DOCUMENT RESUME

ED 417 931 SE 061 139

AUTHOR Gresham, Gina; Sloan, Tina; Vinson, Beth
TITLE Reducing Mathematics Anxiety in Fourth Grade "At-Risk" Students.
PUB DATE 1997-11-12
NOTE 52p.
PUB TYPE Reports - Research (143)
EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Calculators; Cooperative Learning; Decimal Fractions; *Elementary School Students; Geometry; Grade 4; *High Risk Students; Intermediate Grades; Manipulative Materials; *Mathematics Anxiety; Mathematics Education; Measurement; Numbers; Probability; Problem Solving; *Thinking Skills

ABSTRACT

The conception of mathematics anxiety held by a teacher may have a great deal to do with the way in which mathematics is characterized in classroom teaching. The purpose of this study is to determine if fourth-grade students' mathematics anxiety can be decreased by a change in implementing new instructional strategies. The study employed a mathematics anxiety scale at the beginning and at the end of the school year. Instructional strategies implemented include mathematics as problem solving, mathematics as communication, mathematics as reasoning, and mathematical connections. Major instructional changes involved cooperative learning groups, use of manipulatives, real-life problem solving, calculators, and computers. Mathematical concepts covered included estimation, number sense and numeration, concepts of whole number operations, whole number computation, geometry and spatial sense, measurement, statistics and probability, fractions and decimals, and patterns and relationships. A significant decrease in anxiety toward the National Council of Teachers of Mathematics (NCTM) standards was found when these methods were implemented. Contains 39 references. (ASK)

Reducing Mathematics Anxiety in Fourth Grade "At-Risk" Students

Authored by:

Gina Gresham, Ed.S.
Tina Sloan, Ed.S.
Beth Vinson, Ph.D.

TABLE OF CONTENTS

CHAPTER I

Introduction

Mathematics anxiety has been defined in a variety of ways. Tobias (1976) gave the shortest definition of math anxiety as the "I can't" syndrome. She stated, "People almost experience sudden death with math anxiety. It is an extreme feeling of uncertainty, a 'curtain has been drawn', 'an impenetrable wall ahead', or standing on the edge of a cliff, ready to fall off" (p. 45).

Tobias and Weissbrod (1980) stated that "math anxiety was used to describe the panic, helplessness, paralysis, and mental disorganization that arises among some people when they are required to solve a mathematical problem" (p. 65). Lazarus (1974) added that "mathophobia" is an irrational and impeditive dread of mathematics.

Implicit in the various definitions of math anxiety is the beginning of a vicious cycle that leads to educational and societal mathophobes, people with a fatalistic attitude toward mathematics. Such an attitude often becomes a self-fulfilling prophecy, and generally leads to math avoidance (Williams, 1988). Hembree (1990) described mathematics anxiety as the feeling of uncertainty and helplessness in the face of danger. He believed mathematics anxiety was based on beliefs, attitudes, and motions and is more behavioral than cognitive in nature.

Lazarus (1974) believed that current educational practices may have failed to detect that a student has a lack of understanding of mathematics. Therefore, the student may subsequently experience failure and frustration, then inevitably become mathophobic. Greenwood (1992) implied that mathematics learning was largely a function of mathematics teaching. In other words, mathematics anxiety may also be a function of mathematics teaching.

He further stated that the principle cause of math anxiety lies in the teaching methodologies.

Clute and Reyes (1984) reported more recent studies that found a consistent relationship between math anxiety and math achievement. For students from Grade 3 through college, high achievement in mathematics has been related to low math anxiety.

Stenmark and Hall (1983) contended that the root of some math anxiety lies in the teaching of mathematics. The nature of instruction itself seems a powerful source in shaping later attitudes. Therefore, a possible solution to the problem of math anxiety may lie in the preparation of teachers of mathematics (Williams, 1988).

Stodolsky (1985) indicated that the teaching of mathematics suffers from the lack of applied activity and experience. Dodd (1992) added that teachers who limit themselves to the traditional methods will possibly be creating more math phobics. However, "those teachers who expand their instructional stategies cannot only prevent math phobia but may also be able to turn some phobics into fans" (p. 296).

