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ABSTRACT

This report describes a program for improving attitudes towards mathematics and problem solving in order to improve performance in these areas. The targeted population consists of two high school geometry classes. The school is located in a western suburb of a major mid-western city. The problems of negative attitudes towards mathematics and problem solving and poor performance were documented using both student surveys and homework application problems. An analysis of probable cause indicates that both societal beliefs and parental attitudes adversely affect the students' attitudes about mathematics and problem solving. In addition, many of the traditional math programs including textbooks and curriculums are outdated and do not represent the current standards in the field of mathematics. Prior learning experiences of both the student and the teacher including pre-service training and professional development can affect the attitudes of the students. A review of solution strategies suggested by knowledgeable others and an analysis of the problem setting resulted in the development of a three-pronged intervention utilizing an increase in realistic application problems, an increase in writing both reflective and content journals, and the use of cooperative groups. The benefits of these aspects of the intervention are to increase student interest and motivation as well as encourage students to solve problems not by memorization and regurgitation but by understanding the concepts and how to apply them. Post intervention data indicated an improvement in both student attitudes and student level of performance in mathematics. Teacher anecdotal records and post intervention student surveys support the change in student attitudes. The increased level of performance was documented through application problems and content journals. The program described in this report was successful in achieving both of its desired outcomes. (Contains 31 references.) (Author)

IMPROVING STUDENT ATTITUDES AND PERFORMANCE IN MATHEMATICS

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To: Jacob

A love of learning is priceless.

I hope that this treasure you hold grows with you always.

More importantly, pass it on!

ABSTRACT

This report describes a program for improving attitudes towards mathematics and problem solving in order to improve performance in these areas. The targeted population consists of two high school geometry classes. The school is located in a western suburb of a major mid-western city. The problems of negative attitudes towards mathematics and problem solving and poor performance were documented using both student surveys and homework application problems.

An analysis of probable cause indicates that both societal beliefs and parental attitudes adversely affect the students' attitudes about mathematics and problem solving. In addition, many of the traditional math programs including textbooks and curriculums are outdated and do not represent the current standards in the field of mathematics. Prior learning experiences of both the student and the teacher including pre-service training and professional development can affect the attitudes of the students.

A review of solution strategies suggested by knowledgeable others and an analysis of the problem setting resulted in the development of a three-pronged intervention utilizing an increase in realistic application problems, an increase in writing both reflective and content journals, and the use of cooperative groups. The benefits of these aspects of the intervention are to increase student interest and motivation as well as encourage students to solve problems not by memorization and regurgitation but by understanding the concepts and how to apply them.

Post intervention data indicated an improvement in both student attitudes and student level of performance in mathematics. Teacher anecdotal records and post intervention student surveys support the change in student attitudes. The increased level of performance was documented through application problems and content journals. The program described in this report was successful in achieving both of its desired outcomes.

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CHAPTER 1

PROBLEM STATEMENT AND CONTEXT

General Statement of Problem

The targeted high school geometry students exhibit negative attitudes about mathematics and problem solving which inhibit their performance. This is evidenced by student surveys and homework application problems.

Immediate Problem Context

The high school serves grades nine through twelve with a total population of 1,778 students from various racial and ethnic backgrounds. The largest population is Caucasian at 75.9%, followed by a Hispanic population of 16.5% with the remainder being African-American (0.7%) or Asian (7.0%). Due to the school's diverse population there exists a 12.1% of limited-English proficient students who are eligible for bilingual education. The average class consists of 22.9 students. The school also has 8.8% of the students who are from low-income families (School District #88, 1996).

The school has a professional staff of 139 people and an administrative staff of a principal, three assistant principals, and eleven department heads. The mathematics department consists of 14 teachers: 6 women and 8 men who teach a total of 60 mathematics classes. The average years of teaching experience in the mathematics department is 19.9 years. Seventy nine percent have a master's degree or beyond. One of these teachers instructs two sections of bilingual mathematics classes using the Spanish language.

Students entering the mathematics curriculum at the school will take one of several different paths to meet the two year state requirement. Average students

begin with Algebra, move on to Geometry, Advanced Algebra, and finally Analysis and Trigonometry. More advanced students enter in Honors Geometry or regular Geometry, then continue with Advanced Algebra Honors, Analysis with Trigonometry Honors, and Calculus. Finally, the lower level students enter Essentials of Algebra I, continue with Essentials of Algebra II, Essentials of Geometry, and Intermediate Algebra. General Math, Applied Math, and Consumer Math classes are available for those students whose abilities do not meet the low level sequence of courses.

Computer labs and calculators are available from the department to help students learn. The school has both MAC and DOS labs with a variety of mathematics programs including Geometry Sketchpad, Cabri Geometry, and Lotus 1-2-3. Calculators are required in several classes, therefore the department owns seven classroom sets which includes scientific calculators, TI-81, TI-82, and TI-92 graphing calculators.

The school has an eight period school day and classes of 50 minutes in length. A mathematics teacher is available at the mathematics resource center throughout the day to provide students with needed assistance. Additional help is usually available both before and after school by appointment. All students receive quarter grades; and interim progress reports are mailed to the parents after four and a half weeks into the grading period.

The Surrounding Community

The community, located 20 miles west of a major city, is one of the top five largest industrial towns in the state. It has 1,200 acres of industrial park, 800 acres of which is sheltered. According to the 1990 census (as cited by Kopriva, 1997), the community is a middle class community with the median age of 31.2, the median household income of $41,375, and an overall population of 32,058. In 1995, the average sale price for a single-family home was $172,107. The ethnic make-up

of the community is 78.97% white, 13.37% Hispanic, and the remainder consists of 0.12% Native-American, 5.86% Asian-Pacific Islander, and 1.61% black .

The students of this community enroll in two public school districts: an elementary district with seven grade schools and one junior high school and the high school district which contains the site. In addition to the public schools, there is also a catholic high school to serve the community. The high school district contains two high schools in neighboring suburbs. The community is heavily involved in the school system and places a high value on education. During the 1996-1997 school year, there was a proposal to increase the current graduation requirements. The district and the community are currently still reviewing the proposed changes. The final policies of the high school district are determined by an elected school board that makes decisions on facilities, staff, educational programs, and financial matters.

Regional and National Context of Problem

Our country has changed from an industrial to an informational society and with it have changed the uses of mathematics in society. As an industrial society, workers needed strong backs, clever hands, and shopkeeper-type arithmetic skills. Today, in a society sometimes overwhelmed with information, workers need to analyze and interpret data and to utilize the available technology in solving real-life problems using mathematical thinking. As a result, what students learn and how they learn it must change to keep pace.

In 1989, the National Council of Teachers of Mathematics (NCTM) published the Curriculum and Evaluation Standards for School Mathematics as a vision of the mathematics that all students need to know and be able to do. It reflects a shift from memorization and computation to an emphasis on problem solving, mathematical reasoning, data analysis, and real-life applications. The Curriculum

Standards (1989) specifically advocates that a primary goal for students is "that they become mathematical problem solvers" (p. 5).

