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# A problem solving approach in mathematics for second grade children based on cognitive guided instruction

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## Abstract

"Virtually all young children like mathematics" (National Research Council, 1989, p.43). They come to school with knowledge assimilated naturally, based upon observations and experience. Unfortunately, instead of taking advantage of those experiences, teachers can close the door on that natural knowledge by teaching a prescribed curriculum based on accuracy, speed, and memory. Traditionally, elementary mathematics classrooms give little attention to thinking and reasoning. It is a common view under this approach, that facts and skills must first be mastered before students can reason about mathematics. The child's view of mathematics can change from enthusiasm to apprehension, from confidence to fear. (National Research Council, 1989) Eventually the students can become convinced that mathematics is only for the smart kids.

# A PROBLEM SOLVING APPROACH IN MATHEMATICS FOR SECOND GRADE CHILDREN BASED ON COGNITIVE GUIDED INSTRUCTION

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# CHAPTER I

# INTRODUCTION

"Virtually all young children like mathematics" (National Research Council, 1989, p.43). They come to school with knowledge assimilated naturally, based upon observations and experience. Unfortunately, instead of taking advantage of those experiences, teachers can close the door on that natural knowledge by teaching a prescribed curriculum based on accuracy, speed, and memory. Traditionally, elementary mathematics classrooms give little attention to thinking and reasoning. It is a common view under this approach, that facts and skills must first be mastered before students can reason about mathematics. The child's view of mathematics can change from enthusiasm to apprehension, from confidence to fear. (National Research Council, 1989) Eventually the students can become convinced that mathematics is only for the *smart kids*.

Traditional mathematics as taught in the classroom consists of memorization of facts, memorization of rules, and one answer with one method. The instructional method is dictatorial, that is, teachers tell students what the problem is and how to solve the problem. This method is followed by worksheets or textbook pages for individual practice. Hiebert and Lindquist (1990) described traditional mathematics instruction in this statement,

> The evidence from research reported in the past decade suggests that we are not doing enough to help students connect concepts with procedures. Many students learn rules and procedures for performing tasks with virtually no idea of what the problem means,

why the procedure works, or whether the answer is reasonable. (p. 20)

Historical Background

Mathematics has been under going reform for the past four to five decades. Reform started after Russia launched Sputnik in 1957. At that time Americans felt children were behind in mathematical learning. The United States pushed mathematicians to produce a solution to excel learning in mathematics. The *new math* approach began in 1960. The *new math* approach failed because no one took the time to in-service teachers. Teachers were handed material and told to teach. (Braddon, Hall, Taylor, 1993)

The late 1960's and through the 1970's mathematics became known as the *back to basic* years. Teachers were now instructed to place emphasis on computation. Mathematics classes consisted of drill, practice, and memorization of addition, subtraction, multiplication, and division facts. Children spent 75 to 95 percent of their time doing computation. What was lost during this period was the reason to do problem solving. (Braddon, Hall, & Taylor, 1993)

Reform in mathematics came in the 1980's because of technology. Computers and calculators could do computation faster and more accurately. Less emphasis was placed on computation, with more emphasis placed on problem solving. At this time, children needed to learn how to apply their mathematical knowledge. Teaching methods bought the use of developmentally appropriate strategies and manipulatives to help children learn mathematics. (National Council of Teachers of Mathematics, 1989)

The 1980's brought another need for mathematics reform when society changed from an industrial to an information age. In the industrial age students were prepared for a future as workers in factories or in commercial shops. The mathematical training for students consisted of minimum competencies such as memorizing basic addition, subtraction, multiplication, and division facts. The more advanced mathematics instruction was reserved for a few students, who would extend their education to become future leaders in academics, business, and government. (NCTM, 1989)

The information age can be attributed to the use of calculators, computers, and other forms of technology. Through the use of technology students can access and share information with anyone at anytime. Mathematics instruction needs to meet the information age by training students to be communicators and cognitive thinkers.