The conception of mathematics anxiety held by the teacher may have a great deal to do with the way in which mathematics is characterized in classroom teaching. The subtle messages communicated to children through mathematics, may in turn, affect the way they grow to view mathematics (Clements, 1990). Clements has argued that substantive changes in the teaching of mathematics can be guided and reformed by implementing the NCTM Standards in the classroom. Teachers are rethinking their teaching strategies and math curriculums to align more closely with the basic goals of the National Council of Teachers of Mathematics' (NCTM).

NCTM (1989) has helped to influence the direction of mathematics curriculum in schools. NCTM set standards for grades K-12 in the mathematics curriculum. Rowan and Bourne (1994) stated, "The standards is a documented designed program which gives educators a common philosophy and framework within which schools can reflect their own special needs and goal" (p. 20). NCTM specified the five general goals of the standards. Students should: (a) learn to value mathematics, (b) become confident in their ability to do mathematics, (c) become mathematical problem solvers, (d) learn to communicate mathematically, and (e) learn to reason mathematically.

Campbell and Langrall (1993) suggested organizing mathematics instruction around the notion of each student's "making sense" of mathematics. Lappan (1993) added that " considerable change in the patterns of teaching is being called for in the classroom to help reduce the mathematics anxious." (p. 99). Teachers need to begin at ground level and build a support system that can help teach the beliefs and practices for powerful mathematicians. The alternative is to change the environment of the students' instruction to focus on the character of instruction as opposed to the perceived deficiencies of the student.

Statement of the Problem

Math anxiety is commonplace among elementary students. This anxiety can hinder students from reaching their maximum potential in the classroom. Teachers need to be aware that the problem can exist and therefore should focus on relieving math anxiety in students.

Purpose of the Study

The purpose of this study is to determine if fourth-grade students' anxiety towards mathematics can be decreased by a change in implementing new instructional strategies. The NCTM Standards will be used as a base for instructional strategies.

Research Question

Can a change in instructional strategies based on the NCTM Standards reduce mathematics anxiety in fourth-grade students?

Methodology

A mathematics anxiety scale by Chui and Henry was given to students at the beginning and end of the 1996-1997 school year. After the first test was analyzed, instructional strategies were developed and implemented to help reduce mathematics anxiety in fourth-grade students. A journal of instructional strategies as aupported by the NCTM Standards was kept by the researcher. A posttest was given in order to compare the results. A t-test was used to analyze the pretest and posttest data.

Assumptions

The following assumptions were made:

1. Mathematics anxiety can be adequately measured by pencil and paper assessment.

2. The setting and the population were not so unusual that the results could be generalized to other settings with similar conditions.

3. Students responded honestly to the questionnaire.

Limitations of the Study

Limitations of the study are listed below:

1. The study was for a 6-month period of time.

2. The study was done in only one school with one classroom teacher.

3. The researcher was also the implementer of the study.

Summary

This chapter presented the introduction, statement of the problem, purpose of the study, research question, methodology, assumptions, and limitations of the study.

CHAPTER II

Review of the Literature

The literature review was organized into three sections: (a) The NCTM Standards, (b) mathematics anxiety, and (c) instructional strategies. The review of these areas was needed in order to direct instruction toward implementing the NCTM standards to reduce mathematics anxiety.

NCTM Standards

In the early 1980s, several national reports alerted parents and educators to an impending educational crisis. Reports such as A Nation at Risk and Educating Americans for the Twenty-First Century documented many of the problems facing our schools and established the need for reform. In 1986, NCTM responded to the challenge by appointing the Commission on Standards for School Mathematics to create a vision of mathematical literacy and developed a set of national standards to guide schools toward that vision (Rowan & Bourne, 1994).

