. I looked specifically at each research question for my action research project.

<u>My teaching when I try to teach specific word problem strategies</u>

My teaching of word problem strategies mostly occurred outside of the classroom as I prepared for class when I did not have students. My teaching occurred with students for the first

few minutes to introduce the topic and soon turned to one on one teaching time as individual students needed help.

Every time I journaled throughout my action research, one of the questions that I asked was: What did my teaching look like in my classroom while working on the word problem summarization worksheet? In the early weeks of journaling I really struggled with this journal question due to the fact that I did not spend a lot of time explaining and offering advice, I simply introduced the particular type of word problem and let students work. The week of February 15, 2008, I discussed in my journal my early struggles in my action research project of my role as a teacher versus a researcher and the impact that it had on my teaching.

> I want my students to be independent so I am trying not to meddle too much. I want to force them to check things on their own. As a researcher, I would like to not intervene at all and watch improvement come solely from my students, but as a teacher that is impossible. Today I walked around and reminded students to label and read problems that they had incorrect again and asked them to show how they checked to see if their answers were reasonable.

After having students work several word problem summarization worksheets on their own, I decided that it might benefit them to be able to work in small groups. This did not change how I planned for the day or how I introduced the type of word problem, but it did impact the number of students who were asking questions. The following is from a journal entry from the week of March 10th.

> The big change I made with this worksheet, that I hope will not have a huge impact on my data, was I allowed them to work in groups of three. I arranged it so that I randomly put them into groups and made sure that they were eye to eye, knee to knee. My

directions were that they did not have to work together on every word problem, but were there for each other if there were questions. I was surprised at how this changed the environment of the classroom.

I specifically noticed how different groups interacted together. Some groups worked through every problem together at the same pace, while other groups continued working individually. It surprised me to see some groups not taking advantage of the other members of their groups. During the time my students were working, I walked around the room and answered questions from both individuals and groups. A different journal entry the week of April 4th provides evidence as to what my teaching looked like as my students worked on their word problem summarization worksheets:

> I introduced this worksheet with an example problem where the remainder had to be rounded up to next nearest whole number and one where students had to round down in order to get the answer correct. . . I really did not get a lot of questions as students were working together on the worksheet this week and so that allowed me time to walk around and monitor and offer suggestions without being asked.

When working with my teacher research question I asked myself if I could tell a story of my teaching. The main component of my action research is my word problem summarization worksheets. As far as my 'teaching' went, I would introduce the type of word problem found on the summarization worksheet, help students get started, and then give them work time.

My teaching did not put me at the front of the classroom lighting off fireworks to improve my student's ability to solve word problems and increase their motivation. I have, in my few years as a teacher, worked through feelings of guilt. I have finally realized that teaching does not always mean that I am talking or leading at the front of my classroom. Teaching happens

even when I say nothing in class because I have completed all of the leg work ahead of time and I simply become a facilitator. This is the case for my action research. After reading my journals one would know that I introduce the summarization worksheet, do an example problem for the class, typically offer advice, and then let my students begin their learning and practicing. At that point, I take individual student questions and teach more on a one to one basis.

For my action research I tried to understand my student's ability to break down word problems in order for them to become more confident and successful at solving them. The changes in my teaching that I made for my action research project was simply spending more time, more thought, and more focus on word problems.

I found that I had many struggles trying to fulfill my role as a teacher and my role as a researcher. The first issue, that always seems to be an issue as far as teachers are concerned, is time. I struggled with actually taking so much time to specifically work on the word problem summarization worksheet while continuing on with the sixth grade mathematics curriculum. I had originally scheduled to do it every other week, but as the end of the school year drew near I found myself in a crunch.

Another issue that I dealt with as a teacher versus researcher was how to handle the details of the worksheet. I chose not to take grades on these worksheets, therefore I did not assign these worksheets as homework. I included five to six problems on each worksheet and some students could not finish by the close of a 40 minute period. As a researcher, I wanted them to finish. As a teacher, I did not want to give homework that I knew I would not be grading. I followed my instincts as a teacher and asked my students to give me their best for those 40 minutes and what they did not finish, as a researcher, I just marked incomplete. As a teacher and researcher I am really satisfied with the way that my students took to these worksheets. When

they worked hard and put forth effort they learned that word problems are not impossible, but something they can figure out on their own with the right strategies and confidence.