This concern on the importance of real-life applications of mathematics was noted prior to 1989 at the national level. In 1971, a group from the NCTM collaborated with the Mathematical Association of America to seek and obtain funding to produce appropriate instructional materials in the area of math applications due to a lack of such resources available for secondary teachers at that time. This effort resulted in A Sourcebook of Applications of School Mathematics published in 1980. Both publications advocated using real-life applications to motivate students by increasing their appreciation of the usefulness of mathematics in their everyday lives. Although the Sourcebook preceded the Curriculum Standards, it does not seem to be as widely recognized today.

Further evidence that real life application problems are a nationwide concern can be seen by examining the published titles at the 1995 NCTM Annual Meeting. According to a conservative estimate by Glidden (1996), of the 1063 sessions, approximately 200 dealt with mathematical applications. Also, in the September, 1996 issue of Mathematics Teacher, there was a call for manuscripts and authors for the 1999 NCTM Yearbook on Developing Mathematical Reasoning. This demonstrates that the concern over developing mathematical reasoning, which directly relates with applying this reasoning in solving real-life problems, is still a top priority in the nation and there are expectations that it will remain one in 1999.

In addition to publishing standards on curriculum and evaluation, the NCTM has also published other standards including the Professional Standards for Teaching Mathematics (1991). Standard 1 is "Worthwhile Mathematical Tasks" (NCTM, 1991, p. 19). For a task to be worthwhile, it must address the notion that "the goal of teaching mathematics is to help all students develop mathematical power " (NCTM, 1991, p. 21). Possessing mathematical power includes being able

to apply mathematical understanding to new situations, as well as having the confidence to do so. Standard 1 also emphasizes the importance of students' learning to approach problems from situations within and outside mathematics.

The Assessment Standards for School Mathematics (1995) suggests that in planning an assessment for today's students, a teacher ask questions to determine how well the assessment reflects the mathematics that students need to know and be able to do. It proposes using the following two questions which directly relate to the use of real-life applications in the classroom: "How does the assessment engage students in realistic and worthwhile mathematical activities? How does the assessment elicit the use of mathematics that it is important to know and be able to do? " (NCTM, 1995, p. 12).

In a random sampling of 40 of the monthly publication Mathematics Teacher over the past eight years, 75% had at least one article which dealt with problem solving, real-life applications, and examples to be used in the classroom. This emphasis indicates a need for more problems of this type to be included in the classroom and incorporated into the curriculum. Currently, the classroom teacher is the person who brings these applications into the classroom.

According to an assessment given by the National Assessment of Education Progress (as cited by Mitchell, 1990), students are lacking in ability to successfully complete the application, problem solving, and reasoning items. In the world, real-life problems are "word problems," yet many elementary school textbooks continue to treat such problems as extra or to separate these problems from the concept being taught. Generally, these items are not emphasized until first-year algebra and then, too often, still involve situations having no practical applications such as determining the age of Mary and Sam using some highly improbable data (Mitchell, 1990). It seems clear why students question the mathematics that they are being

taught and not surprising that they exhibit difficulty in transferring their knowledge of mathematics to worthwhile and realistic situations.

CHAPTER 2

PROBLEM DOCUMENTATION

Problem Evidence

Students exhibit negative attitudes about mathematics and problem solving which inhibit their level of performance. This is demonstrated by the students' responses to an initial survey as well as their responses to homework application problems.

Student Survey

In order to assess the attitudes towards mathematics and problem solving, a survey (Appendix A) was distributed to the 58 targeted high school geometry students in August, 1997. Usable data was received from 48 students. Six students elected to not have their information included in the research and four students failed to return the surveys. The student survey documented such topics as enjoyment of math, previous experiences in math and in problem solving activities, and perceived usefulness of math in the future.

It was found that one-third of the students do not enjoy math. Each of these sixteen students described both their previous experiences in math and with word problems at a level of moderately successful, frustrating, or very frustrating. A word problem was defined in the student survey as "a situation which requires the use of math to answer the question at hand". None of them felt very successful in their previous experiences. Even amongst those students who responded yes to enjoying math, there is evidence of frustration with word problems. The combined data is represented in Table 1.

Table 1

Student Survey Results from a total of 48 responses

Survey Question	Response Given	%
Enjoyment Of Math	Yes	67%
	No	33%
Prior Experiences With Word Problems	Very Frustrating	0%
	Frustrating	38%
	Moderately Successful	58%
	Very Successful	4%

Even though the majority of students feel moderately successful with word problems, only 4% of the students feel very successful when approaching a situation which requires using math to answer the question. It also presents a concern that since nearly 40% of the students have described their experiences as frustrating, that their preconceived attitudes are hindering their approach to similar problems. This concern of attitudes affecting performance was validated by the results of the first homework application problem used as a baseline assessment.

Homework Application Problems

In September, 1997, a baseline assessment was given to the students to assess their problem solving abilities prior to the intervention. Each student was asked either to use geometric terms from a given lesson to describe the classroom or to provide several real-life illustrations for each of the geometric terms in the lesson. They were told that their work would be evaluated on accuracy, clarity, and completeness. The students could obtain an overall rating of low, medium, high, or exceptional. The results of their efforts are illustrated in Figure 1.

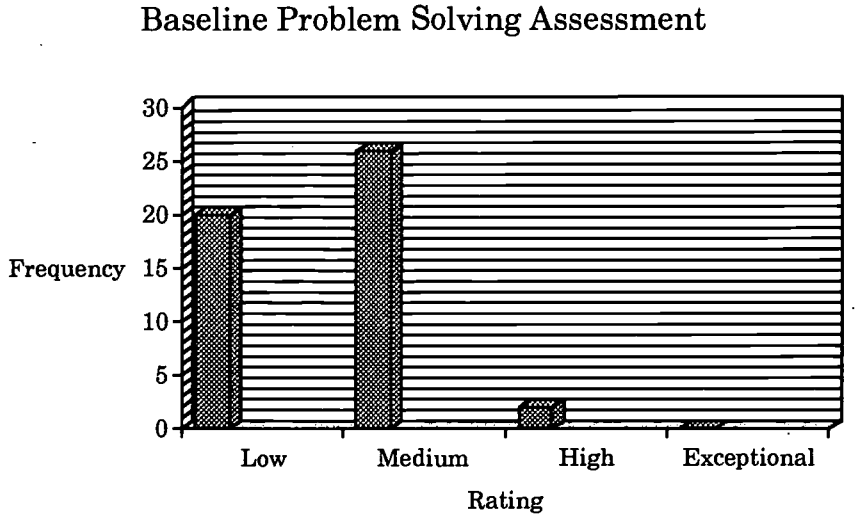

Figure 1. Frequencies of ratings on baseline problem solving assessment.

A large percentage, 42%, of the students scored low on the baseline assessment. The low score indicated major inaccuracies in their responses, unclear explorations of examples, and/or failure to include all the necessary terms. A rating of medium was obtained by 54% of the students. This score of medium represented a fair understanding of concepts with occasional errors, attempts at explanations but with little detail, and addressing each necessary term. A small percentage of students, only 4%, scored high on the assessment. A high score denoted a thorough understanding of the concepts, clearly communicated examples and detailed support, and inclusion of each necessary term. None of the students gave an exceptional response. These results exhibit a connection between their negative attitudes documented in the student survey and their overall poor performance on the baseline assessment. In order to address this problem, possible causes must be examined.

Probable Causes

The literature suggests several causes for negative attitudes towards mathematics and problem solving. Amongst these causes are societal beliefs, parental attitudes, a traditional approach, and prior learning experiences.

