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ABSTRACT

This report describes a program for improving students' comprehension of the language of mathematical problems. The targeted population consists of 5th and 6th grade multi-age students and multi-age learners with special needs at a middle school located outside a major city in a Midwestern community. Evidence for the existence of this problem includes math test scores, teacher observation of math problem solving processes, and student reflective journals. Analysis of probable cause data reveals that students cannot solve mathematical problems due to a number of factors. Students often have difficulty figuring out the relationship between the words and the symbols in mathematical problems. Often they will look past the words in the context of the problem directly to the data. This can lead to "correct" solutions that are inappropriate to the contextual sense of the problem. Students often rely on superficial cues that can lead to incorrect solutions, or solutions that make little sense in terms of the language of the problem. Additionally, the language itself that is used in mathematical problems is different from a students' everyday language and can cause some comprehension difficulties in terms of solving the problem. A review of solution strategies suggests that students need to utilize their prior knowledge to make sense of the language in the problem to participate in discourse with others in order to identify the relevant information that might lead to a solution, and to explore a range of problem solving strategies. The interventions used in this study include cooperative grouping, vocabulary interventions, teacher-student modeling, and student reflective journals. Post intervention data indicates that divergent approaches in problem solving strategies were thought to be a key factor in encouraging students to think more broadly than they had before the intervention. A growing sophistication in students' abilities to metacognitively analyze their approach to problem solving was evidenced in their journal entries. (Contains 50 references.) (ASK)

IMPROVING STUDENT ACHIEVEMENT IN SOLVING MATHEMATICAL WORD PROBLEMS

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A review of solution strategies suggests that students need to utilize their prior knowledge to make sense of the language in the problem; to participate in discourse with others in order to identify the relevant information that might lead to a solution; and, to explore a range of problem solving strategies. The interventions used in this study will include cooperative grouping, vocabulary interventions, teacher-student modeling, and student reflective journals.

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CHAPTER 1

PROBLEM STATEMENT AND CONTEXT

General Statement of the Problem

The students of the targeted 5th/6th multi-age class and the middle school class of multi-age learners with special needs demonstrate difficulty in comprehending the language of mathematical problems. As a result, their academic achievement in math is negatively impacted. Evidence for the existence of this problem includes math test scores, teacher observation of math problem solving processes, and student reflective journals.

Immediate Problem Context

Two school sites are utilized in this study. They are northwest suburban schools near a large mid-western city. Site A is a middle school, comprised of 6th, 7th, and 8th grades with a total enrollment of 932 students. The district expenditure is $6,124 per student, which is comparable to state expenditures per student. The following is a breakdown of ethnic characteristics from the total number of Site A students: 82.2% White, 5.2% Asian/Pacific Islander, 10.6% Hispanic, 1.6% Black, 0.4% Native American. Site A has an attendance rate of 94.4% with 0.1% chronic truancy. The Site A truancy rate is slightly higher than that of Site B. There is also a rate of 11.6% of student mobility at Site A.

The certified staff of Site A includes the following: one principal and three assistant principals. There are 58 classroom teachers of grades six through grades eight. Forty of the teachers are female and 14 of the teachers are male. The support staff includes a social worker, a school psychologist, and a speech-language pathologist. The classified staff consists of 14 employees and the custodial staff numbers six. According to the number of students, it is the largest middle school in the district.

Site A is a neighborhood school located in a residential area. It is a single story building with 46 classrooms, a cafeteria, three gymnasiums, a library media center, and three computer labs. The average class size is 22.6 in grade six, which is lower than the state average. However, class size in grade eight is above the state average with 23.7. These figures are reported in the state report card for the district in which only sixth and eighth grades are listed. The following number of minutes per day are devoted to instruction of core subjects in grades six through eight as mandated by the State Board of Education: 90 minutes for English, 45 minutes for math, 45 minutes for science, and 45 minutes for social science.

Site A's special education programs include a Program for Developmental Instruction (PDI), Learning Disabled (LD), Behavioral Disabled (BD), and Other Health Impaired (OHI) who have Individualized Education Plans (I.E.P.). The students of the targeted special needs class are identified as OHI and PDI. The academic classes offered for these students include math, language arts, science, and social sciences, all of which are modified to meet their needs.

Site A utilizes the Literature series (Prentice-Hall, 1995) for reading. The targeted special needs students at this school also use this series along with the diagnostic STAR (Advantage Learning Systems, Inc., 1998) testing to determine grade level reading ability. The math curriculum at Site A is taught through the Scott, Foresman/Addison-Wesley Mathematics (Addison Wesley, Longman, Inc. 1999) series. Modifications of this math program are provided to the targeted special needs students.

Site B's breakdown of ethnic characteristics of the students is 75.5% White, 8.0% Hispanic, 11.0% Asian/Pacific Islander, 5.0% African-American, and 0.5% Native American. Site B has an attendance rate of 95.9% with 0.0% chronic truancy. There is a rate of 9.6% student mobility, which is lower than Site A

The certified staff of Site B includes one principal and one assistant principal. There are 20 teachers of grades K-6; 90 are female and one is male. The support staff includes a social worker, a school psychologist, a speech-language pathologist, a library media teacher, and two special resource teachers. Site B is a multi-age facility with grade level groupings of 1st/ 2nd, 3rd / 4th, and 5th /6th, and has an average class size of 21 students. Time devoted per day to the teaching of core subjects in sixth grade is 50 minutes for math, 45 minutes for science, 105 minutes for English (includes all language arts), and 27 minutes for social science. The number of minutes per core subject, per day, in grade three is 27 minutes in math, 18 minutes in science, 180 minutes in English (includes all language arts), and 18 minutes for social science. In addition, as part of a grant, 90 minutes per week is allotted for Spanish language instruction per grade due to the growing diversity of the population.

Site B is a neighborhood school located in a residential area. The building is two stories with twenty classrooms, a gymnasium, a library media center, and a computer lab. The second largest public library in the state is located within walking distance of the school. School B has an enrollment of 457 students. Expenditures per student at Site B are $5,541, which ranks in the 84th percentile in state spending and in the 72nd percentile in national spending.

In addition to the regular reading program, Site B provides Title 1 services that are available for identified students who require additional support. The reading curriculum is taught through a blend of two programs. Grades 1/2, 3/4, and 5/6 receive reading instruction through the Houghton-Mifflin Invitations to Literacy series. In addition, grade 5/6 receive instruction through Scott, Foresman Literature series. Site B also delivers instruction in mathematics through the Addison-Wesley Mathematics series. Furthermore, in the fall of 1999, the University of Chicago, Everyday Math series will be implemented in all grade levels.

Site B's special education programs consist of a self-contained LD classroom and a resource program for LD and BD students. All academic areas are taught in a self-contained classroom. Mainstreaming of self-contained students occurs when the student attains the general education level within the subject area. The resource program extends tutorial services to the student through the services of members of the special services resource team of teachers. Speech-language therapy and social work services are also delivered in whole group situations as well as a one-on-one pullout program.