In March of 1989, the NCTM's Curriculum and Evaluation Standards for School Mathematics (Standards) was released. Lindquist (1993) stated that "the purpose of the Standards was to use them as a guide to direct the teaching journey by making mathematics accessible to all students" (p. 63). Rowan and Bourne (1994) added that an essential role of the teacher is to find situations that will be meaningful or interesting to children and develop math content from these situations. The authors emphasized that those classrooms in which teachers incorporate this process and develop instrumental programs that reflect the recommendations found in the NCTM Standards will share many of the following characteristics:

1. They will focus on the process of mathematics, rather than on right answers.
2. They will encourage students to describe their thinking verbally and in writing.
3. They will enable students to value mathematics as a useful and interesting area of learning.
4. They will encourage students to be less reliant on the teacher and better able to validate their own answers as correct.
5. They will encourage students to be persistent and willing to seek alternative ways to solve problems that are not solved on the first attempt.
6. They will show and model mathematical ideas in a variety of ways. This will include multicultural use of mathematics as well as hands-on experiences that will use various manipulatives.
7. They will enable students to become problem solvers and users of mathematics in their everyday lives.
8. They will develop an efficient and encompassing program of mathematics instruction. (p. 32)

The Standards provided background information and examples of appropriate mathematics activities. There were thirteen curriculum standards for grades K-4. These were (a) mathematics as problem solving; (b) mathematics as communication; (c) mathematics as reasoning (d) mathematical connections: (e) estimation; (f) number sense and numeration; (g) concepts of whole number operations; (h) whole number computation; (i) geometry and spatial sense; (j) measurement; (k) statistics and probability; (l) fractions and decimals; (m) patterns and relationships. Rowan and Bourne (1994) noted that the first four standards represented broad avenues for empowering children in mathematics. Standards 5 through 13 designated specific mathematics concepts to be addressed in the classroom.

For NCTM, the development of standards as statements of criteria for excellence in order to promote change was the focus. Gravemeijer (1994) stressed that the changes being promoted have consequences for curriculum studies and curriculum design. The author noted that there is a practical problem: there are few, if any textbook series or other forms of curricula that fulfill the requirements of the NCTM Standards. Therefore, new curricula will have to be developed. Second, the question arises whether the curriculum strategies that are in line with the traditional research-development-diffusion model are apt to develop a curriculum that fits the NCTM Standards. Thus, in curriculum development the focus is on the instructional activities that embody the educational change and the teachers' adaptation to the curriculum.

Carpenter and Moser (1984) suggested that children enter school able to solve real problems that require mathematical skills they have not yet been taught. But sadly, by the time they reach second grade, many of these same students have exhibited exhibit a decrease in their creative abilities. Therefore, the essential role of the teacher is to find situations that will be meaningful or interesting to children and develop math content from these situations. "The method of establishing classroom practices while incorporating the process and development of instructional programs should reflect the recommendations found in the NCTM Standards" (p. 14).

Cauley and Seyfarth (1995) stressed that meeting and implementing the NCTM Standards depended on the development of policies that clearly delineated the curriculum to be delivered and provided the resources to support teacher training, professional growth, curricular development, assessment techniques, and the technology to implement them. The authors pointed out that other factors identified as either a major or minor obstacle by a majority of teachers were lack of training for teachers in methods of incorporating the Standards, lack of enthusiasm among other math teachers, and parents and students attitudes toward mathematics.

The change in progress as Lindquist (1993) noted is to shed the past and embrace the future. The idea is that if students are to be prepared for the future, teachers must use the technology of today. The author indicated that if we are charged with laying a foundation for students' success, teachers must teach mathematics with real-world applications, mathematics that makes sense, and mathematics that instills our students the confidence to say 'I can' Lindquist stressed the NCTM's Standards are the map on which we chart our course by guiding and directing our journey.

In charting this journey, Pejourhy (1992) suggested that the key to the success of the current reform mathematics education movement ultimately depends on classroom teachers. However, teachers' have seemed reluctant to break away from the traditional pattern of mathematics teaching. Teachers have preconceptions about how mathematics should be taught, and their own experiences with more innovative methods has done little to alter their thinking about teaching math. The author indicated that this reluctance to change may stem from the fact that many teachers have been intimidated by mathematics and so have clung to the familiar, traditional algorithms. Many elementary teachers have lacked confidence in their ability to teach math, have had beliefs that are incompatible with those underlying the reform effort, and they mistakenly believe that their lack of understanding will be less noticeable because they teach in the lower grades (Williams, 1988). Battista (1994) stressed because these beliefs have played a critical role not only in what teachers' teach but in how they have taught it. This incompatibility blocks reform and prolongs the use of mathematics curriculum that is seriously damaging the mathematics health of our children.