<u>Students' ability to solve word problems using summarization strategy</u>

The second research question that I was interested in focused directly on the word problem summarization strategy that was introduced to students. The research question is what would happen to my student's ability to solve word problems if they learned to analyze them by using a reading comprehension strategy focused on summarization.

Students had more correct answers using the word problem summarization worksheet than if they were to just answer the word problems without the summarization worksheet. The worksheet often forced them to read the word problem more than one time before attempting to solve the problem. It also seemed to help them understand what the problem was asking by breaking it down into specific questions that they were responsible for answering on the worksheet. I found that when students completed their one step word problem summarization worksheet in class there were fewer questions asked. I observed this in all four of my classes and also noted this in my journal. Of the questions that were asked by students, most of them were trying to determine the correct operation to use to solve a specific word problem. After checking to see if their answer was reasonable or not, most students could go back and choose the correct operation. After students completed the first word problem summarization worksheet, I reflected on the day's events in my journal on February 8, 2008:

> When I had my students work on the word problem summarization worksheet in
> class I was really surprised at their compliance. I had all students on task and
> working independently to finish all of the word problems. The overall feel was
> certainly positive. The word problems were probably easy for most students and I

even told them this, but I wanted them to focus on the summarization part and

making sure that they analyzed each step in answering each word problem.

In the past when I have given students word problems they were done very quickly, but

when using the word problem summarization worksheet some students could not even finish the

five or six word problems by the end of a forty minute class period. Because all students were on

task, I could see that they were taking a longer time to analyze each part of each word problem

and I could also see them go back and read the word problems for a second or even third time.

When analyzing the work that the students completed I could see that they had filled in each step

of the summarization boxes to solving the word problem and had written the computational

sentence for each word problem.

I found that some students seemed to struggle to check their answers for reasonableness

and labels on the summarization worksheet and also on homework assignments and tests. On the

NCLB Word Problem Assessment that I gave as a pretest, one particular word problem asks,

"Fred always leaves a $.25 tip when he orders a cup of coffee at Sam's Café. If Fred orders a cup

of coffee costing $1.39 every day for seven days, how much will he spend (including tips)?"

When considering this problem one might assume that Fred would not spend hundreds of dollars

of on coffee for the week, yet I did have several students with answers in the hundreds and even

thousands of dollars.

I also noticed that as my students were working on the word problem summarization

worksheet that focused on one-step problems, I had to point out to students that their answers

sometimes just did not make sense. For example, one of the word problems was, "Karen earns

$50 each week babysitting. If she baby sits 5 days per week, how much money does she make

per day?" Some students multiplied 5 by 50 to get an answer of $250 per day. This was

frustrating to me because it states specifically that she only earns $50 per week, so an answer of

$250 would not be reasonable. One specific step on the summarization sheet included checking

each answer to make sure that it made sense in context to the problem. I do not know if my

students thought that they did have a reasonable answer, or if they just briefly passed by that step

on the worksheet.

I interviewed six students and had each of them solve several word problems without

using the word problem summarization boxes. After answering a specific word problem during

the interview I asked each of them if they had checked to make sure that their answer was

reasonable upon finishing. Only two of six students checked to make sure that their answer made

sense on that particular word problem when they did not have to fill out the summarization chart,

and simply just answered the problem.

Throughout my research I noticed that students seem to struggle the most when solving

word problems involving more than one step. One example of this was the first NCLB word

problem assessment that I gave to students before practicing any strategies in class. After

correcting student word, I found the percentage of students who had each word problem correct

or incorrect. The pre-test makes if extremely obvious that students struggle when solving word

problems using two or more steps. After giving the exact same assessment as a posttest, I found

that students seemed to have made great strides in their ability to solve the word problems. The

exact same word problems were on the posttest that were on the pretest, given before my

research began and upon its completion. The following table shows the type of word problem

and the percentage of students who had that problem correct on the pretest. It also shows the

percentage of students that had that problem correct on the posttest.