The Surrounding Community

Site A is located in a northwest suburb of a large, mid-western city. The most recent census of the community showed a population of 33,429 residents. The average age of a person living in this community is 32.7 years. Of the total population, 62% are high school graduates, and 34% are college graduates. The median family income for Site A is $62, 362 per year. There are a total of 13,455 housing units with 7,926 single family detached and 5, 529 multiple family units. There are approximately 3.77 persons per household. The median home value for Site A is $180,000. The average rent is $950 per month.

Site A is located in an area with an expansive industrial base. Over 3,600 firms employing approximately 80,000 people, which represent most nationally recognized firms, make this suburb their home. The top employer of full and part-time individuals is Alexian Brothers Medical Center with 2, 200 employees. In addition, there are eleven principal shopping centers and sixteen strip shopping centers within the village.

A total of 10 elementary schools and three junior high schools make up Site A's district with a total enrollment of 6,265 students. The 409 district teachers average 14.1 years of teaching experience with 49.5% of them holding a Master's degree or above. In the district, 86.3% of the teachers are female, while 13.7% are male. The district's teacher racial/ethnic background is 91.5% White, 5.1% Hispanic, 2.2% Asian/Pacific Islander, 1.0% Black, and 0.2% Native American. The average teachers' salary in School A's district is $50, 565, while the average administrator's salary is $84, 327. These salaries are approximately 13% higher than the state average. District expenditures per student are $6,124, which is comparable to the state expenditure per student of $6,281.

The State Board of Education has mandated the establishment of a charter school within the geographic boundaries of Site A's district if the proposed school's charter presents a viable budget and location. The district is required by law to pay the cost for operating this school. It is uncertain at this time whether the charter school will be able to meet the conditions set by the state board.

Site B's community is also located in the northwestern suburban area of a large mid-western city. The most recent census shows the population in this community to be

74,294 residents. The average age of a person living in this community is 35.4 years. From the total population, 61.2% are married, and 38.3% are married with children. The adult education level in this community is as follows: 10.3% are not high school graduates, 89.7% are high school graduates, 31.2% are college graduates, and 7.5% are post graduates. The median family (households with children) income for Site B is $52, 044. There are a total of 32,324 housing units with 11,709 single family detached and the remainder multiple family units. The median home value is $108,700. The average rent is $622 per month. Owner-occupied is 58% of the population and rental-occupied is 42%.

Site B's district is situated in a community that is home to numerous multi-national companies, as well as many large industrial parks. Motorola, Ameritech, and Sears, Roebuck & Company are just a few of these corporations. In addition, one of the world's largest retail malls is the center of an extensive retail industry.

Site B's district has a total number of 975 classroom teachers. The average teaching experience is 18.1 years with 58.95% of the total number of teachers with a Master's degree or above. In this district, 86.7% of the teachers are female, while 13.3% are male. The district's teacher racial/ethnic background breaks down as follows: 97.3% White, 0.7% Black, 0.9% Hispanic, 0.9% Asian/Pacific/Islander, and 0.1% Native American. These figures closely parallel the student's demographics. The ethnic characteristics of students in the district are 72.6% White, 7.1% Hispanic, 13.1% Asian/Pacific Islander, 7.0% African-American, and 0.1% Native American. The average teacher's salary in Site B's district is $41, 883, while the average administrator's salary is $74,222.

Site B's district serves seven communities in a 31 square mile area with an enrollment of 15,901 students. It has the largest elementary school district enrollment in the state serving 58,000 households. There are a total of 27 schools in the district: 22 elementary and five junior high schools. There are no high schools in this district.

Site B's district is currently faced with two specific issues: choice of school site and multi-age class configurations. The district has established a school of choice scheduled to open in the fall of 1999. The school has a multi-age class configuration of about 300 students drawn from the surrounding community. Students were chosen from a lottery of applicants.

The concept of a multi-age class composition has drawn mixed reactions from the community. Parents are interested in having a choice in the type of classroom which their child is assigned. At the present time, Site B is the only school that has a total multi-age classroom configuration. However, there are other multi-age classrooms within numerous schools across the district.

National Context of the Problem

The difficulty students have in comprehension of the language in mathematical problems is more than a localized issue. In a published report of the National Council of Teachers of Mathematics comparing American fifth graders with Chinese and Japanese children, "the Americans had the lowest mean scores on both computation and word problems. In fact, 67 Americans were among the 100 lowest scoring fifth graders in the study which included 720 students. Only one American was among the 100 highest scoring student," (Stevenson, Lummis, and Stigler,1990).

In an examination of problem solving research, Lester (1994, p. 660), comments on the situation with regard to problem solving in American schools. "The situation in American schools with respect to student performance in mathematical problem solving is desperate!" It was noted in a published report from the National Assessment of Educational Progress that "on extended constructed-response tasks, which required students to solve problems requiring a greater depth of understanding and then explain, at some length, specific features of their solutions, the average percentage of students producing satisfactory or better responses was 16 percent at grade 4, 8 percent at grade 8, and 9 percent at grade twelve," (Dossey, Mullis, & Jones, 1993).

In their study of teaching realistic mathematical modeling using word problems, researchers,Verschaffel and De Corte (1997), note that "students demonstrate an inability to make proper use of real-world knowledge and sense-making activities in their solution processes." They point out that only 24% of a national sample of thirteen year-olds in the United States were able to correctly solve a problem that appeared in the Third National Assessment of Educational Progress.

In the same study, these researchers point to more recent studies in which 10 – 13 year old students were presented with word problems. Half of these were problems that could be solved by applying the most obvious arithmetic operation(s) with the given numbers. In the other half of the word problems, the appropriate mathematical model demanded more comprehension of the contextual language. "The analysis of the pupils' reactions to the problematic items yielded an alarmingly small number of realistic responses or comments. Only 17% of all reactions of a large group of 10 and 11 year olds to a set of 10 problematic items could be consisdered realistic," (Verschaffel, De Corte, and Lasure, 1994. p. 578).

Furthermore, this difficulty that students experience in problem solving continues to be addressed in the NCTM review of research. Kroll and Miller (1993) point out that "although most test results from the National Assessment of Educational Progress show that American students denomstrate acceptable mastery of computational skill, they also reveal that many of these same students are unable to apply these skills to anything other than the most routine of mathematical problem solving situations."

Similarly, other research investigating students' interpretations of word problems asserts that children have an implicit understanding of the word order of problems but that their inexperience with the verbal forms used in the problems does not connect with this understanding, (Cummins,1991).

Recently, Curry (1996) concludes in a report, that "written mathematics contains more ideas per line and page than most other disciplines. Words and symbols are continously combined and students' comprehension depends on their ability to discern the relationship between the words and symbols."

Additionally, the NCTM has targeted the areas of problem solving, communication and comprehension for improvement. Most recently the council noted that effective problem solvers need to understand the problem. Both "Standard 6: Problem Solving" and "Standard 8: Communication" in the upcoming "NCTM Standards for 2000" address this need. Standard 6 puts forth a proposal that "mathematical instructional programs should focus on solving problems as part of understanding mathematics. Standard 8 recognizes that there "is sometimes a mismatch between ordinary language and mathematical language" and declares that "students need help to build a bridge between their uses of language within and outside the mathematics classroom," (NCTM, 1999). These standards address the relevant research on learning and teaching mathematics across our nation.

