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Math problem solving in the classroom

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Abstract

This paper describes the important aspects for teaching problem solving in mathematics. Problem solving was used to introduce the concepts as well as to practice them. This research paper discusses mathematical concepts and skills in a student-centered environment of a multi-aged first and second grade classroom in a parochial school and investigates the effects of the approach on students, teacher, and curriculum.

In many primary classrooms mathematics is taught in ways that fail to connect with young children's prior knowledge and ways of learning. The cumulative effect is such that students tend to do math procedures, rather than apply math concepts, in their daily lives. Students need practice in connecting the concepts with situations they will encounter in their life experiences.

Researchers have investigated many elementary classrooms to see the effect of problem solving on students. This paper reflects how researchers and teachers have implemented problem-solving daily in the classroom.

MATH PROBLEM SOLVING IN THE CLASSROOM

A Graduate Project

Submitted to the

Division of Education

Department of Curriculum and Instruction

in Partial Fulfillment

of the Requirements for the Degree

Master of Arts in Education

UNIVERSITY OF NORTHERN IOWA

by

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This Project by: Sister Mary Jane Conrad, P.B.V.M.

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INTRODUCTION

It is a cold winter afternoon in February; it is time for the students' daily math lesson. The teacher stands in front of the class with a smile on her face. "Students, how would you like to go on a scavenger hunt today?"

Her question was followed by a loud chorus of cheers. "All right students," the teacher continued, "I have a problem that needs to be solved. Your task is to find out how many students are in the school." The teacher then divided the class into pairs and she handed each pair a card with specific instruction on it. One card stated, "Your task will be to find out how many boys and girls are in Mrs. Jones' homeroom." A second set of directions stated, "Your task is to find out the total number of students in Mrs. Hazel's homeroom and how many of them are girls." The third set of directions asked the students to find the total number of students in Mr. Berns' homeroom and to calculate how many were boys. The students left with eager anticipation to find their answers.

Ten minutes later the students met with their teacher. "Well, my problem solvers," said the teacher, "what did you find out?" The students excitedly began to chart their information on a graph. It

wasn't long until one student said, "Hey, on every line of the graph there is a box empty." (See the chart below) The teacher pretended not to understand, "Oh, I wonder why that is?" The students soon realized that they would have to use the skills of addition or subtraction in order to find the missing addend. This is an example of part of the chart the students completed:

Teacher's Homeroom	Girls	Boys	Total
Mrs. Jones	16	7	
Mrs. Hazel	12		25
Mr. Berns		8	23

PROBLEM STATEMENT

These second grade students had been approaching mathematics through problems created by the teacher and by themselves. This is a very different approach from a decontextualized presentation of concepts and skills, in which problem solving is introduced after concepts and skills have been

presented. These problems varied from everyday word problems to extended investigations such as the above task.

In many primary classrooms mathematics is taught in ways that fail to "connect" with young children's prior knowledge and ways of learning. Frequently, concepts and skill are presented by the teacher, with little motivation or contextual background.

Students are told how to think and what to do. This is followed by practice exercises on the content presented. Eventually, children may be asked to solve applied problems. The cumulative effect of this approach is that many students tend to "do" math procedures, that is learn to follow rules, rather than "apply" math concepts in their daily lives. They begin to believe that mathematics in school is something quite different from what they had learned on their own. Students need practice in connecting the concepts with situations they will encounter in their life experiences. Thus, this paper is designed to examine an instructional approach that addresses the problem of helping young children learn mathematics meaningfully and connect learning with prior knowledge and experience.

Purpose

The purpose is to investigate an alternative way of teaching mathematics that is believed to help children more readily connect math learning with previous experiences, and make on-going connections between mathematics and its many applications. More specifically the plan was to use familiar experiences stated as word problems as a central thrust of all instruction.

Research Questions

This paper investigates several questions related to the goals of the project, such as: What is the overall effect of writing word problems and problem solving on children's

- mathematical understanding,
- ability to apply mathematics,
- confidence in ability to solve problems, and
- attitude toward learning mathematics?