Word Problem	Type of word problem	Percentage of students with	Percentage of students with	Difference of scores from

		correct answer on PRETEST	correct answer on POSTTEST	pretest to posttest
1	one step	85%	92%	+7
2	one step	84%	94%	+10
3	multi step	43%	72%	+29
4	multi step	47%	73%	+26
5	multi step	80%	79%	-1
6	one step	91%	93%	+2
7	two step	88%	93%	+5
8	multi step	75%	84%	+9
9	multi step	58%	85%	+27
10	multi step	65%	88%	+23
11	interpret remainder	74%	78%	+4

Analyzing the results from the table, word problem number five was the only word problem that students did not improve on from the pretest to the posttest. The ten other word problems the percentages all increased, the greatest of those was word problem number three. Overall, my students performed much better on the posttest than on the pretest given at the start of my action research.

I conducted six student interviews and asked each student the same question, "Do you think the summarization worksheet of word problems that we have used in class is helpful? Why or why not?" Four of the students answered yes, one answered no, and one answered yes and no. Of the five students that answered yes, they all made a comment specific to how using this strategy is allowing them to stay organized and helps to tell them 'what to do.' One student, Tom, said yes and no. He stated, "It takes a long time to complete, but your answer is more accurate." My students seem to recognize that using this strategy is increasing their awareness of each component of a word problem, such as reasonableness and labels.

My students, in general, seem to understand how to solve word problems more efficiently and confidently after our practice in class. On the post-survey given to 88 students, I had 65 of

them, or 74%, say using the word problem summarization boxes made solving word problems easier. Of those 65 students that said the summarization worksheet made solving word problems easier, 54% of them specifically commented that it helped with their organization.

On the post-survey there was a question that asked if the practice that we had completed in class helped students to become more successful when solving word problems. Of 88 students, 84 of them, or 95%, said yes. They feel that they are now more successful when solving word problems due to the practice that we completed in class, than they were before we began the word problem practice.

Student confidence and attitude changes resulting from summarization strategy

I found that, overall, confidence levels in my students seem to improve after repeated practice using the word problem summarization worksheet. I found that the boxes, or steps, on the summarization worksheet gave students the assurance that they needed. I think, for those students who question themselves when working on word problems, it gave them the assurance that they were processing each step involved in solving word problems. I was surprised to find that the repeated practice of working with word problems enhanced student confidence as well.

Through my data collection, I found that using the summarization table helped my students feel more confident about the steps that they have to take to arrive at correct answers. One question asked to each of the six students I interviewed was how they felt about using the word problem summarization worksheet. One student, John, during the post interview commented, "It takes longer (to complete the summarization worksheet), but your answer is reasonable." Alex added, "I like it because it makes it not a word problem and tells you what to do at the top," referring to the steps listed across the top of each summarization worksheet. All six students during the post interview commented that it was beneficial, although two of them

commented that the process was also lengthy.

Each time we worked on a word problem summarization worksheet in class I focused on giving many compliments and comments that I referred to as confidence boosters in my journal entries. What follows is a comment I wrote in my journal about a specific confidence booster used when a student was completing a word problem summarization worksheet.

One of my most struggling students, who continually wants guidance (answers), came to me and worked on a word problem by herself in my presence. I tried to make it a big deal to show and tell her that she really can do it if she puts her mind to it. The summarization worksheet is allowing my students to organize the information in a way they never have before. I hope the strategy continues to benefit them.