According to the National Research Council, current research in learning uncovered defiences in structional approaches based on behaviorism (Grouwns, 1992). Research in learning has shown that students actually construct their own understanding based on new experiences that enlarge the intellectual framework in which ideas can be created. Grouwns stated much of the failure in school mathematics is due to a tradition of teaching that is inappropriate to the way most students' learn. In retrospect, Clements (1990) indicated that the ability to be introspective, to use these standards as a lens through which teachers see their own teaching, is critical to improving the teaching of mathematics. Therefore, the challenge is for teachers to emancipate, empower and transform both themselves and their students' (Campbell & Langrall, 1993).

Mathematics Anxiety

Hembree (1990) broadly defined mathematics anxiety as being in a state of emotion underpinned by qualities of fear and dread. The author described this emotion as unpleasant, is directed toward the future, and is out of all proportion. He concluded that mathematics anxiety is related to poor performance on mathematics achievement tests. It relates inversely to positive attitudes toward mathematics and is bound directly to avoidance of the subject. In examining student anxiety, Hembree noted that persons with strong anxiety drives are prompted by habit to reenact their task-irrelevant behaviors that impair performance.

Some describe mathematics anxiety as no more than subject-specific test anxiety (Brush, 1981). Despite its lack of independent identity, the research of mathematics anxiety has prospered, spurred by increasing perceptions that the construct threatens both achievement and participation in mathematics (Hembree, 1990). Hembree concluded that a variety of treatments and techniques are effective in reducing mathematics anxiety. Improved mathematics performance consistently accompanies valid treatment.

Bass (1993) not only studied improving mathematics performance but its correlation between math and writing anxiety, and offered specific nonthreatening teaching methodology to reduce anxiety. She reported that math students rarely felt anxious about numerical problem solving but reacted with anxiety when preparing, waiting for, and taking mathematics tests. Bass indicated that many also became anxious when they thought teachers would call on them in class or be forced to do something that other people would evaluate. Bass's students used math journals to write about their strengths and weaknesses in math. Skiba (1990) indicated that verbalizing fears and frustrations allowed students to overcome their hostility toward the subject.

Dodd (1992) indicated "hostility is not an inherited trait; it is created" (p. 296). It can be created when teachers place too much emphasis on memorizing formulas and applying rules. Dodd stressed that hostility and anxiety can result when teachers have failed to realize the critical connection between students' academic performance and their feelings about themselves and the subject being studied, or when teachers did not take into consideration students' individual approaches to learning. The author pointed out that lack of confidence in oneself is perhaps the greatest obstacle to learning because beliefs govern action. The belief that they cannot do something may have rendered students unable to perform a task of which they were truly capable. Dodd noted that teachers can help students develop more confidence in themselves by finding ways for them to experience success. However, successes more likely will occur first on a small task than a larger one. Changing negative rooted beliefs is a slow process.

Williams (1988) described negative rooted beliefs as beginning in the teachers and the teaching of mathematics. Some teachers of mathematics have confessed to the anxiety about mathematics. Teachers and parents sometimes pass "mathophobia" on to their students and children (Lazarus, 1974). This new generation of mathophobes may subsequently infect others with the malady, thus effectuating a cycle. She concluded that attitudes toward mathematics anxiety notwithstanding, may be transmittable. Tobias (1976) stated "an unfortunate experience with a math teacher can cause math anxiety" (p. 98). Hodges (1983) argued that failure or success in mathematics may be related to individual learning styles and more specifically with the coupling of learning styles with the way in which material is presented, rather than with the subject matter itself. Greenwood (1984) indicated the principal cause of math anxiety has lied in the teaching methodologies used to convey the basic mathematical skills to students. Stodolsky (1985) reported that the nature of instruction itself sums a powerful force in shaping attitudes, expectations, and conceptions of mathematics. Reyes (1984) reasoned that an important educational goal is developing a positive attitude toward mathematics and reducing students' math anxiety.

In examining math anxiety, Hembree's (1990) results of 151 studies were intergrated by meta-analysis to examine mathematics anxiety. He concluded that mathematics anxiety is related to poor performance, and the avoidance of mathematics. Because of the following evidence it seems that mathematics anxiety depresses performance: (a) higher achievement consistently accompanies reduction in mathematics anxiety; and (b) treatment can restore the performance of formerly high-anxious students to the performance level associated with low mathematics anxiety.