Mary Lindquist, president of the National Council of Teachers of Mathematics, stated in the Los Angeles Times (1994) "It's not enough to get the right answer anymore. We have to be able to look at all the possibilities in solving a problem, to understand the process and to communicate it." (p. 10)

The National Council of Teachers of Mathematics (NCTM) recognized a need for guidelines in teaching mathematics. NCTM organized writing teams in 1986 to set general guidelines for teaching mathematics. In 1989, the NCTM published and recommended five general goals for all K-12 students: (1) that they learn to value mathematics, (2) that they become confident in their abilities to do mathematics, (3) that they become mathematical problem solvers, (4) that they learn to communicate mathematically, and (5) that they learn to reason mathematically. These goals imply that students should be exposed to numerous and varied interrelated experiences that encourage them to value the mathematical enterprise, to develop mathematical habits of mind, and to understand and appreciate the role of mathematics in human affairs. By implementing these goals in the curriculum students will gain *mathematical power*, a term the NCTM uses to denote an individual's ability to explore, conjecture, and reason logically, as well as the ability to use a variety of mathematical methods to solve non routine problems. The National Council of Teachers of Mathematics (NCTM) helped launch the mathematics reform by setting high standards for all students in a rapidly changing, increasingly complex technology-oriented world (Lindquist, 1994).

A contemporary approach in reaching goals set by the NCTM is Cognitive Guided Instruction (CGI). The premise of CGI is that children enter school with a great deal of informal or intuitive knowledge that can serve as a basis for developing formal mathematics of the elementary school curriculum (Carpenter, Fennema, & Franke, 1992). CGI encourages children to build on their natural problem solving strategies by listening to other children. Students ask each other questions and explain how they solved the problem. Less emphasis is placed on the answer, but more importantly, CGI stresses the process that is used in determining an answer, it also teaches the general concepts of addition, subtraction, multiplication, and division. Students then learn the symbols for the concepts and later memorize number facts. (Carpenter, 1985) This same approach is utilized by other projects including the Purdue

Mathematics Project (Cobb, Wood, Yackel, Nicholls, Wheatly, Trigatti, & Perivitz, 1991); Project Impact (Campbell, 1990) at the University of Maryland; and the Primary Mathematics Project (Rathmell & Trafton, 1991) at the University of Northern Iowa.

In these approaches, the focus is on students' thinking processes through a problem solving approach, teachers help students develop mathematical understanding, rather than training them to perform computation procedures. Rich problem solving environments promote mathematical reasoning, student ownership, real life applications, enjoyment, and confidence. (Carpenter, Carey, & Kouba, 1989) Peggy House (1992) stated, "Waiting to teach problem solving until after the kids learn computation is like waiting to teach reading until the kids have learned to spell words." (p. 7)

## Statement of Purpose

The purposes of this study are two fold. One purpose is to review and analyze the literature surrounding problem solving mathematics in early childhood education, and two is to conduct a study using the problem solving approach in a second grade classroom. The following questions will be asked and answered to achieve the pruosese of this study.

1. What does the liteature reveal about the problem solving approach at levels other than second grade?

2. What does the literature reveal about the problem solving approach at second grade?

3. Does the literature agree with the problem solving action research study conducted in a Waterloo, Iowa second grade classroom?

## Need for the Study

New directions for teaching mathematics has been underway for the past decade. A decline in achievement on standardized tests calls for reforms in mathematics curriculums. A change in society, from an industrial to an informational one, calls for reforms in mathematics curriculums. Another reason for reform is today's technology requires different mathematical preparation for students. Students now need to solve problems through thinking and communication. Students need to know the processes to solve complex problems.

Researchers have found different and successful approaches to teaching mathematics that meet current needs of today's students. Educators need to evaluate literature to determine if current methods of teaching mathematics are meeting their students' needs. It is the educator's responsibility to provide quality instruction that will produce literacy in mathematics. This means educators need to make changes in their teaching methods by researching current problem solving practices and implementing those practices.