"I feel confident when solving word problems," was a statement that students had to choose if they agreed or disagree with, or if they were neutral on the survey I gave. They responded on both a pre-survey and a post-survey. On the pre-survey, 58% of my students agreed with the statement compared to 50% on the post-survey, 31% of students answered neutral on the pre-survey compared to 42% on the post-survey, and 11% of my students disagreed with the statement on the pre-survey while only 8% disagreed on the post-survey. I

found this very interesting because when given the same question in essay form on the post survey, "How do you feel when answering a word problem on a test or an assignment and why," students answered with the following results that I classified into the following categories:

Only 8% of students stated that they did not feel confident, 26% stated they felt anxious, nervous or stressed, 6% stated that the way they felt depended on the particular type of word problem, 24% specifically stated they felt OK, and 34% felt confident. I'm not sure why the response from students when given choices differs from the results when answering in essay form.

When analyzing this research question focused on student confidence levels, the outward response from higher ability students tended to be more negative toward the worksheet, but the struggling students seemed to recognize that it might be helping them. They seemed to

understand that they were gaining confidence and learning strategies to effectively solve word problems.

As part of my pre-interviews, I initially had students simply solve a word problem using their own strategies. I then had them use the summarization worksheet to solve another word problem. I asked them, "Did the summarization table make solving the second word problem more difficult or was it easier?" The students I interviewed consisted of two of what I would consider my high achieving mathematic students, two average achieving students, and two students who often struggle. The two struggling students answered, "Easier because you could draw it out and you had the boxes," and, "Easier, because it breaks down the steps." One of my average achieving students stated, "It was easier because you had to write all the information down. I had to think to find the important information in the problem." One of my high achieving students replied, "Difficult because you have us write out the facts, and draw a picture, and tell the operation, and we have to do it step by step and write it all out. In my mind, I usually know what the facts are and remember those steps and then I can find the answer."

When I had students complete a word problem summarization worksheet in class I always set the same expectations. I expected them to try their best, if they did not finish the worksheet it was not a big deal, I focused on quality rather than quantity. I never assigned them as homework and on the last two worksheets students worked with a partner or in a group. The following is an entry from one of my last journal entries.

I have noticed that if I have high achieving students grouped together they often work each problem together, same if I have two average achieving students, or two low achieving students. If there is a mix of abilities in a group it seems as if students do not

work together. It appears that they work independently and the lower achieving students in the group ask questions to me instead of working with their partner. (April 5, 2008)

I do not find this observation surprising; though I wish it were not this way. It is certainly easier to work with someone who is at your level; it makes it less intimidating to ask questions. I can see when I have two lower achieving students work together and they successfully solve a word problem that it is an instant confidence booster. Often times they would even celebrate with a high five or words of encouragement.

I noticed that working on word problems more frequently than I ever had in my past teaching years, seemed to make more students feel confident upon attempting them. On the post-survey that I gave my students one essay question was, "As I make plans for my mathematics class next year, what advice would you give me about using a summarization table for word problems?" I had 70% of 88 students suggest that I use the worksheet to practice word problems again next year. When asked what teachers could do to help make it easier for students to solve word problems 16% of them stated that they should use the 'step by step boxes' found on the word problem summarization worksheet. This shows that practice using the summarization worksheet seemed to enhance student learning.

Application of summarization strategy to other types of word problems

 When analyzing if students could apply what they learned solving one step problems to other types of word problems, I found that as students became familiar with the steps needed to solve word problems, they continued to make errors that resulted in incorrect answers. While having students practice with the word problem summarization worksheets, I noticed that they did carry over what they learned onto worksheets or tests that did not have the 'boxes'. Multi step word problems, through my data collection, are the most difficult word problems for students to

complete.

The summarization table forces students to break down a word problem to find the facts, but they still struggle with a solid understanding of what it is they need to do to successfully complete the word problem. Throughout my pre interviews, all six of the students made a comment about how the word problem summarization worksheet forces them to look at each word problem and break it into parts. Two of those students specifically used the word organized when describing the worksheets.