In what ways do children change throughout the year through a consistent and central emphasis on problem solving? What is the overall effect on teachers who use problem solving on a daily basis?

What is the overall effect on the curriculum if problem solving is used to reinforce mathematical concepts?

Project Description

This paper describes the implementation of a model for teaching mathematics that places problem solving at the core of instruction. In the project, problem solving was used to introduce concepts as well as practice them. This project implemented mathematical concepts and skills in a student-centered environment of a multi-aged first and second grade classroom in a parochial school.

Importance of Project/Rationale

Problem-centered learning is an approach built around the use of problems to introduce and apply math concepts and skills. As such, it re-defines the reasons to teach word problems. Students need to relate mathematical concepts to everyday mathematics. They need to see how numbers relate to their experiences such as, how long is it until lunch and what is the difference in their heights at the beginning of the year and the end of the year.

Current research indicates that students need opportunities to reason, communicate, problem solve, and make connections with

every day mathematical experiences. To enhance this idea, the

National Curriculum and Evaluation Standards for School

Mathematics states:

"A major goal of mathematics instruction is to help children develop the belief that they have the power to do mathematics and they have control over their own success or failure. This autonomy develops as children gain confidence in their ability to reason and justify their thinking. It grows as children learn . . . that mathematics makes sense, is logical and is enjoyable," (NCTM Standards/K-4 p 29).

Definition of Terms

"Mathematical Concept" is a fundamental mathematical idea or relationship that is part of the content in the mathematical field.

"Mathematical Operations" are basic mathematical concepts of addition, subtraction, multiplication and division.

"Problem Solving" applies to situations in which the individuals do not have a direct one-step procedure linking the problem to its solution.

"Procedures" are the sequential techniques for determining an answer.

"Word Problems" are used to indicate a problem about real world situations that is stated verbally and typically require the use of mathematical operations to solve them.

REVIEW OF THE LITERATURE

Methodology

In response to long standing concerns about teaching and learning of mathematics, there is an extensive effort to reform the mathematics curriculum and the teaching and learning of mathematics. This section will examine three areas of mathematical educational literature that bear a significant influence on the project. In particular, the review will focus on literature that addresses the importance of problem solving and mathematical reasoning, both of which are emphasized in this project. The first part will examine the rationale and recommendations for change that exist in the professional literature. Second, the review will present information on the nature and focus of a problem-centered approach to teaching and learning. In the third section, research is presented that supports the use of approaches that help children make sense of mathematics through their active engagement in solving problems and discussing their thinking and solutions.

Rationale and Recommendations for Change

In 1989 the National Council of Teachers of Mathematics issued its "*Curriculum and Evaluation for Standards for School Mathematics*," a comprehensive presentation of the characteristics of a contemporary curriculum that gives attention to both the content of the curriculum and how students should learn that content. The report was the response of the professional organization to the numerous concerns raised about the current curriculum and impact on student learning.

One of the most common concerns indicated by teachers was that the existing curriculum did not meet the needs of their students. Lindquist has noted,

"The initial thrust for change in school mathematics was the poor achievement of students, but there are even more compelling reasons for change. Today's technological society requires a different mathematical preparation for its citizens-and for a greater proportion of its citizens-from that of the past. Astute teachers and researchers, aware that mathematics did not make sense to many students, have

found different and successful approaches to teaching and learning mathematics" (1989, p. 1).

This theme is also captured in the following quote from

Everybody Counts from the National Research Council:

"Virtually all young children like mathematics. They do mathematics naturally, discovering patterns and making conjectures based on observation. Natural curiosity is a powerful teacher, especially for mathematics.

Unfortunately, as children become socialized by school and society, they begin to view mathematics as a rigid system of externally dictated rules governed by standards of accuracy, speed, and memory. Their view of mathematics shifts gradually from enthusiasm to apprehension, from confidence to fear. Eventually, most students leave mathematics under duress, convinced that only geniuses can learn it" (1989, p. 43-44).