## Limitations of the Study

This study is limited because a comparison model was not used. This researcher reviewed the problem solving literature and implemented problem solving in her own second grade classroom using the Cognitive Guided Instruction (CGI) approach, and there were only 15 students involved. The study is further limited because there was not a mathematics curriculum guide to follow in teaching problem solving. The teaching strategies were designed by this researcher. In reviewing the literature of problem solving this researcher located no conflicting information on the CGI problem solving approach, therefore limiting the study. Broad generalizations to other populations can not be made because of the small size of the study.

## Definition of Terms

Terms used in this study will be defined to mean the following:

Traditional Mathematics - A method of teaching mathematics by memorization of facts and rules, teacher dictated, textbook or worksheet practice.

Problem Solving Mathematics - A method of teaching mathematics by presenting a problem and allowing students to construct their own solution.

Industrial Age - Society prepares students to perform jobs as workers in industrial factories or in commercial shops.

Information Age - Society prepares students to be communicators and thinkers of shared information.

Literacy - The process of thinking and understanding mathematical computation.

Developmentally Appropriate - Structuring activities to meet the need of all childrens' ability level.

Manipulatives - The use of hands-on material to teach mathematics.

# CHAPTER II

## REVIEW OF THE LITERATURE

Problem solving is making sense of things, perceiving structures, seeing relationships, and analyzing them in order to explain why something is as it seems. Any mathematics lesson can give students an opportunity to reason and to communicate ideas. Lappan and Schram (1989) describe the thinking process in this statement,

> Asking children to describe what they think is going on in a mathematical situation, why they think they are correct, what their answer means in the context of the original problem situation, or what they thought about that helped them solve the problem can turn a routine lesson into a "learning to think" lesson. (p. 29)

Relying on rules and repetition may develop competence in skills and procedures, but they are of little use when students can not reason about situations in which these skills and procedures are needed to solve problems. (Lappan & Schram, 1989)

Burns and Tank (1988) have suggested that a problem solving approach is language driven, where children are able to share, discuss, and justify their ideas. Communicating in math lessons, both verbally and in writing helps children construct their own understanding of mathematics. Allowing children time to talk and listen among themselves enables them to clarify their thoughts and learn from peers. Writing about problems requires students to reflect upon their strategies and extends their thinking process. Not only does communicating support childrens' learning, but it provides teachers with an opportunity for assessment.

Mathematics is often viewed as getting the right answers rather than creative thinking. The rules and methods of mathematics are often learned without the student understanding why. Children need to construct their own knowledge of mathematics. (Payne, 1990) The National Research Council (1989) has stated,

> ...no one can teach mathematics. Effective teachers are those who can stimulate students to learn mathematics. Educational research offers compelling evidence that students learn mathematics well only when they construct their own mathematical understanding. (p. 58)

Mathematical thinking is a process that draws upon operations, processes, and dynamics that are mathematical in nature. When children are taught to concentrate on their thinking processes through problem solving techniques, their confidence and ability to choose appropriate strategies are positively affected. The ability to think builds the students' confidence to question, challenge, and reflect on what has been learned. (Burton, 1984)