Societal Beliefs

Societal beliefs play a role in influencing students' attitudes. According to Stevenson, (as cited in Skiba, 1990), "Americans believe one is either born with mathematics ability or one is not" (p. 189). Stevenson (as cited in Skiba, 1990) contrasts this to the Asian belief that success in mathematics is realized through "hard work, perseverance, and hours of study" (p. 189). Stevenson's point indicates that many Americans believe they lack personal control over their success in mathematical tasks and hence, once they have encountered difficulty they resolve to accept that they lack the ability to succeed rather than working hard to persevere. Along with societal beliefs, parental attitudes also influence student attitudes.

Parental Attitudes

Parental attitudes about mathematics can be seen to influence their children's attitudes. Surveys were given to students and parents (Appendix B) in part to document attitudes towards mathematics in general, prior experiences, and problem solving. In the parent survey, the attitude response towards mathematics paralleled the student results. There were 75 parental responses. Over one-third of these respondents (27) have a less than positive attitude towards mathematics. According to a comparison of the parent survey with their child's survey, in every case where both parents felt this way, then the child's response to whether s/he enjoyed math was no. Most of these parents' attitudes are a result of the traditional approach by which they were taught mathematics.

Traditional Approach

The traditional approach towards teaching mathematics plays a significant role in the negative attitudes that exist. A "traditional" program emphasizes rote and drill computational activities. These problems rely heavily on memorization of facts rather than real-life application situations. The lack of connections to the use of math in their lives fosters low motivation and negative attitudes towards learning mathematics. Another component of the traditional approach is the extremely teacher-centered instruction with students completing tasks individually. There is also a focus on the notion that since mathematics is a science there is one right answer or unique method to solve the problem (Barrett, Doyle, & Teague, 1988). Many traditional programs include textbooks and curriculums which are outdated and do not represent the current standards in the field of mathematics. They still focus on many skills, which, due to the advance in technology, deserve to be approached in an updated manner (Steen, 1990).

Another problem that exists in many of the traditional textbooks is the use of application problems that often are unrealistic and have little practical use (Barrett et al., 1988; Mitchell, 1990). An example of one such problem that still exists in many current texts is the following: Five years from now Mary will be twice as old as her sister; how old are the girls now? A student is likely to wonder why the girls don't already know their ages. In addition to influencing the attitudes of current students, this traditional approach also affected the prior learning experiences of many of their teachers taught under this methodology.

Prior Learning Experiences

The final cause focuses on the prior learning experiences of both the teacher and the student. Teachers tend to teach the way they were taught (Merseth, 1993). Even many of the younger math teachers were taught in the typical traditional program described earlier. There is also a concern over the existing pre-service

teacher training programs (Steele & Widman, 1997). Many colleges and universities are examining their current programs with a focus on revisions. In the area of teaching mathematics, it is particularly significant that many pre-service programs still do not require any training in the technology and software used or applicable to the secondary level. If a teacher is ill-prepared or even feels ill-prepared for the classroom, her attitude will reflect her frustration and can contribute to a reliance on the aforementioned traditional approach of following an outdated textbook (Adams & Krockover, 1997). The professional development opportunities open to teachers poses another concern when addressing the teacher's experiences. Too often this is still dictated by the financial status of the school district and the allocation of the money.

When addressing the prior learning experiences of the students as a cause towards their negative attitudes, it is quite straightforward. If a student has encountered frequent frustration and/or lack of success in solving mathematical problems, it follows that his/her attitude would mirror these negative experiences.

Societal beliefs as well as parental attitudes contribute to the negative attitude a child has towards mathematics and problem solving. The traditional approach and negative prior learning experiences also contribute to the negative outlook held by the student. There are a number of solutions which address these causes.

CHAPTER 3

THE SOLUTION STRATEGY

Literature Review

The process of integrating more realistic problems into the math curriculum is one of several solutions presented in the literature in order to improve the attitudes of students towards mathematics. Other solutions that will be discussed include writing, cooperative learning, and professional development and pre-service training opportunities.

Realistic Application Problems

If a problem is a realistic application using mathematics, then students can see the importance of the skills involved (Marks, 1994). As students practice and work on solving meaningful problems, they are learning and working on how to transfer their skills and ideas to similar situations (Cuoco, 1995). This differs greatly from the traditional approach which provided very few opportunities for making connections within mathematics itself or to other situations outside mathematics and mistakenly assumed that transfer would occur spontaneously (Wood, 1995). When the students can see the potential use of learning this skill, their level of motivation increases (Daniels, 1989). A typical question asked by students is "When am I ever going to use this?" This question can be and should be answered through the presentation of the applications.

After examining the positive aspects of integrating more realistic problems into the curriculum, it begs the following question. Why isn't this common practice? Many current textbooks lack these problems. It is true that many realistic problems are more complicated than an introduction to word problems could effectively

handle. However, the tendency of textbook authors to pose questions that nobody would realistically seek an answer to continues well beyond the introductory level (Marks, 1994). Since many textbooks lack realistic applications, the classroom teacher is faced with the vast amount of time involved in creating and/or finding such materials. Another concern is that many students in essence have been programmed for the "quick fix" when trying to solve a problem. This results from habitually assigned problems which use only the most recent concept learned or all of which use the same concept in the same repeated way (Schmalz, 1989). These students might become frustrated by the hard work and time involved in solving a nonroutine problem (McLeod, 1993). However, if their hard work and thinking processes were valued through an increased focus on writing, then this frustration could be lessened.

Writing

A second solution addressed in the literature is the process of integrating more writing into the curriculum. Providing written responses with accompanying explanations allows students to formalize their ideas and display their level of understanding for a given problem (Maida, 1995; Price, 1995). It also incorporates the real life skill of providing clear written communication of ideas or processes to others. This written communication also provides the teacher feedback from specific students or the class as a whole with regard to the understanding of a concept (Franke & Carey, 1997). In the traditional approach, a student was generally asked only to manipulate an equation to solve the problem. Many students can perform the steps without ever understanding why they are doing them or when it is appropriate to do so. Providing writing opportunities combats this rote level of understanding and brings it to a higher level (Schmalz, 1989). Another important component of utilizing writing in the mathematics curriculum is that student

thinking and reasoning processes are valued. No longer is there an emphasis on only the answer as right or wrong (Franke & Carey, 1997).

Although integrating writing has many positive results, negative aspects must also be addressed. There has been much research supporting Howard Gardner's theories about the existence of multiple intelligences. According to Gardner (1983), everyone possesses varying levels in each of the intelligences. Some are strong in the logical-mathematical and weak in the musical-rhythmic. Gardner's theories are valid when considering integrating writing as a solution to improving attitudes and performance in math since not all students will be strong in the verbal-linguistic intelligence. One method to combat this situation would be to utilize cooperative learning experiences in the classroom.