Swetman (1994) investigated the level of mathematics anxiety toward mathematics of third-through six-grade elementary students. There was a slight correlation between the teachers' mathematics anxiety level and the students' attitude toward mathematics. The results indicated a slight correlation between the anxiety level of the teachers and the attitude toward mathematics of the students.

Dodd (1992) recommended " the first goal of every teacher should be to help students come to believe they can learn" (p. 297). Teachers who limit themselves to traditional methods will undoubtedly continue to create more math phobics, those who expand their repertoire of teaching strategies are likely to see an increase in math fans. Dodd indicated that a wide variety of games, group activities, and carefully chosen assignments may be needed to overcome firmly entrenched negative beliefs. The author recommended the use of learning logs, free writing, and process journals in order to help all students make personal connections with the concepts being taught. Writing is an effective tool for teachers because it allows the students to talk to the teacher privately on paper. By empowering students as learners, a more personalized and process-oriented approach to teaching can make math phobia a thing of the past. As students realized that they can learn new concepts, their self-confidence increases, thus reducing the level of math anxiety.

Instructional Strategies

Cooperative Learning

Reviews of studies of the effects of cooperative learning have generally yielded positive findings. Slavin (1991) contended that research has shown that cooperative learning methods in the mathematics program enhanced various affective outcomes, including intergroup relations, acceptance of mainstream academically handicapped students by their classmates, higher self-esteem, enjoyment of class or subject, general acceptance of others and reduction of mathematics anxiety in students. Further, achievement effects on cooperative learning are generally positive. In his "best evidence", Slavin found that 72% of the 68 "adequate" studies showed higher achievement in mathematics when using cooperative learning than for controlled conditions. He noted that interaction between higher student ability and positive attitudes toward mathematics was related to cooperative learning. He concluded that cooperative groups lead to enhanced participation and on-task involvement.

Blum-Anderson (1992) encouraged participation through cooperative learning and group projects on a regular basis. Cooperative learning acitivties has allowed students to relax and concentrate on the process rather than on demonstration of abilities. Blum-Anderson claimed that ability grouping should be avoided because it draws attention to the individual and forces students to focus on demonstration of ability at the expense of involvement in the learning process. "Low achievers in mathematics when paired with others on the same level can develop higher levels of mathematics anxiety which leads to failure in experiences resulting in negative self-efficacy feelings" (p. 182). She maintained that groups of three or four students are more beneficial, mainstreaming high achievers with low achievers, and stressed the importance of group membership to be flexible to ensure that students do not become trapped in dysfunctional groups for extended periods of time, therefore creating an interdependence.

Interdependence can be facilitated when students are given specific roles and have a clear understanding of what each role entails. Jong and Hawley (1995) stated that it is clear that the passive behavior of some students during small group work is a significant concern. "Teachers who hope to increase student involvement will have to develop strategies to allow all students to play active roles during small group work" (p. 46). Such roles may include: (a) the leader, makes sure all members participate, reviews instructions, summarizes readings and/or discussion, and keeps the group focused on the task; (b) the mediator, makes sure that everyone has a chance to participate and contributes ideas, helps to facilitate listening instead of arguing; (c) the recorder, takes notes on brainstorming, mapping, reasoning, and decisions of the group; (d) the observer, records who contributes ideas and asks questions and how frequently; (e) the reporter, reports the results of the group to the class or produces the written summary or finished product of the group; and (f) the timekeeper, keeps track of the time allotted for components of an activity for a particular class session and/or monitors the group's overall progress. Jong and Hawley maintained that one of the major reasons for assigning small group roles is to increase student participation, thus eliminating passive student behavior.

Johnson and Johnson (1986) reported, "cooperative learning is the instructional use of small groups so that students work together to maximize their own and each other's learning"(p.174). Within cooperative activities individuals seek outcomes that are beneficial to themselves and beneficial to all other group members. Within cooperative learning groups, students are given two responsibilities: To learn the assigned material and to make sure all other members of their group do likewise. In cooperative learning situations, students perceive that they can reach their learning goals only if other students in the learning group also do so. Students discuss the material to be learned with each other, help and assist each other to understand it, and encourage each other to work hard, while accomplishing shared group goals.