## Studies at Other Grade Levels

Cognitive Guided Instruction (CGI) was designed to help first grade teachers understand how addition and subtraction concepts develop in children (Carpenter, Fennema, Peterson, Chang, & Loef, 1989). CGI teaches teachers how to help children build on their conceptual knowledge and how to analyze thinking. Forty first grade teachers participated in summer workshops in which they learned to classify different types of addition and subtraction problems, and to identify strategies' children use to solve problems. The teachers spent time discussing principles of instruction, and planned their own programs of instruction based on those principles. While instructional practices were not specified, CGI teachers taught problem solving more and basic facts less than control teachers. CGI teachers encourage students to seek a variety of strategies to solve problems. Also these teachers listen to students explain their strategies which they used. CGI teachers found they knew a great deal about individual student's knowledge and learned how to build on the knowledge. All students were given a pre-test and post-test consisting of 14 word problems. Individual interviews were conducted with students which included (1) six word problems with access to counters, and (2) a number fact test without access to counters. Interviews allow students to explain strategies they use to solve problems. Students in the CGI classes exceeded students in the control classes in number facts, problem solving, understanding, and confidence in their ability to problem solve. The CGI teachers spent half as much time teaching number facts as control teachers; yet, CGI students recalled number facts at a higher level than control students. The success of the CGI first grade project has prompted an extension of the project to include kindergarten through third grade. Carpenter, Fennema, and Franke (1993) have stated,

> In order to provide children an opportunity to build upon their informal knowledge, teachers must appreciate and understand the nature of children's mathematical thinking. Helping teachers to acquire that appreciation and understanding has been a primary goal of CGI. (p. 26)

Villasenor and Kepner (1993) conducted a study based on the research of the CGI project (Carpenter et al., 1989). Villasenor and Kepner wanted to know if CGI would work with disadvantaged minorities. The study began with a large Midwestern school district, schools selected had at least a 50 per cent minority population. Twenty-four first grade classrooms were chosen, 12 for a control and 12 for the CGI treatment. The 24 teachers were given workshop training in the summer, 12 teachers received the CGI research and 12 received training on the use of word problems. Data were gathered by a pre-test and post-test from the Carpenter et al. (1989) study. Villasenor and Kepner also used the interview system from the Carpenter et al., (1989) study. Results from the data indicated that CGI students demonstrated significantly greater achievement in solving word problems by using advanced strategies. CGI students also showed superior achievement on completion of number facts and used advanced strategies to complete the facts. The study was consistent with the findings that children need not master computational skills before they can develop problem solving skills.

A 1993 study of kindergarten children's problem solving processes was done by Carpenter, Ansell, Franke, Fennema, and Weisbeck. This study explored the fact that problem solving abilities of young children have been underestimated. Children as early as kindergarten are capable of solving a wider variety of problems than the curriculum has suggested. This study investigated the problem solving strategies of children who had spent a year in kindergarten with opportunities to explore problem situations. The subjects for the study were 70 children from six kindergarten classrooms. The six classrooms were taught by four teachers; two teachers taught morning and afternoon classes, and two taught all-day kindergarten. Both schools in the study were from diverse populations. One school was from a predominately upper-middle-class neighborhood, but approximately a third of the children came from a low income housing project. The second school served an economically mixed neighborhood. Both schools averaged 25 to 30 percent of students on a free or reduced lunch program. Both schools averaged 20 to 30 percent of students were minority. A year-long in-service was provided for the four teachers. The program used was the Cognitive Guided Instruction (CGI) developed by Carpenter et al. (1989). Teachers discussed how they could use the information provided through CGI, but no specific guidelines for instruction or material for instruction were given. Data were gathered by classroom observations and by individual interviews. Children were interviewed after almost completing a year of kindergarten. Interviewed children were asked to solve nine problems read by the interviewer. Children were allowed to use manipulatives or pencil and paper to help solve problems. The nine problems consisted of addition, subtraction, multiplication, division, some were multi-step and nonroutine. The results indicated kindergarten children demonstrated overall success in solving word problems. Almost half of the children used valid strategies to solve the problems. Approximately two thirds of the children correctly answered seven or more of the problems. The study verified that young children can solve a wider range of problems, including multiplication and division, than had been presumed.