Cooperative Learning

Research indicates that cooperative learning experiences promote improved attitudes (Artzt, 1994). Cooperative learning has been compared to team sports (Slavin, 1990). Athletes know that the school is rooting for them and so put forth their best effort. Again, this is in contrast to the traditional classroom where students work as individuals towards their own success. In essence, they compete against each other. Cooperative learning also provides a more realistic simulation for solving problems in the real world. It requires listening, compromising, collaborating, and reaching consensus. Each of these traits will prove valuable in the students' futures. Noteworthy is the simple fact that the students enjoy the comfort they find in working together (Shaw, Chambless, Chessin, Price, & Beardain, 1997). This comfort level leads to improved attitudes and efforts. As the students work cooperatively on a task their ability to derive their own learning is increased since they are active in their study of mathematics rather than passive. Their level of understanding in this situation is retained longer that students who have only a teacher or textbook explanation from which to learn (Simon, 1986). It is

much easier for students to be motivated to learn when they have the proper support system. That support system is cooperative learning (Davidson & Pearce, 1990).

When considering cooperative learning, it is also important to examine some of the negative components of its use. The time involved initially is significant in order to structure appropriate cooperative groups. This involves activities such as those which promote listening, encouraging, maintaining the responsibilities of assigned roles, and respecting others. Students need to recognize a difference between a cooperative task and merely being in a group. There is also teacher time involved in creating and/or locating appropriate cooperative tasks and working to ensure that all members participate and contribute appropriately to the task. Another concern for teachers is the assessment of the task as a group, as individuals, or as a combination. Although these are valid concerns, the negative aspects could be reduced through enhancing both professional development and pre-service activities to include extensive training in cooperative learning.

Professional Development and Pre-service Training

A final solution addressed by the research is the improvement and inclusion of professional development and pre-service training opportunities. Research in the field of student perceptions suggests that students' attitudes towards mathematics can be in part affected by the classroom teacher (as cited in Franke & Carey, 1997). Teachers who feel they have been well prepared bring confidence into the classroom (Franke & Carey, 1997). Quality professional development opportunities keep experienced staff aware of and provide training in proven current techniques. Peer coaching as teachers employ new techniques encourages each teacher to reach their potential (Bouck, Keusch, & Fitzgerald, 1996). Another positive aspect of this solution is that the National Council of Teachers of Mathematics provides numerous and varied opportunities to grow and learn professionally. These include books, journals, conferences, resource catalogs, and a Web page (Price, 1996).

Although these opportunities exist, the monetary cost for school districts or the individual teacher to participate in these programs too often prohibits those who could benefit most. Another major concern is the difficulty in finding such quality pre-service opportunities. This is evidenced by Steel and Widman (1997) who present a study suggesting how to include the constructivist learning theory into pre-service programs since the majority of current programs lack similar components. Adams and Krockover (1997) also document the concerns of beginning teachers and the efficacy of the pre-service programs.

To reduce and prevent future negative attitudes towards mathematics, a variety of methods can be used. Integrating realistic application problems, writing, and cooperative learning are among the solutions. Improving both pre-service training and professional development opportunities is another viable solution.

Project Objective and Process Statements

As a result of integrating more realistic problems and writing into the math curriculum and using cooperative groups, during the period of September, 1997 to January, 1998, the targeted high school geometry students will improve their attitude towards mathematics and improve their performance on the application problems. Their progress will be measured by post-surveys, solutions to application problems, reflection journals, and teacher anecdotal records. In order to accomplish the project objective, the following procedures are necessary:

1. Define group roles, responsibilities and expectations for cooperative activities.
2. Create/locate materials to serve as realistic application problems for the intervention.
3. Model reflective journal writing and provide prompts to encourage student reflection.

4. Include cooperative activities, realistic application problems, and journal writing opportunities within the curriculum.

Action Plan for Intervention

The following steps will be taken to implement the intervention:

I. Assess pre-intervention attitudes and performance levels on application problems.

- Who both students and their parents
- What complete a survey on their experiences in math
- When the first week of school (August, 1997)
- Why to assess their attitudes prior to the intervention in order to have a baseline by which to measure improvement or growth.

II. Define group roles, responsibilities and expectations for cooperative activities.

- Who the teacher researcher
- What 1) provide handouts and provide clear expectations of a student's role and responsibilities as a member of a cooperative group

  2) explain the differences between the terms 'group' and 'cooperative group' using specific role-playing exercises
- When the first two weeks of school (August, 1997) and as needed as refresher information when groups change (mid-October, 1997, beginning of December, 1997)
- Why to provide clear standards that the teacher researcher feels the students should exhibit when working on a cooperative task so that the students understand and meet what is expected of them

III. Create/locate materials to serve as realistic application problems for the intervention.

- Who the teacher researcher

- What create, revise, and locate problems that will serve as realistic application problems throughout the intervention
- When 1) the majority of the application problems will be ready when school begins (August, 1997)
  2) the remaining problems will be created prior to their use (by November, 1997)
- Why realistic problems serve as motivation to the students and aid the students in seeing possible ways that this information or way of thinking can be useful in their lives

IV. Model reflective journal writing and provide prompts to encourage student reflection.

- Who the teacher researcher
- What 1) model reflective journal writing through display of various levels of previous students' sample journals
  2) create and display possible prompts to encourage student reflection
- When the first two weeks of school (August, 1997)
- Why to provide examples of reflections and prompts to aid students in completing their journals

V. Include cooperative activities, realistic application problems, and journal writing opportunities within the curriculum.

- Who the teacher researcher will plan the above for the students
- What cooperative activities, realistic application problems, and journal writing opportunities and combinations of these.

COOPERATIVE LEARNING

- When providing cooperative activities at a minimum of one per chapter which would allow for 7 activities during the intervention

- Why to enable the students to learn from each other and participate as a group working to solve a problem

REALISTIC APPLICATION PROBLEMS

- When the students will be asked to attempt and write up solutions to application problems once or twice a chapter depending on the length or material of the chapter (7-14 problems during the intervention)
- Why these problems serve to motivate and to aid in transfer of the skills and processes being learned to the students' lives

JOURNAL WRITING

- When minimum of 1 reflective journal per week and minimum of 1 content journal per chapter (approximately 16 reflective journals and 7 content journals)
- Why allows students to clarify and deepen their understanding of the problem, gives value to the student's thinking and reasoning processes, and provides an opportunity for both the teacher and student to receive feedback

Methods of Assessment

The teacher researcher will use a modified version of the original student survey to assess any change in student attitudes towards mathematics and problem solving. The teacher researcher will evaluate their solutions to the homework application problems as the students complete them as well as collect all problems for an individual student to look for improvement in performance. The teacher researcher will maintain and evaluate any teacher anecdotal records looking for change in displays of positive or negative attitudes towards mathematics and problem solving. The teacher researcher will also read the weekly reflective journals and the chapter content journals in order to gain feedback from the students that

might demonstrate change in attitude, understanding, or performance. The teacher researcher will evaluate any teacher-made test items that are focused on application problems or test averages on a whole to represent change in overall performance.

CHAPTER 4

PROJECT RESULTS

Historical Description of the Intervention

The objective of this program was to improve student attitudes towards mathematics and improve their performance on application problems. Student surveys and initial homework application problems indicated a need for intervention in these areas. A three pronged approach incorporated the use of realistic applications, writing both reflective and content journals, and cooperative learning.

Realistic Application Problems

In the area of realistic applications, the plan was to have students write up solutions to approximately 7-14 problems during the intervention period from August, 1997 until January, 1998. Possible problems to be used during the first quarter were written and prepared during the summer prior to the intervention. The remaining problems for second quarter were prepared as the students progressed through the content material. Sample problems are located in Appendix C.