After a unit on decimals, I assigned a take home quiz that included four word problems. I purposely chose not to remind students to include labels and to check for reasonableness. I wanted to check for retention of the steps that we have been working on with the summarization worksheets. As I was grading the tests it seemed as if there was little retention, but when I started tallying to see the hard data it was better than what it had seemed as I was grading it. Ninety students completed the test, here are the results:

Word problem	Percentage Correct	Percentage Incorrect
1	75	25
2	80	20
3	81	19
4	75	20

I thought that having 75% of students get a particular word problem correct was acceptable. I would love to see that percentage around 90%, but I have to keep in mind that this includes all students including my lower ability and Special education students. As I was making corrections, it seemed as if a lot of students were not including labels. To get an answer correct a student must have a correct. I decided to look specifically at the labels. Of the 90 students who completed the quiz, 69% included correct labels for each of the four word problems, 16% of

students did not include a label on any of the word problems, and 16% of students had a label for exactly 1, 2, or 3 of their word problems.

One comment that Tom, an average level student, made I found very interesting. I asked him if would use the summarization strategy that we have been practicing to solve word problems if I did not make them. His reply was, "Depends on if the word problem is easy or hard." I am assuming that he would consider two or more step word problems as difficult and has decided that the worksheet would help him to stay organized. He also commented that he would remember each 'box' or step along the way if he did not have the worksheet. This is powerful because he is indicating to me that he could use this strategy without needing the worksheet there to guide him through each step.

CONCLUSIONS

For the past several months I have been engrossed in analyzing student performance in the area of word problems. I have learned a lot about student perceptions, confidence levels, and abilities when solving word problems. I decided to specifically analyze student ability when using a summarization strategy to help students read and understand word problems making the computational part of the problem clearer, leading to more correct answers.

After reading many research articles dealing with word problems, I found that the challenges for teachers and students seem to resound throughout classrooms. The struggle for teachers remains constant in that the specific part of a word problem that a student might struggle with is difficult to identify. Compounding this is the fact that each student that sits in a classroom is different. When you mix the struggles of solving word problems with low self confidence, lack of computational ability, and reading comprehension difficulties, you have a recipe for a disaster as students try to successfully solve word problems.

As Verschaffel, Corte, and Vierstraete (1999) found in their study word problems can be ambiguous and be interpreted differently by different readers. I found this to be true in some of my student's questions. I thoughtfully considered all word problems I had students answer, yet questions arose as to what exactly some of the word problems were asking. Even after careful consideration on my part, some students interpreted the questions differently than what I had. This proves to me that as a teacher I continually must evaluate student answers and question their ideas and responses to keep my mind open to different interpretations and multiple correct answers.

Robinowitz and Woolley (1995) did a study to try to determine if computation and comprehension went hand in hand, or if one or the other played a role in student success. Their study found that there is no interaction between computation and calculation when solving word problems. The researchers found that with an increase in the size of the problem, only the difficulty level of the problem increased, but the understanding of the numbers involved and the way to manipulate them does not. From my action research, I found that sometimes the student's difficulty lied in the understanding of the problem, when other times it seemed the computation was incorrect. My study did not pinpoint the relationship between comprehension and calculation, but I would say through student interaction and questioning that in order to successfully solve any word problem a student must comprehend it in order to do the calculations correctly.

In Sovik, Frostrad, and Heggberget's (1999) research, they found that not only arithmetic knowledge is vital, a student must also have conceptual, linguistic, and situational knowledge to understand a word problem. One specific component that can make a word problem even more difficult for a student is the way that it is expressed linguistically. I found that sometimes just

restating a word problem in a different way can lead students to understand the word problem, because the way it was stated originally was baffling to them. Particularly, even just using a student's name or sibling name can bring understanding to a troubling word problem. When the student owns it, somehow, the understanding happens.

In all of the research that I read, there were no studies that directly addressed the summarization strategy of word problems. From my data collection, I found that with practice using a summarization strategy worksheet solving different types of problems, students' attitudes, perceptions, and ability to solve word problems all improved.

IMPLICATIONS

Solving word problems with a specific summarization strategy worked for my sixth grade students. I most certainly will use the word problem summarization worksheet with future classes that I teach. I feel that its benefits are obvious from the data that I collected with this study. However, I recognize the fact that the practice alone, without the specific strategy could have impacted my results.