Johnson and Johnson (1986) noted that cooperative learning was more effective than individual efforts under key conditions: (a) teachers clearly promoted positive interdependence in groups, (b) teachers ensured individual student accountability, (c) students engaged in face-to-face interaction: discussing, supporting, assisting, and encouraging, (d) students learned and used interpersonal and small group social skills: leadership, communication, conflict management, decision making, and trust building, and (e) teachers ensured periodic group reflection concerning functioning and effectiveness of the group.

According to Hauserman (1992) group effectiveness has been found to delineate levels of student achievement, providing the greatest gains for low and middle achievers, minority groups, and handicapped students. At the same time high achieving students have fared equally well or better in cooperatve learning situations. When compared to individualistic and competitive strategies, cooperative learning has allowed for greater levels of achievement in math and other subjects (Hembree, 1990). Students who have worked cooperatively demonstrate more positive attitudes and behaviors and less anxiety toward the subject matter (Johnson & Johnson, 1986).

Dodd (1992) related loneliness as a barrier to learning, and stressed that cooperative learning activities should be a part of every mathematics class. Dodd added that the lack of confidence, anxiety, and loneliness are all intricately interwoven, and all affect motivation negatively. Students learned to articulate both what they did and did not know. Working with peers in small groups or in pairs satisfies students' need and desire for social interaction while requiring them to be active learners.

Problem Solving

Problem solving has received considerable attention in such national reports as the National Research Council (1989) and the Curriculum and Evaluation Standards, developed by the National Council of Teachers of Mathematics (1989). The latter also stressed the importance of problem solving as a method of inquiry to help students recognize the power and usefulness of mathematics.

According to NCTM (1989),

> Problem solving should be the central focus of the mathematics curriculum. As such, it is a primary goal of all mathematics instruction and an intergral part of all mathematical activity. Problem solving is not a distinct topic but a process that should permeate the entire program and provide the context in which concepts and skills can be learned. (p. 23)

This recommendation not only indicated the importance of problem solving, it also implied that a concerted effort is needed in order to establish problem solving as an intergral part of the mathematics curriculum. The standard emphasized a comprehensive and rich approach to problem solving in a classroom climate that encourages and supports problem solving efforts (Fennema, 1977).

A comprehensive review of research related to problem solving was undertaken by Shann (1976). Most children in the elementary school were introduced to problem solving before entering school. Rowan and Bourne (1994) pointed out that research suggested that children enter school able to solve real problems that required mathematics skills they have not yet been taught. But sadly, by the time they reached second grade, many of these same students exhibited a decrease in their creative abilities.

Problem solving has clearly emerged as a central emphasis for elementary school mathematics to facilitate students' transition into the twenty-first century (Rosenbaum, 1989). Schroder (1989) emphasized that the main role of problem solving was improving students' understanding of mathematics. There were three approaches to improving and making problem solving the focus of mathematics: (a) teaching about problem solving (b) teaching for problem solving, and (c) teaching via problem solving.

Stanic and Kilpatrick (1988) indicated "problem solving" was a vehicle in the service of other curricular goals. The authors identified the roles that problem solving played: (a) as a justification for teaching mathematics; (b) to provide specific motivation for subject topics; (c) as recreation: (d) as a means of developing new skills; (e) as practice. In all five areas, problems are seen as a means to an end. That is, problem solving is not usually seen as goal in itself, but solving problems as facilitating the achievement of other goals.

Cauley and Seyfarth (1995) noted the emphasis on problem solving, reasoning, communication, and connections requires a different type of instruction. The authors stated, "no longer can teachers rely on an instructional sequence of review of homework, introduce and explain new material, assign problems for seatwork and homework" (p. 25). Cauley and Seyfarth added that students should learn mathematics in the context of engaging in problematic approaches.