CHAPTER 2

PROBLEM DOCUMENTATION

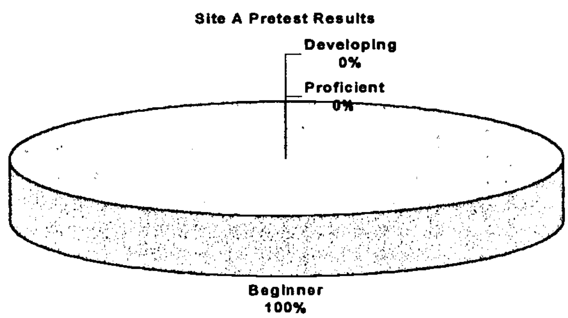
Problem Evidence

In order to document the difficulties students demonstrate in their comprehension of the language in mathematical problems tests were administered to the targeted student population. These tests were designed to assess the use and understanding of the language in mathematical story problems, the application of problem solving skills as well as general math knowledge. Anecdotal evidence collected both through teacher observation of students' problem solving processes and student reflective journals indicated a need for addressing this aspect of student mathematical understanding.

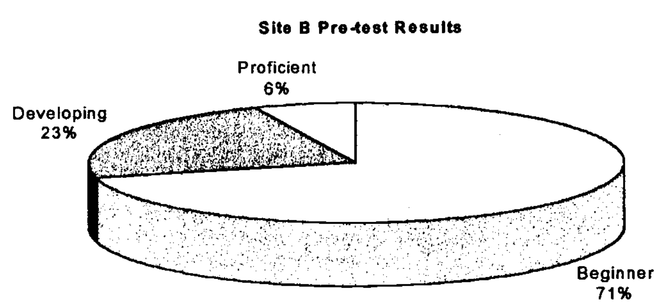
Students' work is evaluated and a beginning, developing or proficient rating is then determined for each open-ended task. A beginning problem-solver would demonstrate responses that have fragments of appropriate material and show efforts to solve the problem. Next, a developing problem –solver would develop responses which would show that they could revise the work to a proficient performance with the help of feedback (i.e. teacher prompts). While there is a basic understanding, it is not quite proficient or completely independent. Finally, a proficient problem-solver would be able to meet the demands of the task and demonstrate a broad range of understanding, and apply their understanding in different contexts.

Of the five students in the special needs math class at Site A who were considered for this project, only two students qualified for the 16 week intervention program. Both students qualified as beginners in the problem solving process. A class checklist for intervention, as well as an individual profile of progress for problem solving, were developed to aid in the recording process. A summary of this collected data is presented in figure one.

At Site B, 35 of the 40 students in class were included in the collection of the data needed for problem documentation. Of the 35 students tested, 71% were determined to be beginners, 23% were determined to be developing problem solvers, and 6% were determined to be proficient in their problem solving processes. A summary of this collected data is presented in figure two.



<u>Figure One:</u> Results of pre-test given to students at Site A in the fall of 1999.



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<u>Figure Two:</u> Results of pre-tests given to students at Site B in the fall of 1999.

Probable Cause

The analysis of probable cause data indicates that students demonstrate difficulty in comprehending the language of mathematical problems. Among the causes are the following: a rush to find a solution without fully understanding the problem; superficial solutions used in the problem solving process; the broad range of reading abilities that exist within a classroom; frustration experienced in trying to make sense of the context of a problem; as well as vocabulary and syntactic complexities of math language. Evidence of these probable causes was found at the targeted sites, as well as in a review of the literature.

Research has shown that when faced with solving a story problem, students often look for a quick algorithmic solution without much regard to the textual complexities and necessary meaning-making needed to solve it thoughtfully. Students tend to read quickly, looking only for a clue word and numerical data in order to arrive at an expeditious solution (Sowder, 1988; Szetela, 1993). A disproportionate emphasis is placed on "getting the answer." According to Schoenfeld (1983), children do not establish meaningful connections between the contextual language of problems and arithmetic operations because they "perceive mathematics as a 'given.' It is not likely that they feel compelled to make judgements about their strategies or solutions to problems." Many students at the targeted sites have exhibited this superficial problem solving technique resulting in inadequate solutions. Arriving at an answer quickly is their top priority giving little regard to adequately thinking through the contextual language and meaning of the problem. Speed and computational accuracy are perceived as the goals rather than persisting in the problem solving process in a deliberate manner to arrive at a more thoughtful solution.

Traditionally, teachers at the targeted sites have regarded themselves as the primary dispensers of mathematical knowledge rather than facilitators of student thinking. Limited emphasis has been given to assisting students in negotiating the meaning of the language in a given story problem. Mathematics instruction has tended to be textbook driven with minimal group discussion or development of the thinking process resulting in superficial solutions to problems. Clarification of the contextual language used in a story problem has not been an area of focus.

Moreover, problem solving is often completed by students in isolation with the expectation that skills in computation were the primary tools necessary for completion of the problem. Limited opportunities have been available for cooperative groups where students could be actively engaged in collaborative problem solving. Thus, the situation has limited the opportunity for discourse through which students could negotiate a better understanding of the contextual language imbedded in a mathematical story problem.

Contributing to the challenge of helping students derive more meaning from the context of a story problem is the wide range of reading abilities found in any classroom. It has been said that the reading ability levels range from 3rd grade up to the reading level of a second year college student, (Curry, 1989). Further complicating this situation is the recognition by most researchers that the language in mathematics textbooks is written at a higher reading ability level than is customarily the case for a given grade level, (Brennan & Dunlap, 1985). This has been especially troublesome for the special needs students at Site A who exhibit a range of reading abilities from non-reader to a reading level of 3rd grade. Reading mathematical story problems is predominately teacher-directed at this site. The students at this site are not alone in their frustration with interpreting these problems. Insufficient reading skills have been identified as a reason that many students experience difficulty in mathematical problem solving , (Ballew, 1982; Davidson, 1977; Muth, 1984).

Further complicating the task of interpreting a story problem is the observation that the language used in mathematics texts is very different from that found in other subject areas. The combination of ordinary language as well as technical language, definitions, symbols, notations, as well as a specific set of rules and procedures can be frustrating for students trying to negotiate meaning, (Hoyles, 1989). It is very different, for instance, from reading a narrative passage. Curry has analyzed this situation with a breakdown of the types of language found in a mathematics text.

> When reading a mathematics book, the student is actually reading several kinds of Language: (1) the language that appears in a mathematics lesson and rarely elsewhere, such as the vocabulary words "rhombus" and "equation;" (2) words that have multiple meanings with very specific meanings in mathematics, such as "prime" and "set;" and, (3) the language of symbols and numbers, (Curry, 1989).