## Studies at Second Grade Level

A study conducted on a second grade mathematics project was completed by Cobb, Wood, Yackel, Nicholls, Wheatley, Trigatti, and Perivitz (1991). The project met the National Council of Teachers of Mathematics (1989) and the National Research Council (1989) recommendations concerning student learning. The instructional approach developed for the project was the constructivist view that mathematics is a process where students construct conceptual knowledge and make the development of new knowledge possible. Eighteen second grade classrooms participated in the study with a population almost exclusively Caucasian with a wide range of socioeconomic backgrounds. Ten classrooms composed the treatment group. These teachers attended a workshop learning how to use instructional activities based on the constructivist view where students organize the activity to their conceptual learning level. Teachers in control classrooms used the Addison-Wesley textbook as the basis of their mathematics program. Mathematics was taught to both groups for a 45 minute period daily. Two types of mathematics tests were administered to collect data. These tests were a state mandated multiple choice standardized achievement test and the Project Arithmetic Test (PAT) which was developed by the project staff. The PAT was a problem solving test and students were requested to show how they solved the problems. The comparison of students' performance on both sets of tests indicated that project students had developed a higher sense of reasoning than non-project students. The results of the scores on the tests showed no significant differences in computation, but differences were found in students' use of algorithms. The data suggest that a problem centered instructional approach has mathematical meaning. Cobb et al., (1991) states,

> Both this second-grade project and the first-grade Cognitive Guided Instruction project (Carpenter et al., 1989) reject the traditional separation of acquisition from application

> and attempted to guide teachers' development of forms of instructional practice compatible with constructivist learning theory. (p. 25)

A study by R. McInroy (1991) compared two second grade classrooms with different teaching styles. In one classroom the approach to mathematics was teacher directed, with the teacher asking the questions and the students responding with an answer. This was followed with seat work after the lesson has been presented. The other classroom had a problem centered approach to mathematics. The teacher presented a problem to the class through literature, a real life situation, or from mathematical content. The teacher allowed students to decide how the problem should be solved. Students then shared their reasoning for solving the problem. From past experiences, many different responses may be given. McInroy used an eight item test to administer to each classroom. The test was intended to allow students to demonstrate their mathematical knowledge in problem solving. In addition to the test, individual interviews were conducted with four students from each classroom answering four questions. Students were allowed to use manipulatives to solve the problem and were asked to explain how they arrived at the answer. The results of the eight item test showed no significant differences between the two classrooms. The differences between the classrooms came from the individual interviews. Students from the teacher directed classroom relied on pencil and paper to solve the problems. Students from the problem centered classroom choose other methods to help determine their answers, with fewer errors.

Cobb and Merkel (1989) implemented a problem-centered approach in a second grade curriculum. The study was based on the idea that, instruction which encourages children to construct their own thinking strategies nurtures the development of mathematical concepts. This second grade classroom contained 20 students in a public school. The curriculum consisted of all mathematical concepts and skills, including computation. Mathematics concepts were taught in small group problem solving sessions followed by entire class discussion of students' solutions. Video tapes were made of all mathematics lessons to be viewed and analyzed. Individual student interviews were also used to gather data. The results of the taped lessons and the interviews showed all but one student used a variety of strategies to solve a wide range of problems. Students developed an interest in and a curiosity about mathematics. The premise of the problem solving approach is that children need to be given more responsibility for their learning, if educators and researchers expect children to learn meaningfully.

## Discussion of Literature

The review of literature clearly suggests another approach in the teaching of mathematics. The problem solving approach allows children to build on natural talents they possess. Educators can promote mathematical thinking through the problem solving approach. This thinking happens when children construct their own understanding and discuss with others their thoughts.

Studies in the review of literature have a common consensus, when children are taught with a problem solving base they have a better understanding of the mathematical situation. In most studies children were compared with a control group. When the students were compared on a computational test there were not large significant differences.

Children did show significant difference when they discussed how and why they got the answer. This shows that children with a problem solving approach can verbalize their justification of answers to problems. One of the needs for mathematics reform is to help children become better communicators in mathematics and with the problem solving approach this seems to be happening. The problem solving approach has shown positive evidence that creative student learning is taking place. Implementation of the NCTM standards is being done with problem solving mathematics.