Rowan and Bourne (1994) stated, "an essential role of the teacher, then, is to find situations that will be meaningful or interesting to children and develop math content from these situations" (p. 29). The authors added that those classrooms in which teachers incorporate this process and develop instrumental programs that reflect the recommendations found in the NCTM Standards will share many of the following characteristics: (a) they will focus on the process of mathematics, rather than on the right answers; (b) they will encourage students to describe their thinking verbally and in writing; (c) they will enable students to value mathematics as a useful and interesting area of learning; (d) they will encourage students to be less reliant on the teacher and better able to validate their own answers as correct; (e) they will encourage students to be persistent and willing to seek alternative ways to solve problems that are not solved on the first attempt; (f) they will show and model mathematical ideas in a variey of ways. This will include multicultural uses of mathematics as well as hands-on experience that will use various manipulatives; (g) they will enable students to become problem solvers and users of mathematics in their everyday lives; and (h) they will develop an efficient and encompassing program of mathematics instruction.

It has been found, that correct solutions to problems involved setting up a plan, however brief, for the solution (Krubik, 1980). Another finding is that different students have approached the same problem in a variety of ways, indicating the existence of a style or preference. This has suggested that teachers' should consider instruction in problem solving in a variety of approaches.

Weidemann (1995) reported "problem solving provides a means of retaining interest in mathematics while providing an alternative to textbook exercises and worksheets" (p. 13). When teachers provided challenging problems that were relevant to the world and daily living, chances of keeping students' interested in mathematics were greatly increased.

Manipulatives

Recent documents about mathematics education such as the Curriculum and Evaluation Standards for School Mathematics (NCTM,1989) and the Professional Standards for Teaching Mathematics (NCTM,1991) called for mathematics to be an active constructive discipline. In the Curriculum and Evaluation Standards, a basic assumption about instruction is that students will become active learners and that every classroom will be equipped with ample sets of manipulatives and materials (counters, cubes, connecting links, base-ten, attribute, pattern blocks, tiles, geometric models, rulers, spinners, colored rods, geoboards, balances, fraction pieces, graphs, grids and dot paper) (NCTM, 1989). Many researchers have studied the effects of manipulatives and much has been written advocating the use of manipulatives (Kennedy, 1986).

Using a manipulative approach to mathematics instruction has required the knowledge, skills, and experiences necessary to respond to students who are learning mathematics. A basic assumption in the Professional Standards for Teachers of Mathematics (1989) states, "Teachers and students are influenced by the teaching they see and experience" (p. 124).

Ball and Schroeder (1992) indicated that prior experiences has given vivid images of mathematics as a fixed body of knowledge best taught through memorization and drill. Studies of mathematics teaching suggested that the mathematics classrooms have depicted mathematics teaching as teacher-dominated settings with rules, theorems, drill, and practice (Stodolsky, 1985). According to Scott (1987), students need to experience mathematics as an active process in which they interact with peers and teachers.

Rowan and Bourne (1994) reported learning theory suggested that children's mathematics knowledge originated with their actions upon objects. The authors stated, "conceptual understanding moves from the concrete (working with objects) to the semi-concrete (pictorial or representational) to the abstract (mental or symbolic)" (p. 74). The authors noted that manipulatives provided the props with which children explore mathematics concepts. With concrete materials in hand, students can experiment, build, add, divide, weigh, measure, and compare. Props invite reflection, stimulation, facilitate conversation, and assist explanation in which students can develop and apply abstract ideas, make hypothesis and test ideas.

Dossey (1989) indicated that the curriculum should provide for students' participation, across the grades. This construction must involve students in "doing mathematics" with manipulatives, discussing the results of their investigations, and writing the results of their experiences. He added, "such experiences, at each grade level, allow students to build on their extant knowledge by inventing new methods of assaulting problems" (p. 22). He concluded that while providing students ample opportunities to grow in their ability to apply mathematics using manipulatives, such approaches will also develop confidence in their ability to succeed in mathematics.

Tankersley (1993) revealed a hands-on approach to learning mathematics in a Cordova School manipulative lab. At Cordova, which serves grades K-8, teachers wanted to develop a mathematics program that was not only effective, but that also generated student interest and positive self-esteem. During a year long investigation, they read the latest research, attended workshops, visited other schools, and listened to guest speakers. They became convinced of the need to recapture the concrete experience that small children bring to learning math. Tankersley stated, "not only did students show growth in tested math concepts after using manipulatives, but the program instilled an enjoyment of mathematics and sense of confidence in our students'" (p. 13). Lappan (1993) maintained that manipulatives are "fun" tools to be used thoughtfully to help motivate and encourage students to engage in, and make sense of mathematics.