Curry (1989) concluded that there are more ideas per line and per page in the written language of mathematics as compared to other disciplines. These complex reading demands have frustrated students at both targeted sites. This difficulty is particularly evident with the students at Site A who have difficulties with processing and understanding anything other than everyday language. Continuous restatement of the problem and modeling must be demonstrated by the teacher in order for these students to be successful in problem solving.

Additionally, language and symbols in mathematics texts are often put together in such a way that the students' ability to distinguish a connection between the two affects an understanding of the meaning in a mathematical passage. This arrangement of language and mathematical symbols in story problems impacts a student's capacity to find a thoughtful solution. It has been observed that students fail to visualize and categorize the given information imbedded in the language of a story problem to their knowledge of mathematical concepts, (Irons & Irons, 1989). These are connections that are missing from the problem solving practices of students at the targeted sites.

Further complicating the challenge facing students when they attempt to solve mathematical story problems is the difficulty they experience in discerning the linguistic form unique to mathematical texts. The readers' frustration in deciphering word problems results from their inexperience and insufficient knowledge of the linguistic forms, (Cummins, 1991; Curry, 1996; Muth, 1984; Rudnitsky, 1995). While students may have an intuitive understanding of the semantic structure, it is a lack of experience with verbal forms that conflicts with their natural sense of this structure. Students are accustomed to sentences with the more familiar subject + verb + object form. The difference in semantic structure found in mathematical story problems compromises their comprehension, (Cummins, 1991).

Furthermore, reading strategies that assist learners to negotiate meaning have infrequently been incorporated into mathematics instruction, (Borasi, Siegel, Fonzi, Smith, 1999). Reading has been characterized as a process of "meaning -making in which readers use their knowledge of language and the world to construct and negotiate interpretations of text in light of particular situations within which they are read," (Borasi et al., 1999). This reading process frequently does not occur when interpreting the language used in mathematical story problems in classrooms at the targeted sites. These students experience difficulty in this meaning-making process when solving mathematical story problems. It has been noted that "written language is clearly more abstract than the spoken word. It relies on the connection of written symbols to the concepts experienced and labeled in our minds," (Hyde, 1991). Students at these sites are not personally making the connection with real-life situations and the mathematical concepts imbedded in mathematical story problems.

Underscoring this difficulty for pupils in interpreting the sense of a problem is the report from a recent study in which a large number of students did not make use of their real-world knowledge to solve unrealistic problems such as: "There are 26 sheep and 10 goats on a ship. How old is the captain?" Researchers found that "a large number of students 'solved' these problems by combining the numbers in them without being aware of the meaninglessness of the problems and of their solutions," (Vershaffel & DeCorte, 1997). Students at the targeted sites, similarly, often look past the sense of a mathematical story problem in order to find an algorithmic solution.

Clearly, there is a particular need for children at the targeted sites to make more sense from the language used in mathematical story problems. An emphasis on negotiating the contextual language inherent in such problems may result in more thoughtful problem solving processes on the part of these students.

CHAPTER 3

THE SOLUTION STRATEGY

Literature Review

A review of the literature on students' difficulties in comprehending the language in mathematical story problems included a variety of solution strategies. Among those that have been researched are the following: implementation of reading strategies in the solution process; the use of literature; emphasis on vocabulary development; developing metacognitive thinking; use of reflective journals; implementation and utilization of cooperative groups; class discourse; student and teacher modeling; as well as, open-ended constructed tasks.

Problem Solving

To begin with, problem solving as viewed by many includes activities that involve uncertainty. According to Wirtz and Kahn, "Problem solving...requires the use of reflective thought, trial and error, evaluation, decision-making, and other high-level cognitive skills, attitudes and behaviors," (1982). According to many researchers, teachers can enhance a pupil's conceptual understanding of problem situations in several ways (Hilke, 1995; Hyde, 1991, Rathmell & Huinker, 1989; Fraivillig, 1999). Three teacher actions that have been suggested to assist students in understanding the language in a mathematical story problem are the following: (1) activate what students already know, their schemata, in order to address a problem; (2) utilize a variety of ways to represent a problem; and, (3) carefully plan, monitor, check and develop other metacognitive functions, (Hyde, 1991).

For the purposes of this study, problem solving is viewed as the process of interpreting the language of mathematical story problems as students work toward solutions. When children realize that problem situations in real life are full of uncertainty, they may be more likely to develop the kind of mathematical thinking required to solve mathematical story problems. It has been pointed out by Schoenfeld in his article, "What's All the Fuss about Metacognition," that "most of what we do is wrong. That is, most of our guesses – when we're working on real problems - turn out not to be right. That's natural; the problems wouldn't be problems, but exercises, if that weren't true," (Shoenfeld, 1987).

Reading Strategies

Over the past 30 years, considerable research has addressed reading strategies as they pertain to the solution of math story problems. Most of the focus of reading instruction by teachers has been to assist students in the interpretation of the technical language involved in mathematics textbooks. This instruction has included specialized vocabulary and symbols, use of graphic representations, density of text, and the layout of mathematical texts, (Borasi, Seigel, Fonzi, Smith, 1999). Teachers have assisted students to interpret mathematical story problems in a variety of ways that include recognizing and decoding language through word find exercises, flashcards, puzzles, and word matching activities, (Ciani, 1981; Hollander, 1975; Krulik, 1980). Attention has been given to the adjustments student's make in their reading rate of mathematical texts for a variety of purposes: in order for them to get a general idea of the information it contains; reread to take notes; and, reread to write clarifying questions, (Henrichs & Sisson, 1980). Use of a variety of aids and manipulatives has helped students develop skills needed to read mathematics story problems, (Rentzel, 1983).

Another recommended reading strategy to assist students in mathematical story problems has been to teach structural analysis. This requires teaching them how to separate the word into meaningful parts, (Brennan & Dunlap, 1985). Curry (1989), recommends using a Directed Reading Activity (DRA) in mathematics problem solving which involves a systematic approach for students to interpret the language in story problems. The steps in this strategy include (1) establishing a readiness stage to provide motivation; (2) developing vocabulary; and, (3) setting a purpose for reading.

More recently, teachers have been encouraged to focus less on text-based strategies and more on strategies that consider reading as meaning- making. When students use their understanding of language and real world experiences they can construct meaning for themselves, (Irons & Irons, 1989). A number of researchers advocate that a variety of texts be incorporated into mathematics classrooms, not simply mathematics textbooks. Additionally, they feel that the emphasis on mathematical reading needs go beyond textbooks and word problems. This is important "in order to expose math students to issues that are becoming more significant as the goals for school mathematics are redefined" (Borasi, et. al., 1999). Some of the reading strategies used in this approach are the followng: Say Something, Cloning an Author, and Sketch to Stretch, (Harste and Short, 1988; Seigel, 1984).

The use of literature has been an important strategy in making mathematics more meaningful for children, (Thrailkill, 1994). Open discussion is more likely to occur in mathematics classrooms when literature is used to introduce, reinforce, or extend mathematical concepts and skills, (Ohanian, 1989; Dupuis & Merchant, 1993). The use of mathematical problems that are embedded in literature allow teachers to effectively integrate mathematics instruction in other content areas, (Sakshaug, 1997).