A distinctive characteristic of the 1989 NCTM Standards is the inclusion of four "process" standards at each of the three levels (K-4, 5-8, 9-12) that deal with broad aspects of learning mathematics that cut across all content areas. They are

"mathematics as problem solving," "mathematics as communication," "mathematics as reasoning," and "mathematical connections" (p. 23-35). These standards highlight the importance of problem solving, and the importance of having children think and reason together. The problem solving standards suggest that problem solving should be emphasized so that students can use problem solving approaches to learn content.

The "Mathematics on Problem-Solving Standards" for grades K-4 make the following points: "In grades K-4, the study of mathematics should emphasize problem solving so that students can

- use problem solving approaches to investigate and understand mathematical content;
 - formulate problems from everyday and mathematical situations;
 - develop and apply strategies to solve a wide variety of problems;
 - verify and interpret results with respect to the original problem;
 - acquire confidence in using mathematics meaningfully"
- (NCTM, p. 23).

The discussion of the NCTM Standards highlights that students should have ample opportunities to share their thinking and strategies with each other in order for in-depth learning to take place. The discussion goes on to note that to help students understand problems, "students should have many experiences in creating problems from real world activities, from organized data, and from equations" (p. 23). Students must be able to link mathematical problems to real-world situations so they will have connections with experiences they have had in their school and home environments.

The importance for teaching the skills of reasoning is further developed in Standard Three: Mathematics as Reasoning of the 1989 NCTM Standard states,

"In grades K - 4, the study of mathematics should emphasize reasoning so that students can -

- draw logical conclusions about mathematics;

- use models, know facts, properties, and relationships to explain their thinking;

- justify their answers and solution processes;

-use patterns and relationships to analyze
 mathematical situations;

-believe that mathematics make sense" (p. 29).

Students need to be able to discuss mathematical problems in order to help them understand the processes involved. The third standard states: "Children need to know that being able to explain and justify their thinking is important and that how a problem is solved is as important as its answer" (p. 29). When children are allowed to communicate their thoughts, a community is formed because students begin to understand each other as partners in the learning process. "A classroom that values reasoning also values communicating and problem solving, all of which are components of the broad goals of the entire elementary school curriculum" (1989, p. 29). Both standards provide strong support for the focus of this project.

In 1991, the Council published its Professional Standards For Teaching Mathematics. The teaching standards highlight the important role of worthwhile mathematical tasks that develop mathematical understanding and skills (p. 25). One key aspect of the

discussion for this standard is the use of problems in promoting learning. The teaching standards also highlight the role of discourse which is described as "ways of coming to know mathematics" and emphasize the active role of students in discussing, sharing, and reasoning. One central part is the creation of a mathematical environment that promotes and supports discourse. The reason for this is suggested by the following statement, "Students' learning of mathematics is enhanced in a learning environment that is built as a community of people collaborating to make sense of mathematical ideas" (p. 58).

Throughout the Curriculum and Evaluation Standards for School Mathematics (The National Council of Teachers of Mathematics, 1989) and the Professional Standards For Teaching Mathematics (The National Council of Teachers of Mathematics, 1989) a new view of the role of the teacher has emerged. No longer is the teacher viewed simply as a dispenser of knowledge, but is to serve more as a facilitator of learning.

Support for the kind of change recommended in these standards is found in the proceedings of the Third International Mathematics and Science Study (TIMSS) Conference, in which the initial report for

grade 8 suggests that the curriculum is very broad and superficial. Teaching of the curriculum also does not promote student thinking, reasoning or how to problem solve (U.S. National Research Center Report No. 6, 1996).

Problem-Centered Approach

The second key aspect of the literature review focuses on the notion of teaching mathematics through problem solving and the development of children's thinking and reasoning skills. Many types of techniques involving problem solving and the ways children process thinking have captured the attention of researchers and curriculum specialists. The approaches described in this section are similar to those used in this current project.

The Wisconsin Center for Education Research at the University of Wisconsin, Madison, used an approach to mathematics which centered around Cognitively Guided Instruction (CGI). This approach consisted of posing problems to students in which they had to decide which mathematical operations to use to solve for answers (Viadero, 1995). Problem solving was further enhanced through discussion of the strategies Carpenter et al (1996) used to solve the problems.