As part of our school improvement goal, a group of teachers and me focused on reading comprehension in mathematics through using different strategies. I have shared the word problem summarization worksheets with colleagues who have found it valuable in their classrooms as well. Recognizing the fact the worksheet is certainly time consuming, its benefits outweigh its disadvantages.

I found that allowing students to solve word problems in pairs or groups created a learning environment where students were engrossed and actively involved. It also meant fewer questions directed toward me, and allowed for more one on one interaction with students. I could spend more time pinpointing student struggles and intervening in a meaningful way. My opinion

of my role as a teacher changed in that I did not have to stand at the front of the room and tell students what they needed to know, I was prepared for class and students could learn by using their own reasoning skills and also from each other when given the opportunity.

Each and every student has to be equipped with the ability to solve word problems. I will certainly change the way I have taught word problems in the past. It is essential that students have the skills needed to be successful word problem solvers, but more importantly they must think they can solve word problems. They have to have confidence in their abilities and their perception of word problems has to be positive. This is a daunting task for one teacher to take on, therefore this idea must be fostered early in each students education.

REFERENCES

Christou, C., & Philippou, G. (1998). The developmental nature of ability to solve one-step problems. *Journal for Research in Mathematics Education, 29*, 436-442.

Cooper, B., & Harries, T. (2002). Children's responses to contrasting 'realistic' mathematics problems: Just how realistic are children ready to be? *Educational Studies in Mathematics, 49*, 1-23.

Franke, M. L., & Carey, D. A. (1997). Young children's perceptions of mathematics in problem solving environments. *Journal for Research in Mathematics Education, 28*, 8-25.

Franke, M. L., & Elham, K. (2001). Learning to teach mathematics: Focus on student thinking. *Theory into Practice, 40*, 102-109.

Garderen, D. V. (2004). Reciprocal teaching as a comprehension strategy for understanding mathematical word problems. *Reading and Writing Quarterly, 20*, 225-229.

Gonzalez, J. E. J., & Espinel, A. I. G. (2002). Strategy choice in solving arithmetic word problems: Are there differences between students with learning disabilities, G-V poor performance and typical achievement students? *Learning Disability Quarterly, 25*, 113-122.

Li, F. L. N. (1990). The effect of superfluous information on children's solution of story arithmetic problems. *Educational Studies in Mathematics, 21*, 509-520.

Li, Y. (2000). A comparison of problems that follow selected content presentations in American and Chinese mathematics textbooks. *Journal For Research in Mathematics Education, 31*, 234-241.

Montague, M., & Applegate, B. (2000). Middle school students' perceptions, persistence, and performance in mathematical problem solving. *Learning Disability Quarterly, 23*, 215-227.

Peterson, I. (1991). Searching for new mathematics. *SIAM Review, 33*, 37-42.

Rabinowitz, M., & Woolley, K. E. (1995). Much ado about nothing: The relationship among computational skill, arithmetic word problem comprehension, and limited attentional resources. *Cognition and Instruction, 13*, 51-71.

Sovik, N., Frostrad, P., & Heggberget, M. (1999). The relation between reading comprehension and task-specific strategies used in arithmetical word problems. *Scandinavian Journal of Educational Research, 43*, 371-398.

Verschaffel, L., & Corte, E. D. (1997). Teaching realistic mathematicsematical modeling in the elementary school: A teaching experiment with fifth graders. *Journal for Research in Mathematics Education, 28*, 577-601.

Verschaffel, L., Corte, E. D. , & Vierstraete, H. (1999). Upper elementary school pupils' difficulties in modeling and solving nonstandard additive word problems involving ordinal numbers. *Journal for Research in Mathematics Education, 30*, 265-285.

Appendix A

Math Assessments

Name _____

Date _____ Grade _____

Beginning	Progressing	Proficient	Advanced
0 - 3	4 - 25	26 - 37	38 - 38

(2006) **NCLB**

Word Problems Grade 6 $\overline{38}$

Calculators may be used.

+2   1)   Buddy is a pilot. Last year, he landed his plane 775,001 times at the airport. So far this year, he has landed 110,749 times. How many times has Buddy landed at the airport?