Young children have a natural curiosity about the world they live in, they construct knowledge from that curiosity. The statement made from the National Research Council (1989) summarizes this review, "Educational research offers compelling evidence that students learn mathematics well only when they construct their own mathematical thinking" (p. 58). The literature does not show that instructing children with a problem solving approach helps them become more proficient in computations. Instruction using a problem solving approach does help children understand the mathematical process by building on childrens' natural talents.

# CHAPTER III

# ACTION RESEARCH STUDY

## Method

The subjects being used in this study are from a self-contained second grade classroom of 15 students. The students in the study are from a public urban school with 45 percent minority, 52 percent mobility rate, and 78 percent are of low income families based on free and reduced lunch data. The teacher will be using the CGI approach to teach mathematics through literature, real life situations, and calendar math. Through problem solving instruction the teacher will focus students' attention on curriculum concepts covered in the school district's learner outcomes for mathematics.

Data were gathered in three ways. First, by using the mathematics portion of the Iowa Tests of Basic Skills (ITBS). Students were given an ITBS pre-test in October and a post-test in April. Second, students were selected from three second grade rooms in the same school to take a pencil and paper test. This test consisted of eight problems (McInroy, 1991) which were read to the students. (see appendix A) Students were not allowed to use manipulatives for this test. Third, individual interviews were conducted with students selected from three second grade classrooms in the same school. The interviews (Carpenter et al,1993) consisted of six word problems. (see appendix B) Students were read each problem and allowed time to solve each problem. Students could use pencil and paper or manipulatives to help reach the solution. Students were asked how they solved the problem. The interviews were video taped to help facilitate the researcher's analysis.

# CHAPTER IV

# RESULTS

The ITBS mathematical subtest on problem solving was used as a pre- and post-test to compare normal growth difference of second grade students during a single year. The results for the researcher's class of 15 second graders indicated a significant difference between the pre-test and post-test ($t=2.21$, $p < .05$ two tail).

An eight item pencil and paper test (Appendix A) was administered to provide data on students' ability to solve problems and communicate mathematically. The eight item pencil and paper test (table 1) compared nine students (Group A) from the researcher's classroom, (problem solving instruction) with ten students (Group B) from two other second grade classrooms (some problem solving instruction, mostly traditional mathematics). Group A displayed a stronger performance on 7 of 8 items. The results showed Group A had a total of 53 out of 73 correct responses (73%) and Group B had a total of 40 out of 80 correct responses (50%). This percentage of correct responses indicates Group A's mathematical thinking is more developed than Group B.

On this test Group A showed major differences on 6 of 8 items. Items 2, 5, 6, and 8 were problems using basic computational skills. Although Group A performed with more accuracy on these computational problems then Group B. Items 1, 3, 4, and 7 provided data on the children's problem solving ability. Group A performed more strongly on items 3 and 4. Item 3 was a problem using division strategies. Most of the children in Group A gave an answer which included a remainder. Item 4 was a problem using doubling strategies. Most of the children in

Group A solved the problem by doubling numbers.

Group A's performance overall was more accurate than Group B with the exception of item 1. This question used estimation to solve the problem. All students from Group A answered incorrectly, when comparing their answers one half of the students answered (a) and one half answered (c). This researcher is unclear as to students' inability to answer the question, and would like to have heard students' explain their thinking.

TABLE 1: Percent of correct answers by item

| Item | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | % |
|---|---|---|---|---|---|---|---|---|---|
| Group A | 0 | 100 | 78 | 67 | 89 | 89 | 67 | 100 | 73 |
| Group B | 40 | 70 | 40 | 20 | 60 | 20 | 60 | 90 | 50 |

This eight item group test was limited to provide data on how students communicate problem solving strategies. To provide date on ways students communicate problem solving strategies individual interviews were conducted with three students (Group 1) from the researcher's classroom who had participated in problem solving instruction, three students from two other second grade classrooms (Group 2 and Group 3) with little problem solving instruction. The researcher used video tape of the interviews to facilitate the analysis. Data were collected on the percentages of correct responses. quality of verbal explanations, flexibility and richness of multiple responses, and the thinking process to justify solutions.