During the actual intervention, students were assigned 10 application problems. Although the original plan was designed to include the evaluation of each application problem as well as individualized teacher feedback, only three of the application problems, were evaluated in this way. After the baseline assessment was given in early September, the researcher decided an initial non-evaluative approach to the application problems was necessary. This time would serve as a "learning" time for the students prior to a formal evaluation of their work. In September, the students completed one application problem per week, for a total of four. Each problem was discussed thoroughly afterwards to enable students to

distinguish low, medium, high, and exceptional responses from one another. In the months of October, November, and December, two application problems per month were completed. One problem each month was collected and evaluated by the teacher. The in-class discussions continued on those problems not formally evaluated to supplement their understanding of the levels of proficiency in answering the problems. The second component of the intervention incorporated writing both reflective and content journals.

Writing

Initial modeling activities were utilized to help students understand the expectations and have a list of possible prompts for "free" journal entries. The goal of the intervention was to include one reflective journal per week, approximately 16, and 7 content journals, one per chapter. The time necessary to respond to each student's journal entries took longer than anticipated. As a result neither the numerical goal for reflective journals nor for content journals was met.

Of the eight reflective journals actually completed, four required the students to self-assess their performance on a quiz or test (Appendix D). The remaining reflective journals asked the students to relate their thoughts about a specific project or cooperative activity. For the content journals, four of the intended seven entries were completed and evaluated. Content journals addressed the issues of how to complete a certain procedure as well as comparing and contrasting two concepts. The final aspect of the intervention was cooperative learning.

Cooperative Learning

There was an initial "set-up" activity in order to define group roles and provide clear expectations for future cooperative activities. This preparation activity was scheduled for the second week of school, but was not implemented until the fifth week. The aforementioned focus on the application problems during September contributed to this delayed start in implementing cooperative activities. However

as a result, there was no need to incorporate the planned refresher of expectations during mid-October or early December since groups did not change and expectations were still being met.

The intended plan for cooperative activities was to include one per chapter which meant a minimum of seven activities would be used. Although there was a delayed start and the plan of one activity per chapter was not maintained, the teacher exceeded the overall goal of 7 activities by utilizing 10 activities during the intervention.

It has been noted that each component of the intervention deviated from the original action plan. The realistic problems fell within the range of the intended number of problems, but fell short in the formal evaluation of only three of the ten problems. Time contributed to reducing the number of both reflective and content journal entries by approximately half. Finally, according to the schedule, the use of cooperative activities started late but nonetheless exceeded the intended number of activities originally planned. An analysis of the data collected during each component of the intervention will demonstrate the effectiveness of the intervention on improving student attitudes and performance in mathematics.

Presentation and Analysis of Results

Various methods of assessment were used to measure any improvement in performance or student attitudes during the intervention. Identical scoring rubrics were used to assess the changes in performance on both the realistic application problems and the content journals. A distinct rubric was used to evaluate the activity and project reflection journals while the self-evaluation reflection journals were analyzed by comparing student predictions with their actual performance on a quiz or test. A post-intervention student survey was used to measure any shift in student attitudes since the start of the intervention. Teacher anecdotal records also documented student attitudes and comments.

Realistic Application Problems

The first component of the intervention, the use of realistic application problems, was measured using a rubric. The rubric scored a student's response to the problem as low, medium, high, or exceptional. A low score indicated major inaccuracies in their response, unclear or inappropriate conclusions drawn and/or failure to address all aspects of the problem. A rating of medium represented a fair understanding of the concepts with occasional errors, attempts at explanations but with little detail, and addressing each aspect of the problem. A high score denoted a complete understanding of the concepts, clearly communicated examples and detailed support, and inclusion of all aspects of the problem. An exceptional response indicated a thorough understanding of the concepts, clear and elegant explanations using examples and counter examples, inclusion of detailed support, and all aspects of the problem addressed.

Recall that in the baseline assessment given in September 42% of students scored low, 54% medium, and 4% high. None of the students gave an exceptional response at that time. However, after completing and thoroughly discussing problems during more than a month of "learning" time, the dramatic change in results is clear. The percentage of students who scored low dropped to 19%. The score of medium dropped 8% to 42%. The most significant changes were the increase by 31% for the students obtaining a ranking of high and the inclusion of a response rated as exceptional.

The scores obtained between October and December evaluations were not nearly as dramatic. This could be a result of not analyzing one problem per week, as had been done in September, and instead only analyzing one problem every two weeks. Nonetheless progress is still visible. The data for the three problems evaluated during this time is categorized by month and presented in Figure 2.

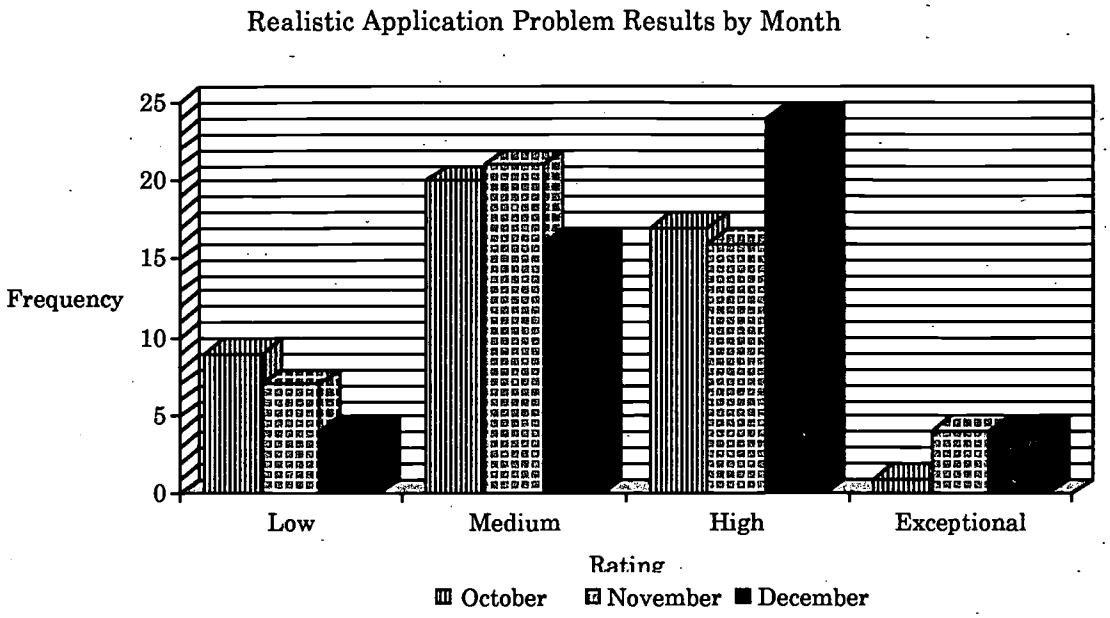

Figure 2. Frequencies of ratings on realistic application problems.

Over the course of the three months, the number of students earning low and medium ratings both declined while those receiving high and exceptional continued to increase. On the final evaluation of application problems in December, 50% of the students had obtained a rating of high and 8% of the responses were considered exceptional. It appears that through clearly defined expectations and thorough analysis of various student responses, performance on realistic application problems have significantly improved. Improvements were also seen in the writing components of the intervention.