_____   _____ times
work   answer

+2   2)   Using the facts about Buddy's landings, how many more times did Buddy land last year, than so far this year?

_____   _____ times
work   answer

+3   3)   Riley has 2 ten-dollar bills, 4 one-dollar bills and 7 quarters. Kay has $6.05 more than Riley. How much money does Kay have?

_____ $_____
work   answer

+3   4)   Strawberries are on sale for $1.99 a pound. A 6 pound carton of strawberries sells for $10. How much money would you save by buying the 6 pound carton?

_____ $_____
work   answer

+3   5)   Fred always leaves a $ .25 tip when he orders a cup of coffee at Sam's Cafe. If Fred orders a cup of coffee costing $1.39 every day for seven days, how much will he spend (including tips)?

_____ $_____ $\overline{13}$
work   answer

Study the table showing art supply prices and answer questions 6 - 9.

ART SUPPLY KIT	
drawing pencil	$ 2.95
marker	$ 3.59
water paint	$ 2.75
glue stick	$ 1.29
scissors	$ 4.99
art tablet	$ 3.89

+2   6)   How much more are the scissors, than the water paints?

_____ $_____
work   answer

+2   7)   How much would the marker, scissors and art tablet cost?

_____ $_____
work   answer

+2   8)   If you needed to buy two gluesticks, water paint and an art tablet, how much money would you need?

_____ $_____
work   answer

+3   9)   How much change would you receive from a twenty dollar bill, if you purchased a complete art supply kit?

_____ $_____
work   answer

+3   10) There are two groups of 6th grade students attending a concert at the school auditorium. One group has 74 students and the other group has 102 students. If each row has 22 seats, how many rows of seats will they need to reserve so that all the students can sit together?

_____   _____ rows
work   answer

+3   11) Taylor can save $48 a week by mowing lawns. How many weeks will it take to save for a $300 bike and a $36 helmet?

_____   _____weeks
work   answer

15

Appendix B
Student Word Problem Survey
Date _____
Please give your honest response to each question. Shade the circles.

	Agree	Neutral	Disagree
1. I feel confident when solving word problems.	O	O	O
2. I know what operation to use when solving word problems.	O	O	O
3. I always read a word problem more than one time before I solve it.	O	O	O
4. I enjoy solving word problems.	O	O	O
5. I always check to see if my answer is reasonable.	O	O	O
6. Sometimes I struggle reading word problems.	O	O	O
7. I ask myself questions when trying to solve word problems on my own.	O	O	O
8. It is easy for me to pick out the key words so that I know what operation to use.	O	O	O
9. I know what key words to look for when solving a word problem.	O	O	O
10. I feel confident in knowing how to choose the correct label when answering a word problem.	O	O	O
11. I usually know what steps to take to solve a word problem.	O	O	O
12. Doing the mathematical computations in a word problem is difficult for me.	O	O	O

Appendix C

Student Interviews for Action Research Project
Student Name _____   Date_____

1. How do you feel when you see word problems on a test or an assignment?

2. How many times do you usually read a word problem before trying to solve it? Why do you think that is?

3. What is the easiest part of solving a word problem? Why?

4. What is the most difficult part of solving a word problem? Why?

5. Do you think the summarization worksheet of word problems that we have used in class is helpful? Why or why not?

6. What could teachers do to help make it easier for students to solve word problems?

7. I would like to watch you solve the following problem.   Please explain your thoughts to me as you find your solution.
The box office sold 2,948 tickets to a basketball game in advance. 956 tickets were sold the night of the game. How many tickets were sold in all?

*How many times did you read this question?
*What operation did you use? How did you know that one to use?
*Did you picture the problem in your mind? If so, explain it.
*Do you have a label?
*Did you check to see if your answer made sense? If so, what did you do?

8. Now I would like you to solve this word problem. This time rather than explaining to me each step in your process, I would like you to fill out each box of the summarization table.