The results of the analysis of the interviews indicated a major difference in the correct responses between Group1 and Groups 2 and 3 (table 2). Group 1 had a total 16 out of 18 correct responses (89%); Group 2 had a total 12 out of 18 correct responses (67%); and Group 3 had a total 5 out of 18 correct responses (28%).

TABLE 2: percent of correct answers by interview item

| Item | 1 | 2 | 3 | 4 | 5 | 6 | Total % |
|---|---|---|---|---|---|---|---|
| Group 1 | 100 | 67 | 100 | 100 | 67 | 100 | 89 |
| Group 2 | 67 | 100 | 100 | 67 | 67 | 0 | 67 |
| Group 3 | 100 | 67 | 0 | 0 | 0 | 0 | 28 |

There were major differences in responses to questions 3, 4, and 6 by Group 1. These questions were either multiplication or division, more complex than a traditional mathematics program would have in it. The researcher was not only looking for correct responses, but also the problem solving skills of the students. Most of the students in the interviews used manipulatives to solve the problems. The students from Group 1 used counting strategies such as counting sixes, making groups of threes and counting by threes. Group 1 students were more verbal in their answers by explaining their thinking process or how they had used the manipulatives to solve the problem. Students from Group 1 displayed a variety of responses showing their flexibility in thinking.

Students from Group 2 counted by ones to arrive at an answer and had some difficultly explaining their answer, many times the response was "I guessed" or "I just knew it". Responses from Group 2 were explained by "I added" or "I subtracted". Students from Group 3 were not clear in solving questions 3, 4, 5, and 6. An example, the problem which stated, Tad had 15 guppies. He put 3 guppies in each jar. How many jars did Tad put guppies in?, the students from Group 3 subtracted 3 and gave the answer of 12 jars. Group 3 students used only addition or subtraction to arrive at a solution.

Students with the problem solving instruction were able to explain their thinking and used a variety of strategies to arrive at their answers. Results from this second grade classroom study indicates the problem solving approach does nurture children's thinking, reasoning, and communication skills.

# CHAPTER V

# SUMMARY, CONCLUSION, RECOMMENDATIONS

## Summary

There were two purposes of this study. One purpose was to review and analyze the literature surrounding problem solving mathematics in early childhood education, and two was to conduct an action research study in a second grade classroom. The following questions were asked and will be reviewed to achieve the purposes of this study.

1. What does the literature reveal about the problem solving approach a levels other than second grade?

Literature revealed from studies at first grade and kindergarten, that young children are capable of solving a wider range of problems including multiplication and division than had been presumed. Young children have demonstrated significantly greater achievement in mathematical problem solving by using advanced strategies. The problem solving approach has given young children an understanding of mathematics, in which they can show mathematical power. Studies on first grade (Carpenter et al., 1989) and kindergarten (Carpenter et al., 1993) children prompted an extension of the Cognitive Guided Instruction project to include kindergarten through third grade.

2. What does the literature reveal about the problem solving approach at the second grade level?

Three studies conducted in second grade classrooms revealed students with problem solving instruction showed mathematical meaning. Students were able to construct new knowledge from past knowledge, show a higher sense of mathematical reasoning, and use a wider variety of strategies to solve problems. The problem solving approach enables children to become communicators of mathematics, by allowing children time to explain their understanding and thinking. Consensus from studies on second grade classrooms suggests problem solving instruction gives students mathematical power.

3. Does the literature agree with the problem solving action research study conducted in a Waterloo, Iowa second grade classroom?