Writing

The inclusion of journal writing activities was the second component of the intervention. The reflective journals were subdivided in two categories: self-assessment and activity/project evaluations. The goal of the self-evaluation journals was to enable the students to learn to accurately reflect on their performance. Predicting how they have performed leads directly to understanding what to do in order to perform better in the future.

Students were asked to self-assess their performance on a quiz or test four times during the intervention, once each month from September through December. One component of this assessment included a percentage prediction of their performance as well as an inclusion of the actual percentage after it was known. Table 2 illustrates the percent differences for the 48 students between their predictions and their actual percentages.

Table 2

Frequency of Percentage Differences between Predicted and Actual Scores

Month	0-5%	6-10%	11-15%	16-20%	21-25%	26-30%	31% or more
September	10	11	10	7	3	3	4
October	23	16	7	0	1	0	0
November	25	17	5	1	0	0	0
December	25	19	3	1	0	0	0

By the end of the intervention, over half of the students were consistently able to predict their grade within 5% of their actual grade. Another 40% had predictions that fell with 6-10% of the actual grade. These numbers clearly represent that the goal to achieve accurate student self-assessment was obtained during the intervention.

The second category of the reflective journal component was the use of activity and project reflections. The goal of these reflections was to provide primarily the teacher and the student with feedback regarding the enjoyment and usefulness of various activities. These reflections were assessed using a score of 'OK', 'Good', or 'Great'. A rating of 'OK' was earned if the response was severely lacking in detail or personal input. 'Good' was given to those students whose response was complete and provided some explanations of their feelings. A rating of 'Great' was assigned to a reflection that provided clear thoughts and complete justifications and possible

suggestions for future situations. Once again the results of these reflections are categorized according to month and displayed in Table 3.

Table 3

Activity and Project Reflection Ratings from a total of 48 responses

Month	OK	Good	Great
September	18	28	2
October	13	25	10
November	9	28	11
December	15	22	11

In general, there was a decrease in the students who were at the 'OK' level and increase in those receiving a rating of 'Great'. The number of students rated as writing 'Good' reflections remained fairly consistent. It can be seen that the reflections for December seem to go against the desired trend. The reflection prompt for December was vague in comparison to previous prompts. The undesired change in results seems to indicate that the students were not ready to make the transition to a less structured prompt. However, the overall trend still indicated an accomplished goal since an average 71% of the students provided a reflection rated higher than OK.

The final aspect of the journal writing was the inclusion of four graded content journals. The goal of content journals was to allow students to clarify and deepen their understanding of various concepts as well as to provide both the teacher and student with feedback to the student's level of understanding. These responses were evaluated using the same categories as the application problems: low, medium, high, or exceptional. One content journal per month was given between September and December. The results are located in Figure 3.

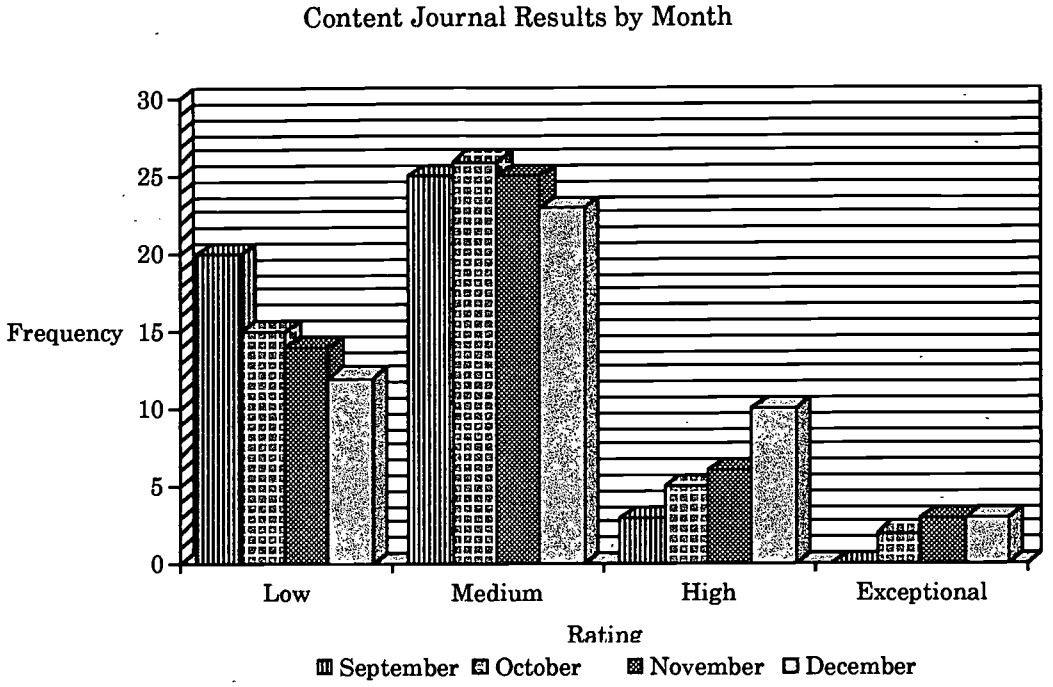

Figure 3. Frequency of ratings on content journals.

Similar to the application problems, initially there was no one who achieved a ranking of exceptional on the content journals. A significant 42% scored low on the first content journal in September. By December, the responses clearly had improved as seen by the drop in the low ratings to only 25%. Another noteworthy trend was an increase in the number of high and exceptional responses. Initially, only 6% of the responses were categorized as high or exceptional, but by the December evaluation, this combined number had increased to 27%. These decreases in low levels coupled with increases in upper levels demonstrate a greater understanding and performance by the students. The success of the intervention continued through cooperative learning activities as well.

Cooperative Learning

The third and final prong of the intervention was the use of cooperative learning. The goal of cooperative learning was to enable students the opportunity to learn from each other which would improve their performance as well as to make the

learning process more enjoyable hence improving their attitudes about mathematics. To assess these goals, the teacher researcher kept anecdotal records of verbal responses and written comments in the reflective journals. A sample of typical repeated comments include the following statements:

This activity was very fun.

I want to do it again.

Everybody was having fun.

It was fun and helped me to understand proofs better.

Each of us learned how important working together is.

I liked that everyone worked together.

It was easy to ask someone in my group when I got stuck.

It was fun and educational.

A tally of positive and negative comments was kept while reading the reflective activity journals and during the 10 classroom cooperative activities. A total number of 547 comments related to cooperative activities were recorded during the intervention. Seventy-five percent of the comments made were positive. This large percentage exhibits the positive attitudes towards cooperative learning in mathematics.

One culminating activity was used to determine how and if the students' attitudes had changed towards mathematics in general during the intervention. A post-intervention student survey (Appendix E) was conducted in January, 1998 in order to see how the students currently felt about math as well as their experiences during the intervention.

According to the initial student survey, one third of the students responded 'no' to the question of whether they enjoyed math. The post-survey showed an 8% drop in the number of students responding this way to just 25% of the students. More convincing than this figure however, were the responses to the direct questions

about attitude. What is your current attitude about math? How has your attitude about math changed since the beginning of the school year? The students were given a choice of five responses to each question. The results are listed in Table 4.