Vocabulary Development

Traditionally, mathematics instruction has not included explicit language activities for students. However, a child must use all of his or her reading strategies to read story problems in order to interpret the meaning. Then, a child needs to translate this meaning into a mathematical context. Yet, students who cannot interpret the vocabulary used in mathematical problems find this translation to be difficult. This may lead to a lack of success in solving these problems.

Strategies that have been suggested as ways to assist students in this translation process include the development of reading skills, decoding and encoding skills, translation between vocabularies of reading and mathematics, and the use of context clues.

Emphasis on vocabulary development as a strategy includes the use of a mathematics glossary to designate an appropriate meaning to content vocabulary, (Gardner, 1992; Krulik, 1980). Key strategies used to develop students' understanding of the vocabulary of mathematical language are phonetic analysis, modified cloze exercises, word completion tasks, use of newspapers to identify real-world mathematical language, concept maps, and graphic organizers, (Brennan & Dunlap, 1985; Hall, 1984).

Metacognition

Metacognition has been described as the knowledge and regulation of a cognitive task, (Muth, 1984). Schoenfeld (1987) suggests that capable problem solvers are people who are good at arguing with themselves. If children are to interpret the language found in mathematical story problems, they will need to develop sound metacognitive strategies. These strategies should be a part of any mathematics lesson or activity. For example, teacher modeling in the process of solving story problems will help students think through the context of the problem before solving it, (Hyde, 1991). Also, students can visualize the problem by drawing or labeling. Furthermore, self-checking the reasoning used in the solution also needs to be part of the process (Kresse, 1984).

Additionally, comprehension monitoring has been described as a process that includes planning, monitoring, self-checking, and remediation, (Muth, 1987; Hyde, 1991). These are the components of metacognitive processing according to Bellanca and Fogarty (1992). Students need to become conscious of their own thinking before, during and after the learning experience. Metacognitive strategies such as partner think-alouds, where students voice their thought processes aloud as they work through the problem, bring an awareness of their thought processes to a conscious level (Bellanca & Fogarty, 1992).

Reflective Journals

Additionally, the use of reflective journals underscores the metacognitive importance that is placed on students' evaluation of their own thinking, (Kulm, 1994). Researcher have identified benefits for students in reflective writing which include expression of feelings about math; expanded understandings of lesson content; increased ability to problem solve; as well as development of a more positive attitude toward mathematics, (Lester, Masingila, Mau, Lambdin, Pereira dos Santos & Raymond, 1994; Borasi & Rose, 1989). The regular use of reflective writing is an asset to developing students' mathematical learning, (Curry, 1989).

Cooperative Learning

Furthermore, understanding the language used in mathematical problem solving can be enhanced in a social and cultural context. When students collaborate and express their ideas aloud, powerful thinking occurs. Considerable research has shown that the implementation and utilization of cooperative groups encourages this type of active student participation and produces higher student achievement in mathematical problem solving, (Rudnitsky, et. al., 1995; Manouchehri, 1999; Cobb, 1992; Borasi et al, 1999; Fravillig, 1999). Emphasis has been placed on students' active involvement in meaningful problem solving where their explanation and elaboration of the problem, as well as their reasoning behind the solution, is completed in small groups. In order to advance children's thinking in problem solving, collaboration has been recommended with students working as a team to solve problems, (Fraivillig, et al, 1999). Slavin's study (1989) supports this concept noting that small-group activities result in positive outcomes when group members express and share their ideas with others.

The communication of ideas within small groups is important. However, in the context of the larger class setting, communication is also regarded as essential in negotiating meaning when problem solving, (Manouchehri & Enderson, 1999). Mary Lindquist (1996), the past president of the National Council of Teachers of Mathematics, in fact, addresses the need for discourse in a recent interview.

> If we think mathematics is a language, how do we learn a language? We talk, we listen, we read, we write. We build the concepts underlying the ideas so we can communicate with meaning. We build the skills that allow us to communicate with others.

Teachers who encourage students to discuss ideas among themselves, to take a position with regard to each others' contributions, and to help each other develop clear explanations and reasoning, are those who promote discourse to develop student thinking, (Manouchehri & Enderson, 1999). In classrooms where knowledge is regarded as a social construction, language takes on new importance. Members of the community of learners use language to negotiate meaning. This is significantly different from the use of mathematical language with techniques as the primary goal, (Siegel, Borasi & Fonzi, 1998).

Teacher Modeling

It has been suggested that teacher modeling is an effective strategy to develop good problem solving behaviors in students. When teachers "think aloud" as they go through a problem in front of the class, students can get a better idea of how the solution process works, (Schoenfeld, 1985). Furthermore, research indicates that using one student's step-by-step solution method with the entire class enhances the understanding of this process. A safe classroom climate and mutual respect within the community of learners are essential ingredients for fruitful discourse to occur, (Fraivilig, et. al., 1999; Nagasaki & Becker, 1993).

Two outstanding examples of this type of risk-free learning environment have been noted in research. The first is taken from a Japanese classroom where the learning events are organized to capitalize on a variety of students' thinking. Teacher "wait time" is extremely important in this regard. The teacher respects, "to a very significant degree," the differences in student thinking as it relates to the problem. No less important is the discussion of student ideas as they are expected, sometimes at length, to explain their ideas. Both whole and small group discourse among students, or between the students and the teacher, is extensive and considered pivotal in meeting the objectives of the lesson, (Nagasaki & Becker, 1993).

The next example cited in research is from an American classroom in which the teacher sets the stage for a high level of mathematical thinking. A safe environment is created through the teacher's efforts to foster teamwork and risk-taking. She accomplishes this by modeling respect for her students' thinking, and by placing emphasis on each student's strengths. Her combination of a "tough, no-nonsense manner with a deep affection for her students" develops a confidence in her students that their ideas will be accepted. These children felt free to volunteer an explanation of their thinking process during class discussions. "The rapport and the level of respect between the teacher and the children were exceptional; learning was a mutual endeavor," (Fraivillig et al., 1999).

Open-ended Questions

Research indicates that in order to gain a more complete understanding of students' problem solving processes, the use of open-ended, context-driven questions requiring an explanation of students' thinking is required, (Franke & Carey, 1997). This is the type of problem solving format that is recommended by the National Assessment of Educational Progress in their website explanation of the questions used on the Nations Report Card. In 1992, the extended constructed-response questions focused on communication and reasoning by asking children to make connections across mathematical strands. The 1996 assessment devoted more than 50 percent of student assessment time to constructed-response questions, (National Assessment of Educational Progress, 1999). For the purposes of this study, this type of question will be referred to as an open-ended constructed task.

Interestingly, it has been noted in research that after two years in a problem-centered curriculum, student achievement is higher on standardized achievement tests. Improved understanding of mathematical concepts and better task-orientation occurs in these classrooms as compared to students receiving instruction in traditional textbook-driven classrooms. These gains in problem solving remain with students even when they return to a more traditional mathematical program, (Wood & Sellers, 1997).