Cobb, Merkel, Wheatly, Wood, and Yackel (1990) emphasized the importance of a social interaction problem-centered approach in learning mathematics. They suggested that allowing children to work together, to discuss the problems, and to share their strategies for solving the problems, helped them internalize the concepts and enabled them to acquire knowledge in a variety of ways. They have found that

"Children construct their own mathematical knowledge. That is, in our view, mathematical knowledge cannot be given to children. Rather they develop mathematical concepts as they engage in mathematical activities, including trying to make sense of methods and explanations they see and here from others" (p. 13).

Jill Bodner Lester, a classroom teacher, wrote an essay (1996) describing the process of building a classroom environment that creates a community of learners. This idea is discussed in the Professional Teaching Standards (1989) and in the writings of researchers. (Carpenter, Cobb, Lester & Trafton) A community of learners is built when a teacher engages students in problems involving real-life situations in which students solve problems

collaboratively. Lester discussed how she went about creating a community of learners. She reflected on the first two months of the school year and noted the characteristics of the classroom. She stated, "The children were immersed in thinking about the multitude of possible solutions and strategies that were accessible to them and they considered how the strategies were related to one another. They were no longer frightened or timid about tackling unfamiliar problems; they were energized by the challenge" (p. 102). One of the activities Lester used to launch her work was also implemented in this project: it was introduced by this author at the beginning of this paper.

This same approach to problem solving has been explored by Trafton et al (1997) at the University of Northern Iowa. A team of researchers have been involved in a five-year program of working with teachers to teach mathematics in a problem-centered approach. They note that,

"Problem-centered instruction is especially powerful for young children. It enables them to continue learning the same way they acquired a considerable amount of knowledge before entering school - in applied situations. It lets young children

connect their informal, intuitive mathematical knowledge to classroom experiences and to use this knowledge to construct new understandings and skills" (p. 17).

They also noted the powerful effect this seemed to have on students' achievement.

Use of Problem-Centered Approaches

There are many research examples that support the effectiveness of problem-centered learning. There is a growing body of research literature dealing with the effects of problem-centered learning on students' attitudes and confidence in mathematical learning.

One study involved the CGI approach. A team of researchers examined the effects of a year-long emphasis on presenting a wide variety of word problems including addition, subtraction, multiplication, and division at the kindergarten level. The results showed that children were able to use a wide range of problems, including multiplication and division. The study concluded by noting, "If from an early age children are taught to approach problem solving as an effort to make sense out of problem situations, they may come to believe that learning and doing mathematics involves the solution

of problems in ways that always make sense" (Ansell, Carpenter, Fennema, Franke & Weisbeck, 1993, p. 440).

A second CGI study involved first grade teachers in an urban school district. Twelve teachers taught mathematics in an experimental setting using the CGI framework and another twelve teachers did not emphasize problem solving all year. The results indicated that the experimental students spent less time on worksheet drills and that instruction focused on the process to show the students how to solve the problems. The experimental students performed significantly better in solving word problems as well as completing them (Kepner & Villasenor, 1993, p. 62).

The CGI was implemented in a third experimental study. Twenty-one primary grade teachers used problem solving techniques daily. This addition to their mathematical instruction had a direct effect on their student achievement. The children were able to develop a broader range of mathematical strategies to complete word problems. (Carpenter, Epton, Fennema, Franke, Jacobs & Levi, 1996).

A fourth study, (Sellers & Wood, 1997) conducted at Purdue University compared the performance of children who had been in a

problem-centered mathematics program one year or two years and those who had received text book instruction. After completion of this study, the researchers stated,

"The results of the analysis indicated after two years in problem-centered classes, students have significantly higher achievement on standardized achievement measures, better conceptual understanding and more task-oriented beliefs for learning mathematics than do those in textbook instruction. In addition, these differences remain after problem-centered students returned to classes using textbook instruction" (p. 163).