Table 4

Post Student Survey Results from a total of 48 responses

Survey Question	Response Given	%
Current Attitude	Very positive	16.7%
	Positive	58.3%
	No opinion	14.6%
	Negative	10.4%
	Very Negative	0.0%
Change in Attitude	Significantly improved	25.0%
	Slightly improved	20.8%
	Remained the same	39.6%
	Slightly worsened	12.5%
	Significantly worsened	2.1%

The responses to the question of current attitudes were overwhelmingly positive. Seventy-five percent of the students possess positive or very positive attitudes towards math. Of the remaining 25%, only 10% classify their attitude as negative. None of the students feel very negative towards math. Since this question was not on the initial student survey, no direct comparison of pre and post-surveys can be completed. However, asking the students to reflect on their own change in attitude allows for an analysis of improvement during the course of the intervention.

As shown in Table 4, one fourth of the students feel their attitudes have significantly improved and an additional 20% have noticed slight improvement. Although nearly 15% have reported a worsened attitude to some degree, this number is not as large as those whose attitudes have improved during the intervention. The

strong indication of a nearly 46% improvement in student attitudes towards math successfully obtains the second of the two initial project objectives.

Conclusions and Recommendations

The purpose in analyzing the data is to determine the effectiveness of the intervention on the original project objectives. The two goals for this research project were to improve student attitudes towards mathematics and to improve their performance. Based on the data presented earlier, both of the objectives were met.

The improvement in student attitudes was displayed in their responses to a post-intervention survey. Anecdotal records indicated that cooperative learning activities contributed to this positive outlook and to greater understanding of the mathematical concepts. However, cooperative learning was not the only factor that increased the level of student performance.

Both the use of realistic application problems and journal writing opportunities resulted in improved performance. The application problems gave meaning and purpose to the mathematics being taught. The traditional question, "why do we have to learn this?", rarely was uttered since the answer had been addressed.

In conjunction with the application problems was the use of reflective journals. These journals proved effective for both the teacher and the students. The teacher was able to quickly assess misconceptions held by the students and address these needs. The students obtained a deeper understanding of the mathematics through the execution of communicating their ideas clearly and accurately. Students also learned how to better assess their own performance through the journal writing activities.

The combined use of realistic application problems, journal writing, and cooperative learning had an overall positive effect on both student attitudes and

performance in mathematics. The researcher recommends the continuation of this intervention with some modifications.

First, the initial student survey should be revised to include questions reflecting general attitude and attitude towards usage of various teaching techniques. This would allow for a direct analysis of changes in the students' attitudes. Both the parent survey and the post-intervention student survey could provide options for improving the initial student survey.

Second, the post-intervention student survey should be completed in December rather than January. This is closer in proximity to the intervention and could result in a more accurate representation of changes. Due to the two week winter break and very little use of the intervention techniques due to preparation for final exams, the results might have been different.

Last, the action plan must be kept manageable. Some items to consider when creating an action plan are to consider working with a colleague. This might help the teacher researcher not to deviate from the action plan since each can motivate and encourage one another. Also, the teacher researcher should consider utilizing this intervention in a new class rather than a familiar preparation (if applicable). Since much of ones attention will be focused on the new class, it will be easier than trying to split the focus between a new class and serious commitments to the research in the familiar class. The teacher researcher should consider implementing each component through a series of stages as well. This could alleviate the frustration that accompanies trying to do too much at once, both for the teacher and the students. An example of stage implementation is beginning with realistic application problems, incorporating journal writing, and finally adding cooperative learning.

When researching a solution strategy to the initial problem, various approaches were encountered: realistic application problems, journal writing, and

cooperative learning. Each approach separately carried with it advantages and disadvantages. However, using a combination of these approaches resulted in both an improvement in student attitudes and in their level of performance. This approach likewise would be effective if implemented nationally to address the widespread concern for improvement in applying and transferring mathematics in the workplace. It would also meet the universal need for improvement in written communication skills particularly with regard to appropriate usage of mathematical language. Every teacher, at some point, has struggled with negative student attitudes and poor performance. This research has shown that both of these struggles can be reduced and even overcome.

REFERENCES

Adams, P. & Krockover, G. (1997). Concerns and perceptions of beginning secondary science and mathematics teachers. Science Education, 81, 29-51.

Artzt, A. (1994). Integrating writing and cooperative learning in the mathematics class. Mathematics Teacher, 87, 80-85.

Barrett, G., Doyle, D., & Teague, D. (1988). Using data analysis in precalculus to model cooling. Mathematics Teacher, 81, 680-684.

Bouck, M., Keusch, T., & Fitzgerald, W. (1996). Developing as a teacher of mathematics. Mathematics Teacher, 89, 769.

Cuoco, A. (1995). Some worries about mathematics education. Mathematics Teacher, 88, 186-187.

Daniels, D. (1989). Fast brakes! Mathematics Teacher, 82, 104-111.

Davidson, M. & Pearce, L. (1988). Writing activities in junior high mathematics texts. School Science and Mathematics, 88, 493-499.

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

Gardner, H. (1983). Frames of mind. New York: Basic Books.

Glidden, P. L. (1996). Teaching applications: Will the pendulum of reform swing too far? Mathematics Teacher, 89, 450-451.

Kopriva, D. (Ed.). (1997). Market facts & book of lists [Special issue]. The Business Ledger.

Maida, P. (1995). Reading and note-taking prior to instruction. Mathematics Teacher, 88, 470-473.

Marks, D. (1994). A guide to more sensible word problems. Mathematics Teacher, 87, 610-611.

Mathematical Association of America and the National Council of Teachers of Mathematics. (1980). A sourcebook of applications of school mathematics. Reston, VA: Author.

McLeod, D. (1993). Affective responses to problem solving. Mathematics Teacher, 86, 761-763.

Merseth, K. (1993). How old is the shepherd? Phi Delta Kappan, 74, 548-555.

Mitchell, C. E. (1990). Real-world mathematics. Mathematics Teacher, 83, 12-16.

National Council of Teachers of Mathematics, Assessment Standards Working Groups. (1995). Assessment standards for school mathematics. Reston, VA: Author.

National Council of Teachers of Mathematics, Commission on Standards for School Mathematics. (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: Author.

National Council of Teachers of Mathematics, Commission on Teaching Standards for School Mathematics. (1991). Professional standards for teaching mathematics. Reston, VA: Author.

Price, J. (1995). Selling and buying reform: If we build it, will they come? Mathematics Teacher, 88, 532-534.

Price, J. (1996). Building bridges of mathematical understanding for all children. Teaching Children Mathematics, 89, 48-51.

Schmalz, R. (1989). Problem solving-An attitude as well as a strategy. Mathematics Teacher, 82, 685-687.

School District #88. [1996]. Addison Trail High School Report Card, Addison, IL. Author.

Shaw, J., Chambless, M., Chessin, D., Price, V., & Beardain, G. (1997). Cooperative problem solving: Using K-W-D-L as an organizational technique. Teaching Children Mathematics, 90, 482-486.

Simon, M. (1986). The teacher's role in increasing student understanding of mathematics. Educational Leadership, 43, 40-43.

Skiba, A. (1990). Reviewing an old subject: Math anxiety. Mathematics Teacher, 83, 188-189.

Slavin, R. (1990). Student team learning in mathematics. In N. Davidson (Eds.), Cooperative Learning in Mathematics: A Handbook for Teachers. (pp. 69-102). Addison-Wesley Publishing.