Project Objectives and Processes

As a result of increased instructional emphasis on language comprehension in mathematical problems during the period of September, 1999, to January, 2000, the students of the targeted $5^{th}/6^{th}$ multi-age class and the middle school class of multi-age learners with special needs will improve their mathematical problem-solving abilities, as measured by pre and post mathematics tests, open-ended constructed tasks, and review of student reflective journals.

In order to accomplish this project objective, the following processes are necessary:

1. Obtain curricular materials that foster language comprehension in mathematical story problems.
2. Develop learning activities and assessments that address language comprehension in mathematical story problems.
3. Revise classroom curriculum schedule to allow adequate time for mathematical story problem activities.

Action Plan for Intervention

An action research intervention to improve students' problem-solving skills is planned for implementation from September through December of the 1999 school year.

Several group meetings to plan, prepare materials, and finalize details for the students' arrival at the beginning of the school year will take place during the months of July and August.

Plans are for the action research problem solving interventions to be implemented at two sites. One is a middle school special education classroom, Site A. The second site is comprised of two $5^{th}/6^{th}$ grade elementary classrooms, both located at Site B. Implementation of the interventions will begin the first week of school. Prior to the intervention the researchers will:

I. Prepare the environment prior to student arrival

A. Gather materials necessary for implementation of action plan

B. Set up time-frame for math lesson scheduling

C. Teacher reflection journal set up

Assessments of the general math levels of the students will be administered during the first week of the school year. The rationale for the intervention, as well as the practical matters involved in establishing a positive classroom climate, will take place.

An assessment will be made midway through the intervention to determine the effect it is having on the students and to serve as an indicator for the direction and choice of problem stories to be used for instruction in the next series of lessons. The assessments will provide the action researchers with valuable data in making the determination of how much support (scaffolding) individual students may need as they develop as problem solvers.

II. Week One (August 31 – September 3)

A. Student preparation for the project

1. Individual assessment of the general mathematical ability of students
2. Individual assessment of the ability to independently solve an open-ended math problem

B. Teacher instructional tasks

1. Whole group explanation to the students of the problem solving steps involved in the intervention
2. Teachers organize cooperative groups of students for problem solving

The intervention to improve students' mathematical problem-solving will always include the following teaching strategies: (1) whole group introduction of an open-ended problem; (2) class discourse involving the identification of the central problem(s); (3) problem solving in cooperative groups; (4) teacher monitoring of cooperative groups; (5) whole group discussion of problem solutions; (6) students' recording of insights from the problem solving experience in reflective journals. This routine for each of the lessons will serve as a template for instruction. This format will be used in a group of sessions called the Instructional Period.

III. Weeks Two to Seven (September 6 – September 15); instructional period

A. Whole class introduction of the problem

B. Cooperative group problem solving

C. Monitoring of groups by teacher

D. Class discourse of process used in solving problem

E. Individual student recording of solution to problem in journal

F. Individual reflection of the problem solving session in journal

G. Teacher use of rubric to evaluate and record student solutions from individual journals

An evaluation of student progress during the eighth week will provide the researchers with important information with regard to individual student progress in problem solving. The assessment will require each student to solve an open-ended problem on their own. This task will be similar to the type of open-ended problem used in the group sessions and will measure the students' ability to independently apply the strategies introduced in class to the solution of a story problem. The results will offer the action researchers the opportunity to collect the pertinent data to determine the overall effect of instruction, as well as to direct the selection of problems and instructional emphasis for the next series of lessons.

IV. Week Eight: (October 22) evaluation period

A. Individual student evaluation of problem solving progress

B. Reflective journal entry

V. Weeks Nine – Fifteen (October 29 – December 10): instructional period

A. Whole class introduction of the problem

B. Cooperative group problem solving

C. Monitoring of groups by teacher

D. Class discourse of process used in solving problem

E. Individual student recording of solution to problem in journal

F. Individual reflection of the problem solving session in journal

G. Teacher use of rubric to evaluate and record student solutions from individual journals

VI. Week Sixteen (December 14): evaluation period

A. Individual student evaluation of problem solving progress

B. Final reflective journal entry

Chapter 4

PROJECT RESULTS

Historical Description of the Intervention

The objectives of this project were to improve the students' comprehension of the language used in mathematical word problems in order to improve their problem solving ability. The interventions implemented in order to achieve the desired change included whole group introduction of an open-ended problem; class discourse involving identification of the central problem; problem solving in cooperative groups; teacher monitoring of cooperative groups; whole group discussion of problem solutions; students' recording of their insights from the problem solving experience in reflective journals. Samples of these journal pages can be found in Appendix A. The Class Checklist for Intervention is located in Appendix B.

The first phase of the action plan was to collect data in order to show where the students were functioning mathematically. During the first week the students at site A were given the Dr. Lola May Diagnostic Analysis test as a pre-test to assess their basic mathematical skills. The students at site B were given the Addison-Wesley End of the Year Test to assess their basic mathematical skills. Fifth graders were given the fourth grade end of the year test and sixth graders were given the fifth grade end of the year test. These pre-tests provided documentation of the students' mathematical ability level.

Next, another pretest was administered to all targeted students at both sites. Site A administered a test, which consisted of a word problem taken from the third grade level Illinois Standard Achievement Test, Sample Math Materials. Site B administered a word problem from the fourth through fifth grade Exemplars Math Workbook. The teacher researchers recorded the student responses as the Exemplars were completed on a teacher- constructed rubric. A sample of this rubric can be found in Appendix C.

After pretests were administered, Exemplars were administered once a week. Students at Site A received direct instruction in the comprehension of the problem during a 45 minute class period. Working with the teacher researcher, the students read the problem orally, underlined words they did not comprehend and discussed the meaning and relevance of these words. Next, the teacher researcher modeled problems, which were similar to the Exemplar they were attempting to solve. Finally, students worked with partners and individually to solve the problems with the inclusion of teacher monitoring. After completion of the solution to the word problem, students recorded their problem solving processes in journals, along with reflections of their feelings and reactions.

Site B initially administered Exemplar word problems once a week during a 60-minute class period. Over the course of the 16 week intervention, it was necessary to extend this class period to 75 minutes in order to better accommodate the students' completion of the metacognitive reflection portion of the journal.

Lastly, the teacher-researchers administered a post-test to assess the progress of the students during the course of this intervention. The post-test that was administered at Site A was identical to the pretest. Site B teacher-researchers administered an open-ended constructed task similar to the one given as a pretest at the beginning of the intervention. The results of the post-test at both sites A and B were tallied and analyzed.

Presentation and Analysis of Results

In order to assess the effect of the intervention on the students' comprehension of mathematical word problems, the results of weekly problem solving were recorded on a class checklist. At Site A, this record-keeping instrument allowed the teacher-researcher to gauge the progress of the students. The checklist was used in the same manner at Site B. It also served as a diagnostic tool allowing the teacher-researchers at Site B to better select an open-ended constructed task for the next problem-solving session.

Following the results of the diagnostic testing at the beginning of the intervention, students at both sites were given an open-ended constructed task as a pretest. The task chosen at Site A was selected from the Illinois Standard Achievement Test Sample Book at the third grade level. The open-ended constructed task selected as a pretest at Site B was chosen from the Exemplars Math Workbook.