The evidence from the study conducted by the researcher in her second grade classroom supports the studies in the literature. The results from this researchers study and that of the other studies suggest the problem solving approach in teaching mathematics is very powerful. If students can maintain current levels of computational skills and also understand the reasoning behind those skills achievement in mathematics will rise. With the problem solving approach classrooms can become places where problems are explored and important mathematical ideas are implemented. The National Council of Teachers of Mathematics (1989) believes mathematics curriculums should include the traditional areas of mathematics currently taught (algorithms, measurement, fractions, geometry, time, and money), but with a different emphasis. As discussed in the literature, the National Council of Teachers of Mathematics goals (1989) can be achieved through problem solving teaching techniques. In meeting these goals students will become mathematically literate and powerful learners of mathematics.

## Conclusion

This researcher found no conflicting literature on the problem solving approach in teaching mathematics to young children. Therefore the assumption is that problem solving enhances childrens' thinking and mathematical talents. The literature suggested that students taught with a problem solving approach do not show a significant difference in computational skills, so in using this approach children may not become more proficient in mathematical computation. Computation was not the focus in this second grade study, rather problem solving and communication skills in explaining solutions was emphasized in this researchers study.

In reviewing the literature it was found that problem solving enhances the natural talents in children by allowing children to build on past knowledge, explore new experiences, and create new knowledge. Not only does the problem solving approach in teaching mathematics allow students to understand the processes, but it allows children to communicate those processes. The literature does not view the problem solving approach as helping children become proficient in mathematical computation skills. Studies show that children taught with problem solving methods are equal to their peers taught with traditional methods when computational skills are measured, but do not exceed them.

## Recommendations

The study conducted by this researcher was on a small sampling of subjects. It is recommended this study of childrens' development of mathematical problem solving skills be replicated using a larger amount of subjects. In addition a study which would explore how problem solving improves computational skills is recommended. Educators involved in the teaching of problem solving need to inform the larger educational community of their success in helping children become powerful mathematical problem solvers. It is recommended that educators who are teaching problem solving mathematics become leaders; by allowing others in their classrooms to observe and learn, write articles explaining teaching strategies, speak at conferences, and hold workshops for training colleagues in problem solving mathematics.

From this study this researcher has become inspired to continue to pursue the problem solving approach in teaching mathematics. This researcher would like to become an active informer of problem solving by speaking at future mathematics conferences, writing articles, and helping with teacher in-servicing.

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Appendix A

## Group Test

1. Alice is going to see her grandmother. Grandma lives 500 miles away. Alice and her family have driven 295 miles.

Is Alice

a. almost there

b. a little more than halfway there

c. less than halfway there

2. Circle the answer

45 + _____ = 60

15    25    35

3. I have 21 cents in my pocket. Bubble gum costs 5 cents each. How many pieces of bubble gum can I buy?

4. Nick has 72 baseball cards. Tim has about half as many cards. Does Tim have

26 cards    34 cards    42 cards

5. 38 + 36 = _____

Is the answer

a. more than 70

b. less than 70

6. Choose 2 numbers when added together will have an answer very close to 100.

46    55

86    29

7. Pretend you are a squirrel. There are 6 trees. You find 4 nuts under each tree. How many nuts do you find?

8. Megan has $3.00. How many more dollars does she need to earn to have $8.00?

Appendix B

## Interview Questions

1. Paco had 17 cookies. He ate 9 of them. How many cookies does Paco have left?

2. James has 12 balloons. Amy has 7 balloons. How many more balloons does James have than Amy?

3. Robin has 3 packages of gum. There are 6 pieces of gum in each package. How many pieces of gum does Robin have?

4. Mr. Gomez had 20 cupcakes. He put the cupcakes into 4 boxes so that there were the same number of cupcakes in each box. How many cupcakes did Mr. Gomez put in each box?

5. 19 children are going to the circus. 5 children can ride in each car. How many cars will be needed to get all 19 children to the circus?

6. Tad had 15 guppies. He put 3 guppies in each jar. How many jars did Tad put guppies in?