A final study to consider is one that researchers Megan Loeff Franke and Deborah A. Carey (1997) conducted. They looked at the mathematical beliefs of the students who have had problem-centered instruction. They discovered that

"Generally, the children perceived of mathematics as a problem-solving endeavor in which many different strategies are considered viable and communicating mathematical thinking is an integral part of the task. The children recognized and accepted a variety of solution strategies,

with many of the children valuing all solutions equally and assuming a shared responsibility with the teacher for their mathematical learning" (p. 8).

In summary, researchers have demonstrated that learning from a problem solving perspective is very important. Mathematics must involve:

- * using students' prior knowledge,
- * exposing students to a wide range of problems,
- * actively involving students in the learning,
- * enabling student discussion of problems and strategies used in mathematical processes.

When students are involved in these four areas, mathematics will become very meaningful in their lives instead of than consisting of a series of memorized facts without real-life connections.

Description of the Project

For many years, problem solving has been one of my deep concerns when I am teaching mathematics. Whenever students were asked to do word problems, they became very uncomfortable. I was not sure if it was because they had a fear of being wrong, were unable to read the problem, or were unable to get the right answer

the right way. Perhaps it was that they did not know how to approach the problem. One of the ways I tried to help my students was simply providing more problems for them to solve, and spent many hours creating problems for them. When they would try to solve them, they were not sure of the wording or which operations they were to use. They were frustrated and, as a result, I was frustrated.

One night, another teacher and I were discussing this very issue. She made the statement, "I wish someone would write a book with word problems for students to solve at various grade levels". This statement intrigued me because I was thinking the same thing. I did not have a direct answer for my colleague at that time but I kept replaying this conversation over and over in my head. Finally it occurred to me: why wait for someone else to write the problems? Have my students write them for each other. My project centered around this idea. I would have students write a word problem every week based on the concepts taught within the week. Then I would take their problems, compile them, copy them and then distribute them to each child. Once a week they were to solve each others problems.

RESULTS

Phase I: October Through December

I launched the project in the first week of October. I began by discussing with students how word problems were set up. We looked at the wording, possible number sequences, and especially how the questions were asked. For example, when adding two numbers, it did not matter which number came first but in subtraction the larger one always needed to come first. The idea soon sparked an interest in my students and they caught on very quickly.

As concepts were presented to them each week, they wrote and solved a word problem to demonstrate what they had learned. For example, when they were learning about addition and subtraction facts through 18, they created word problems that focused on these facts. An example was, "John has five dogs and Suzie has seven more dogs. How many dogs all together?" (See Appendix A for more examples). These problems were compiled, typed, printed, and distributed to the students to solve. I planned to do this at least once a week to give them more practice with solving word problems.

At first, the students had some trouble writing their ideas on paper. They questioned why they had to write words in Math Class.

Their image of math class was doing worksheets only. But as they created the problems week after week, they soon began to have fun creating and answering each others' problems. They were very excited to see their words and ideas in print. They also commented on who had the hardest problem for the week. Even more important, from a mathematical perspective, they began to see how numbers fit into real-life situations. Solving problems became more interesting because they were putting into practice what they were learning.

Phase II: January Through February

As time passed, I was finding that more of the students were creating problems with greater complexity. After they were taught the concept of one and two-step problems in class, they tried to create problems with more than one step. An example of some of these problems would focus on counting money. They first started with counting coins, then went to adding and subtracting dollars and cents. Last, they constructed problems where they counted back change. (See Appendix A for examples.) Students were stretching far beyond my expectations. They created two- and three-step problems for each other. They were challenging each other to stretch their knowledge.

Phase III: March Through May

At this particular time, I was finding myself wanting to know more about problem solving from experts. I discussed my work with Dr. Paul Trafton, a University of Northern Iowa Mathematics professor. Out of our discussions came literature on problem-centered learning, additional resources for problems, and examples of other teachers' work. As a result of our conversation, I realized that I must keep expanding students' understanding of mathematics on their level no matter "what the book says".