An evaluation tool entitled "Individual Profile of Progress: Problem Solving" was utilized to record students' problem solving skills. The teacher-researchers adapted this document from both the University of Chicago Mathematics Project and the Illinois Standards Achievement Test Rubric. The evaluation of the students problem solving expertise was based on three levels of proficiency: Beginning (B), Developing (D), and Proficient (P).

The results of the pretest at Site A demonstrated that all of the students were at the beginning level (B) of proficiency in problem solving. The pretest administered at Site B revealed mixed results. Seventy one percent of the students at this site were evaluated at the beginning level (B) of proficiency, while 23% were developing (D). Only 6% of the tested students measured at the proficient (P) level of problem solving.

Finally, the posttest was administered to all of the students in the study. This test at Site A consisted of the identical problem given as the pretest. While fifty percent of the students at Site A remained at the beginning level (B), the other fifty percent were evaluated at the developing level (D) (see figure three). The results of the posttest at Site B indicated that 14% of the students remained at the beginning level (B). The majority of students (47%) were assessed at the developing level of proficiency (D), while 39% attained the proficient level (P) of problem solving expertise (see figure four).

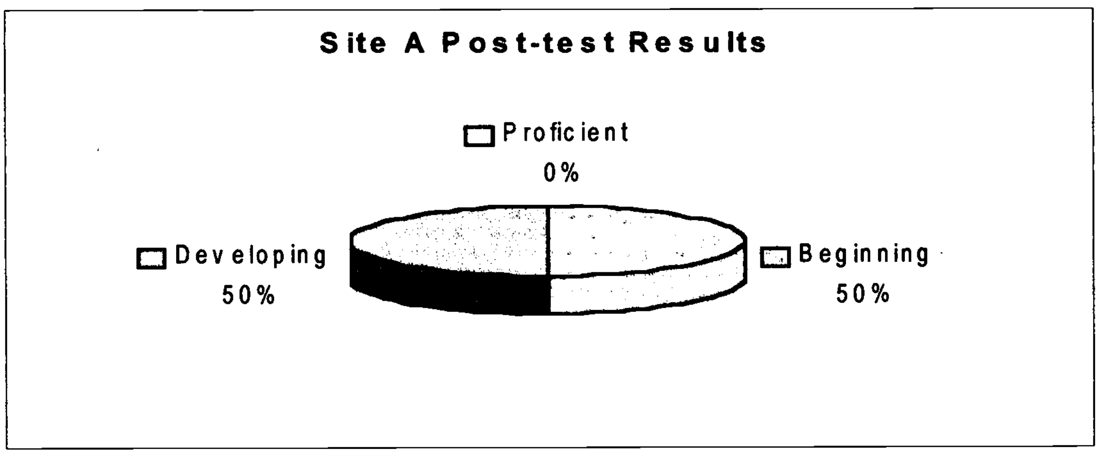

Figure Three: Results of post-test given to students at Site A in December of 1999.

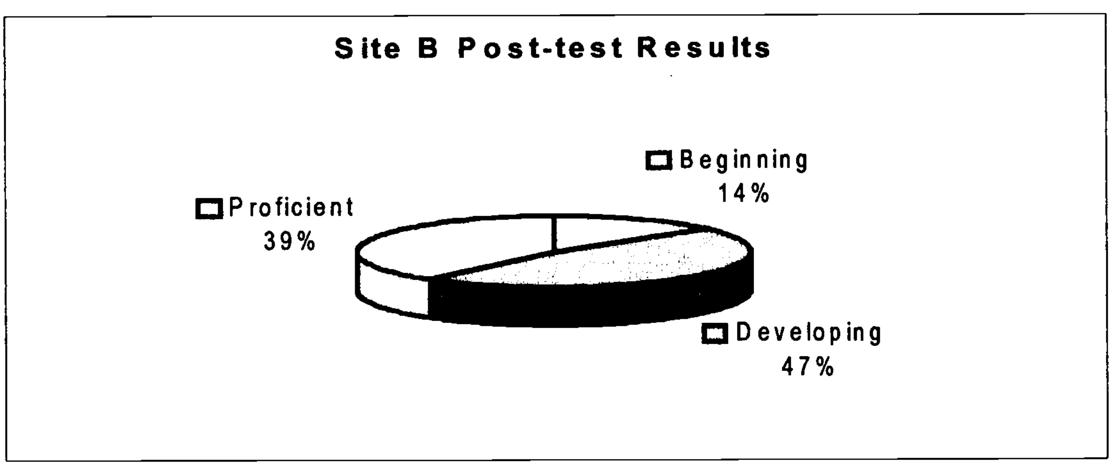

Figure Four: Results of post-test given to students at Site B in December of 1999.

Conclusions and Recommendations

Based on the presentation and analysis of the data on the students' comprehension of the language used in mathematical word problems, students showed an improvement in their problem solving ability. The analysis of the language used in an open-ended constructed task, class discourse involving identification of the central problem, and teacher monitoring as students worked in cooperative groups appears to have enabled the students to become more independent problem solvers. Additionally, as a result of teacher and peer modeling of the problem solving process, whole group discussion of the problem, as well as the use of student journals, some students were able to more confidently approach an open ended constructed task in order to solve it.

The teacher researcher at Site A noticed an improvement in the ability of her students as they analyzed and solved open-ended problems. Before the intervention, these special needs students would rely on teacher direction and guidance throughout the process. However, this teacher researcher noticed an improvement in both their independent analysis and solution of the problem. These students now appear to be less hesitant and more confident in approaching this type of task with minimal support.

Furthermore, through the use of student journals, the special needs children at Site A demonstrated a noticeable improvement in the use of mathematical language to explain the solution to a problem. Before the intervention strategies were employed, these students utilized a minimum of mathematical language to express their thinking with regard to an open-ended problem. After the intervention, the special needs students at Site A were more apt to independently use mathematical language to express their solution strategies.

Interestingly, the special needs children at this site demonstrated a sense of ownership in their thinking in a way not evidenced before the intervention. If one of the students made progress toward reaching a solution to the open-ended problem, that student would share his or her thinking with the others in the form of discourse. This discussion would be conducted using mathematical appropriate terminology in a manner not observed before by the teacher researcher.

An analysis of the data at Site B revealed an improvement in most students' problem solving abilities. Initially, the analysis of open-ended constructed tasks was a challenge for most of the students. Mini-lessons on problem solving strategies, whole group analysis of the language used in the problem, as well as identification of the central problem and data to be used in solving it, appears to have helped these students become more confident in their approach to this type of task. The cooperative group setting was particularly conducive to discourse. Most students were able to listen and share ideas using mathematical language in a way not observed by the teacher researchers before the intervention. Later, several groups would share their problem solving strategies with the entire class. The teacher researchers tried to choose groups that used different approaches to the solution of a given problem in order for everyone to observe divergent thinking about the problem at hand.