Steele, D. & Widman, T. (1997). Practitioner's research: A study in changing preservice teacher's conceptions about mathematics and mathematics teaching and learning. School Science and Mathematics, 97, 184-191.

Steen, L. (1990). Making math matter. Instructor, 99, 21-23.

Wood, E. (1995). Gas-bill mathematics. Mathematics Teacher, 88, 214-217.

APPENDIX A

STUDENT SURVEY

Student Survey Name _____

Instructions Place your name in the provided blank on the survey. Please answer all of the following questions as openly and as accurately as possible. Answers will NOT affect your grade in any way. Use an "X" in the box that is most appropriate.

Are you male or female? ☐ male ☐ female

Do you enjoy math? Please explain why or why not. ☐ yes ☐ no

_____

_____

_____

How would you describe your previous experiences in math?

☐ Very Frustrating ☐ Frustrating ☐ Moderately Successful ☐ Very Successful

Using the following definition for a "word problem" to answer questions # 4 - #9. A word problem is a situation which requires the use of math to answer the question at hand.

How would you describe your previous experience with word problems?

☐ Very Frustrating ☐ Frustrating ☐ Moderately Successful ☐ Very Successful

How often were problems like this assigned? (use last year's math class)

☐ Every day ☐ 2 times a week ☐ 1 time a week ☐ 1 time a month ☐ 1 time a month

How often did you complete these problems?

☐ Never ☐ Rarely ☐ Sometimes ☐ Almost always

Is this consistent with past math classes? (if no, please explain why not) ☐ yes ☐ no

_____

_____

_____

When you experienced word problems, how were they presented? (if other, please describe)

☐ End of the lesson ☐ Entire class period ☐ Separate from lesson ☐ Other

_____

_____

_____

How often do you see word problems that are real-life applications?

☐ Never ☐ Rarely ☐ Sometimes ☐ Almost always

Please indicate what career(s) you think you might choose in the future?

_____

_____

_____

How useful do you think math will be in your future?

☐ Not very useful (beyond simple arithmetic) ☐ Somewhat useful ☐ Very useful

What methods have you found helpful when learning math?

Please describe a situation where you were frustrated in math class. Include what happened to make you feel that way and what did you do as a result of the situation.

Some of the algebra students are wondering what it will be like to take algebra this year. What would YOU tell them about the kinds of things that you did last year in math? (5-8 sentences)

What do you think is the most important aspect of learning math?

APPENDIX B

PARENT SURVEY

Parent/Guardian Survey

Parent/Guardian Name _____Student Name _____

Instructions: Place your name and your student's name in the provided blanks on the survey. Please answer all of the following question as openly and as accurately as possible. Answers will NOT affect your student's grade and they will be kept entirely confidential. Use an "X" in the box(es) that is appropriate.

1. How many different math courses did you complete during high school? (Choose one)

☐	☐	☐	☐	☐
0	1	2	3	4 or more

2. How many different math courses did you complete after high school? (Choose one)

☐	☐	☐	☐	☐
0	1	2	3	4 or more

3. Please check EACH of the following that seem best to describe your experience in math courses.

☐ rote and drill

☐ emphasis on memorization of skills

☐ teacher lecture

☐ use of manipulatives

☐ working together with peers

☐ real-life applications of math

☐ connecting math to other subjects

☐ other _____
(please explain)

4. What was your attitude about the math courses & content you learned? (Choose one)

☐	☐	☐	☐	☐
Very negative	Negative	No opinion	Positive	Very positive

5. How did you feel when doing math? (Check all that apply)

☐ Frustrated ☐ Defeated ☐ Confused

☐ Nervous ☐ Bored ☐ Challenged

☐ Successful ☐ Excited ☐ Other _____
(please explain)

6. How useful do you find math in your life?

☐	☐	☐
Not useful at all	Somewhat useful	Extremely useful

**Thank you so much for taking the time to complete this survey. If there is any additional information you want to provide (e.g. age, profession, additional comments, etc.), please feel free to do so on the back of this survey. Thanks again!!!!!

APPENDIX C

SAMPLE REALISTIC APPLICATION PROBLEMS

Realistic Application Problems

- The tenth grade at Addison Trail High School has a dance every year. Last year there were 80 students who went to the dance, and the party cost $200. This year there are 100 students attending the dance. How much should they plan on spending? What assumption must be made in order to solve the problem?

- A yardstick casts a shadow of 30 in. at the same time that a column casts a shadow of 85 ft. 5 in. What is the height of the column?

- How many parallel parking spaces can a city planner fit in an area 15 ft. X 105 ft. if the spaces must be arranged at a 45° angle and are 10 ft. wide? How much space is wasted? Illustrate your answer with a drawing.

- What is the largest number of regular pyramids having square bases that measure 4 in. on a side and 6 in. high that can be packed into a box 12 in. X 8 in. X 8 in.? Explain how to pack them most efficiently.

APPENDIX D

STUDENT TEST ASSESSMENT EVALUATION

Evaluation Form

Answer Before Getting Test/Quiz Back

1. How do you think you did on the test/quiz? Indicate your prediction for your grade and an adjective describing your performance. (e.g. "I think I got a 85% and I feel the test went well.") _____

2. What did you do to study or prepare for the test/quiz? _____

Answer After Getting Test/Quiz Back

3. How did you do on the test/quiz? (Indicate your actual percentage.) _____

4. How do you feel about this score? (e.g. Are you pleased, disappointed, surprised, etc.?) _____

5. Looking back, is there anything you would do different in preparing for this test/quiz? If so, what would you do? _____

6. Please list any other comments you wish to make to me. _____

APPENDIX E

POST-INTERVENTION STUDENT SURVEY

Student Survey Name _____

Instructions: Place your name in the provided blank on the survey. Please answer all of the following questions as openly and as accurately as possible. Answers will NOT affect your grade in any way. Use an "x" in the box that is most appropriate.

Are you male or female? ☐ male ☐ female Do you enjoy math? ☐ yes ☐ no

How would you describe your experiences in math this year? Explain.

☐ Very Frustrating	☐ Frustrating	☐ Moderately Successful	☐ Very Successful

_____

_____

What methods have been helpful? Check all that apply. Rank your top three in the blanks.

_____ ☐ rote and drill
_____ ☐ emphasis on memorization of skills
_____ ☐ teacher lecture
_____ ☐ use of manipulatives
_____ ☐ reflection journals
_____ ☐ working together with peers
_____ ☐ real-life applications of math
_____ ☐ connecting math to other areas
_____ ☐ use of technology
_____ ☐ other _____ (please explain)

Please rate each of the following activities:

	Did Not Enjoy	No Opinion	Somewhat Enjoyed	Enjoyed
Fettucine	☐	☐	☐	☐
Puzzle Proof	☐	☐	☐	☐
TI-92 Calculators	☐	☐	☐	☐
Tessellations	☐	☐	☐	☐
Journals	☐	☐	☐	☐

What was your favorite part of this class/subject this year? Please explain why you chose this. _____

_____

_____

What is your current attitude about math?

☐ Very negative	☐ Negative	☐ No opinion	☐ Positive	☐ Very positive

In your opinion, how has your attitude about math changed from the beginning of this school year?

☐ Significantly worsened	☐ Slightly worsened	☐ Remained about the same	☐ Slightly improved	☐ Significantly improved

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