I began to read literature from a variety of researchers who have been working in this area. In these articles, I found new ways of helping children internalize the problem solving process. One article in particular, (Lester, 1996), referenced at the beginning of this paper, described an activity that I decided to try with my students. I followed her pattern but changed the data to fit my situation. The reaction of the students to this activity was so positive, I knew I had to keep doing more things like this to keep the students engaged in their learning of mathematics. For several days after our data collecting, the students used the chart for other concepts. These included: fractions, addition and subtraction of

two- and three-digit numbers, comparison of numbers, and patterns of numbers.

Because of this activity, the students became more interested in how to manipulate numbers. The more the students got excited about word problems, the more I wanted to continue to read and get new ideas to help them in this process. By now students were asking questions about how to write three- and four-digit numbers.

They also continued to work with money so they used decimal points. They asked what the decimal point meant if it did not involve money. This was an excellent teaching moment to connect with our work on fractions. We talked about using $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ to help us put the numbers into a percentage. The use of calculators was encouraged more at this time to help students see the relationship between decimals in money and fractions.

Calculators were also used to help the students check their work. They were working on two-, three-, and four-digit numbers so they were allowed to check their answers using a calculator for reinforcement. When they got one answer on paper and another on the calculator. It caused the students to go back to the problem on paper to try to find out why the answers did not coincide. Students

understood the process better, they were becoming more confident, and would try to figure out problems on their own. Only when they were really unsure did they come to me for help. The majority of the time their mistakes were in the renaming process associated with the problem. Once they were shown the process again they missed very few problems.

Skills and conceptualizations learned in computation carried over into their problem solving activities. As a result of reading research, I tried many different techniques to keep the students motivated. The students were allowed to use any manipulatives they wanted in order to solve problems. I began to develop more time having students engage in discussing their solutions and their strategies.

I was initially of the mind set that they should work by themselves but the researchers highly emphasized that greater learning takes place when students are able to discuss their thinking process aloud. I found that these students were more interested in completing word problems when they could work together and share what they were thinking. By sharing, they internalized the concepts better just as the researchers had stated.

By the end of April, when I concluded the actual study, I was curious to see what the students thought about word problems. I wanted to know if they felt any different about solving word problems now than they did before. Six of the students responded that creating their own problems had made them better thinkers and that they were more able to solve problems on their own.

RECOMMENDATIONS/CONCLUSIONS

Overall Effect of Student Writing and Solving Problems

Students want to learn and do meaningful activities that include real-life problems and situations. When students had a chance to discuss their problems, they got a different perspective of how to solve the problems. They also began to teach each other different ways to look at problems and began to realize that there were several strategies used in solving problems. They also noticed that not all problems had one correct way to solve for the answer. Students actually enjoyed writing and solving problems they created for each other especially when they could work in small groups.

Changes in Children

Children developed many skills when they had the opportunity to practice writing and solving word problems. Discussion skills such as listening and questioning techniques were enhanced. The vocalization and practice of various strategies were strengthened. Higher level thinking skills such as deductive reasoning and evaluation were further developed. Children began to see the relationship between an equation and what it represents. This understanding of the concept came about through:

- a) students writing word problems,
- b) small group discussions of the written word problems,
- c) small group discussion of different strategies used to solve the problems, and
- d) total group discussion and summarization of strategies used to solve problems.

As a result of the students' growing interest in problem solving, the students wanted more challenging problems. They persevered in working such problems.

Changes in Teacher Perspectives

I have learned from this process that students need time to absorb concepts and practice them. Using word problems as a primary source of teaching mathematics has helped students to formulate problems as well as solve the problems. I have observed that some students are still on a level of dealing mainly with basic facts while others have developed two- and three-step problems.

This is okay because as students continue to develop mathematical capabilities they will begin to see relationships. Students learn and develop at different rates. I need to respect this

in each child and teach him/her at the level for which he/she is ready.

I have also learned how much students need to talk to each other while working on solving problems. I learned to step back and let other students answer questions posed by their peers. This was very difficult, especially in the beginning, but very beneficial for student learning.

Overall Effect on Mathematical Curriculum

The students benefitted greatly from experiences not found in the textbook that focused on mathematical concepts within the context of word problems. They were able to connect the concepts learned to real-life situations and internalize what the mathematical concepts really meant. Here are some of the second grade students' responses when they were asked what they had learned through word problems:

Student Interviews:

B.N.:

"I learned when you do minus or subtraction you can't subtract 3 sets of numbers. You have to subtract only 2 sets at a time."