Word Problem	What are the facts? What do I need to know?	What operation is appropriate? How do you know?	Draw a picture of the problem.	Write the number sentence for this problem.	Write the solution and label.	Is your answer reasonable?
Pilot Amy has flown 6,923 air miles. Pilot Ed has flown 2,834 air miles. How many more miles has Pilot Amy flown?						

9. Did the summarization table make solving the second word problem more difficult, or was it easier? Why?

10. How do you feel about using the summarization table to solve word problems?

11. Could you remember each step in the summarization table if it was not on the worksheet and you had to fill out each box?

12. Would you do each step in the summarization table if the table was not on the worksheet and you just had to answer the word problem, why?

13. As I make plans for my mathematics class next year, what advice would you give me about using a summarization table for word problems?

Appendix D

Action Research Project – Tara Schwanebeck's Word Problem Journal
Week of _____

Thoughts/happenings during the week:

Reflection Questions:

1. What went well this week in regards to my problem of practice?

2. What, in my opinion was the overall feel in the classroom as students work on word problems – were students positive, frustrated, bored? Explain.

3. When monitoring student work describe the most frequently asked question by students while working on their word problems.

4. Write 3 specific confidence boosters I used directed at the entire class or at individual students to boost students self confidence geared at word problems.

5. What did my teaching look like in my classroom while working on the word problems?

Write a story about one of the events from above.

Appendix E
Student Word Problem Post Survey
Additional Essay Questions

Does using the word problem summarization boxes make solving word problems easier or difficult? Why?

As I make plans for my mathematics class next year, what advice would you give me about using a summarization table for word problems?

How do you feel when you see word problems on a test or an assignment? Why?

What could teachers do to help make it easier for students to solve word problems?

Do you think our practice in class has helped you to become more successful when solving word problem?

Appendix F

Statement Presurvey – 90 students Postsurvey – 88 students	Agree Pre - survey	Agree Post - survey	Nuetral Pre - survey	Neutral Post - survey	Disagree Pre - survey	Disagree Post - survey
1. I feel confident when solving word problems.	58%	50%	31%	42%	11%	8%
2. I know what operation to use when solving word problems.	70%	52%	23%	5%	7%	43%
3. I always read a word problem more than one time before I solve it.	64%	53%	16%	11%	20%	35%
4. I enjoy solving word problems.	20%	23%	22%	32%	58%	45%
5. I always check to see if my answer is reasonable.	44%	36%	29%	13%	27%	51%
6. Sometimes I struggle reading word problems.	49%	33%	7%	42%	43%	25%
7. I ask myself questions when trying to solve word problems on my own.	57%	47%	18%	21%	25%	32%
8. It is easy for me to pick out the key words so that I know what operation to use.	59%%	58%	26%	9%	16%	33%
9. I know what key words to look for when solving a word problem.	68%	60%	12%	6%	20%	34%
10. I feel confident in knowing how to choose the correct label when answering a word problem.	77%	76%	14%	6%	9%	18%
11. I usually know what steps to take to solve a word problem.	71%	64%	14%	6%	14%	30%
12. Doing the mathematical computations in a word problem is difficult for me.	19%	13%	28%	51%	56%	36%

Appendix G
Student Interviews for Action Research Project
Student Name _____   Date_____

1. How many times do you usually read a word problem before trying to solve it?

Why do you think that is?

Has that number changed since we began working with the 'boxes'? Why or why not?

2. What is the easiest part of solving a word problem? Why?

3. What is the most difficult part of solving a word problem? Why?

4. Please list from memory as many of the boxes off of the word problem summarization worksheets as you can.

5. Do you do each step in the summarization table if the table is not on the worksheet/test and you just have to answer the word problem, why?

What boxes do you think about?

6. Explain to me your confidence levels when it comes to word problems from the start of the school year until now.

7. What is your attitude toward solving word problems. Explain how you felt at the beginning of the year and if that is still the same or has it changed, if so in what ways?

8. Which type of word problem is your favorite? One step, hidden info, extra info, multistep, interpret remainders…?

Which is the easiest?

The most difficult?

How do you think that you did on the word problem assessment? Explain – was it easy difficult, be specific.