Additionally, the students at Site B appeared to utilize their journals as a resource for solving some problems. Comments such as, "This problem reminds me of one that we solved before" were heard with increasing frequency. The teacher researcher noticed some students looking back in their journals for similar problems. Also observed was a growing sophistication in the students' abilities to complete the open-ended statements on the final page for each problem in the journal. Moreover, the metacognitive analysis on the last journal page encouraged students to analyze their own approach to problem solving. Both Site A and

Site B would encourage the use of reflective journals as a pivotal factor in students' problem solving development. Additionally, these journals became portfolios when the students were asked to chose those problems that they felt best represented their progress in problem solving. The journals will be used as a conferencing tool to demonstrate students' progress over time.

Furthermore, class discourse at both sites was considered to be instrumental in developing students' thinking as they progressed toward becoming more confident and independent problem solvers. Divergent approaches in problem solving strategies were thought to be a key factor in encouraging students to think more broadly than they had before the intervention.

Upon reflection, the teacher researchers at both Site A and Site B believe that the type of open-ended constructed tasks needs to be given more careful consideration than was rendered in this particular intervention. Specifically, the teacher researchers noted that each of these problems required unique mathematical skills. Some of the open-ended tasks involved multiple steps. Sensitivity to student experience in both mathematical skill level and approaches to multiple step problems is important to take into consideration. For example, if the students were currently working on a unit in measurement, then a measurement task would be most appropriate because the students would then have the necessary background in the mathematics required for successful solution. If students have experience with two-step or three-step problems, then these types of problems could be used rather than more complex problems. One should tailor the choice of an open-ended constructed task to most optimally match the students' present abilities in these areas.

It is suggested that teachers might tailor a given problem to match a present unit of study across the curriculum. For instance, the teacher researchers at Site B were working with the students in a Greek studies unit. The open-ended constructed task that was then chosen for that particular week was modified to include Greek characters in an Athenian setting. This was done with increasing frequency, and as a result, the students started to suggest other modifications that could be made. This student ownership of their learning was an unanticipated, but pleasant surprise.

Finally, a cautionary word needs to be added with regard to the time frame necessary for student completion of a given problem. The teacher researcher at Site A was restricted in this area because of the need for the students to leave after forty-five minutes for another class. The teacher thought that more flexibility in scheduling would alleviate some of the stress associated with limited time in the problem solving process and permit students to cultivate their thinking to a greater degree. While the time constraints were less rigid at Site B, the teacher researchers there were able to work out time constraints by arranging a recess period after the allotted hour so that students who needed extra time could complete their work.

Overall, the teacher researchers at both sites were surprised at the success of this intervention. Although the data was accumulated week by week, a full analysis was not conducted until the end of the 16-week period. When the data was analyzed and the charts developed, the teacher researchers then realized the full extent of student progress.

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APPENDICES

Appendix A
Problem Solving Journal Page

PROBLEM SOLVING STEPS Date: ____________________

Name of exemplar ____

What is the problem or "big question" that I need to solve?

What information did I use in solving this problem?

My solution is reasonable because . . .

Appendix A
Problem Solving Journal Page

This is how I solved the problem.

Appendix A
Problem Solving Journal Page

Math Journal

Date: ______________ ___________

What did I understand about today's lesson?

____

____

____

____

____

What did I not understand?

____

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____

____

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Where did I get confused?

____

____

____

____

____

What helped me to understand the problem better?

____

____

____

____

Appendix B
Class Checklist for Intervention

CLASS CHECKLIST FOR INTERVENTION

Student	Pre-test #1	Pre-test #2	ARI #1	ARI #2	ARI #3	ARI #4	ARI #5	ARI #6	ARI #7	#8 Eval	ARI #9	ARI #10	ARI #11	ARI #12	ARI #13	ARI #14	ARI #15	Post-test

B - Beginning: students' responses have fragments of appropriate material and show efforts to accomplish the task. Students do not explain either the concepts or procedures involved.

ARI = Action Research Intervention

D = Developing: Responses convince you that students can revise the work to a Proficient performance with the help of feedback (i.e. teacher prompts). While there is a basic understanding, it is not quite proficient or completely independent.

P = Proficient: A Proficient performance is exciting. In addition to meeting the demands of the task and demonstrating a firm grasp of the concepts and procedures involved, their responses also demonstrate a broad range of understanding, and students apply their understanding in different contexts.

(Rubric adapted from The University of Chicago Mathematics Project)

Appendix C
Teacher Constructed Rubric

Individual Profile of Progress: Problem Solving

Name: ______________________ Date: ___________

✓ Check

B	D	P	Problem Solving Skill	Comments
			<u>Language Skills</u> Connects the language in a problem to math symbols/operations necessary for the solution	
			<u>Mathematical Knowledge</u> Knowledge of mathematical principles and concepts which result in a correct solution to a problem	
			<u>Strategic Knowledge</u> Identification of important elements of the problem and the use of models, diagrams, symbols and /or algorithms to systematically represent and integrate concepts	
			<u>Explanation</u> Written explanation and rationales that translate into words the steps of the solution process and provide justification for each step	

Adapted from the University of Chicago Mathematics Project

B = Beginning: students' responses have fragments of appropriate material and show efforts to accomplish the task. Students do not explain either the concepts or procedures involved.

D = Developing: Responses convince you that students can revise the work to a Proficient performance with the help of feedback (i.e. teacher prompts). While there is a basic understanding, it is not quite proficient or completely independent.

P = Proficient: A Proficient performance is exciting. In addition to meeting the demands of the task and demonstrating a firm grasp of the concepts and procedures involved, their responses also demonstrate a broad range of understanding, and students apply their understanding in different contexts.

Appendix D
Letter to Parents

August 31, 1999

Dear Parents:

Welcome to the 1999-2000 school year! We hope the summer was enjoyable for both you and your family.

This year, we are participating in a Master's degree program from St. Xavier University. We are conducting an action research project to assess a student's ability to problem solve in mathematics. The purpose of this study is to develop strategies and implement authentic assessment tools that will show individual student growth in comprehending and solving mathematical word problems. These measures of a student's application of strategies presented in class will provide a visual, efficient way of recording student growth. The study will take place over a fifteen-week period of time. The comprehension and solution of mathematical word problems will be the major focus of the study.

Student participation in this study will not interfere with day-to-day schooling. The benefit to your child will be that she/he will develop skills to become a more strategic mathematical problem solver. Additionally, your child may develop useful thinking skills as she/he learns to analyze and solve math story problems. Your child's grade or evaluation will not be affected.

The privacy of all participants will be respected throughout the study. Names are not reported and no information will be released to unauthorized personnel. There is no cost or compensation for participating in this study. Please fill out and return the attached page. Your cooperation is greatly appreciated.

If you have any question, please don't hesitate to call.

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Signature: Susan M. Zerafa Carol Trahey Joan Roti	Printed Name/Position/Title: Student/s FBMP	
Organization/Address: Saint Xavier University E. Mosak 3700 W. 103rd St. Chgo, IL 60655	Telephone: 708-802-6214	FAX: 708-802-6208
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