J. M.:

"I learned how to add and subtract. I have learned a lot by working with other students by everyone sharing their ideas about the problems."

J. H.:

"I am able to reason the problems by using addition, subtraction and multiplication. I learned from my classmates different ways to figure out the problems."

B. K.:

"Writing and solving word problems have helped me to understand addition, subtraction and multiplication. Sharing the problems have helped me listen to different ways to solve problems."

J. R.:

"Writing and solving problems have helped me because I can count objects and use addition, subtraction and multiplication to solve each problem. Sharing with others has helped me think through the problems and use other people's ways to solve the problems."

This project has convinced me that a problem-centered curriculum is a very important aspect of teaching mathematics in second grade. I will change my teaching style to include this important focus in my mathematics class. Students will continue to write and solve each others' problems. I will begin my class with word problems to enhance concepts. Students will discover a variety of ways to solve problems instead of me telling them how to solve them. This will help students to process their knowledge as well as hear different strategies used by their peers. Students will definitely discuss with each other to engage them more deeply and directly in the learning process and create a motivating and stimulating atmosphere. These changes will take a lot of thinking and planning on my part but it will be worth it when the students gain confidence and come to class excited at the prospect of solving another problem.

Looking back over this school year, I see that the students have learned the importance of problem solving. They went from very simple problems to very complex. I as a teacher have changed in how I look at teaching mathematics. I know I have more work to do to help students with their problem solving skills. I have seen first

hand that students need, enjoy, and desire more of an active role in their learning of mathematics.

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Appendix**Student Problems**

October - December

1. Joe has 9 dogs. He bought 10 more dogs at the pet store. He gave 9 dogs to his friend, Billy, so how many dogs does Joe have left?
2. Ann has 18 dogs and 1 cat. She gave her friend 5 dogs. How many animals does she have left?
3. Jon started reading at 5:00. He stopped reading at 10:00. How many hours did he read?
4. Tom measured his pencil and it was 15 inches long. He measured another pencil and it was 10 inches long. What is the difference between the two?
5. The second grade class went to the zoo. The zoo had 58 books and 35 pens. In one week 13 books were sold. In two weeks, 15 pens were sold. How many books and pen were sold during this time?

January - February

1. I have 72 dogs. My brother took 52 dogs away from me. My mom and Dad took 10 more dogs away. How many dogs are left?

2. Mrs. Alemao and Brittany went shopping for their moms. Brittany bought 2 coats for \$59.00. Mrs. Alemao bought a gold caret watch for \$49.00. How much money did they spend together?
3. I have 90 turtles. I gave 33 to my friend. Then my parents took 20 away. How many do I have now?
4. Taya and Mrs. Alemao went shopping with \$99.00. They spent \$36.00 on medicine to make Taya feel better. Then Mrs. Alemao bought a cute little fur coat for \$29.00. How much money is left?
5. I have \$12. I bought a ball. It cost \$3. Then I bought a dog for \$5. Then I bought some gum for \$.25. How much do I have left?

March - April

1. I bought 4 pieces of gum for \$.20. I gave the clerk \$.25. How much change do I get back?
2. There are 3 green leaves and 4 red leaves. What part of the leaves are green?
3. Mrs. Alemao had a car accident with her son and needed a new car. She had \$80.00 to spend. She bought a red sports car for \$70.00. and a broken down car for \$1.86 and a motor cycle for \$2.89. How much money does she have left?

4. Mrs. McAlpin and Mrs. Melichar went to the store to buy groceries. They bought a loaf of bread for \$1.00 and then bought an ice cream cone for 5 cents, then some flowers for 75 cents. They started out with \$10.00, so how much do they have left?

5. Mrs. Alemao went to the store. She saw some really pretty nailpolish. She bought 2 bottles of it. It cost \$7.00 per bottle. Then she bought 2 more bottles. How much money did she spend?