Calculators

The NCTM's (1989) stated, "the K-4 curriculum should make appropriate and ongoing use of calculators" (p. 19). Calculators must be accepted at the K-4 level as valuable tools for learning mathematics. Calculators enable children to explore number ideas and patterns, to have valuable concept-development experiences, to focus on problem-solving processes, and to investigate realistic applications. The thoughtful use of calculators can increase the quality of children learning (NCTM, 1989).

Rowan and Bourne (1994) indicated that calculators are part of the real world and are here to stay. The authors noted calculators take away the drudging of mathematics, improve efficiency, and increase accuracy of computation. Students can use calculators to investigate number patterns and the effect of computational algorithms. Used this way, calculators provide a dimension to the instructional program that could not be achieved with paper and pencil alone (Rowan & Bourne, 1994).

Studies have consistently shown that calculators can improve students' ability to solve problems when they are not so concerned with the basic computation of the problem (Hembree, 1990). If calculators are allowed then the emphasis can be on high-order thinking skills. If teachers would begin to de-emphasize the teaching of computation they could then concentrate more on developing better problem-solving skills and thinking skills through the use of calculators. Hembree stressed that in addition, calculators can help lessen mathematics anxiety as students become more confident in their ability to do mathematics. Clements (1990) maintained that heavy use of calculators in the early grades as part of instruction and assessment does not harm computational ability and frequently enhances problem solving skill and concept development.

Cruikshank and Sheffield (1992) stressed that calculators be used as an everyday part of the mathematics curriculum. The authors suggested the following ways to implement calculators in the curriculum: (a) to develop an understanding of the calculator; (b) to develop number sense and place value concepts; (c) to develop and recognize patterns; (d) to develop concepts of operations; (e) to develop problem-solving and thinking abilities; (f) to get a graphic picture of the data; (g) to solve problems where the computation might otherwise be prohibitive; (h) to improve mental computation and estimation skills. Wheatley and Shumway (1980) emphasized the potential of calculators to transform the study of mathematics. The authors stressed calculators should be used for all but 15% of school mathematics. Therefore, the focus would be on meaning and mathematical reasoning rather than procedures and steps.

Finley (1992) implemented the use of calculators in the classroom 5 years ago in fourth- and fifth-grade mathematics classes. Students realized the calculator did not compute until it was told what to do, and if it was told to do the wrong thing it gave wrong answers. Therefore, the calculator had to be checked for accuracy in a different way. Finley reported less capable students were more willing to work on difficult problems and to try out different theories. The process of having correct answers and the instant gratification was a great self-esteem builder.

Computers

Computers can compliment mathematics instruction and enhance understanding (Rowan & Bourne, 1994). The authors stressed that classroom technology adds a dimension to the instructional program that could not be achieved with paper and pencil alone. Cruikshank and Sheffield (1992) suggested the following ways in which computers may be used in the classroom: (a) to teach programming; (b) as a tool for either student or teacher use; (c) for drill and practice; (d) to stimulate real life; (e) to give students experience in problem solving, reasoning, and logic; (f) as a tutorial; and (g) to aid in spatial visualization. The power of computers also needs to be used in contemporary mathematics programs. The thoughtful and creative use of technology can greatly improve both the quality of the curriculum and the quality of children's learning.

Clements (1990) added, "computers supply representations that are just as personally meaningful to students as are real objects; that is they might help develop integrated-concrete knowledge" (p. 271). In addition Clements offered specific advantages of computer use in the classroom: (a) computers offer a managable clean manipulative, (b) computers afford flexibility, (c) computers allow for changing the arrangement of representation, (d) computers store and later retrieve configurations, (e) computers record and replay students' actions, and, (f) computers link the concrete and the symbolic by means of feedback. The author stressed that in a series of studies, students in fourth grade through high school learned problem solving strategies better than those who were taught the same strategies with non-computer manipulatives.

One group of researchers studied pairs of students as they worked on computers and found that the computer somehow draws the attention of pupils and becomes a focus for discussion (Battista, 1994). The author concluded that although most children seemed to enjoy working on the computer, such activity was especially motivating for students who had been unsuccessful with mathematics.

CHAPTER III

Methodology

This study investigated the mathematics anxiety levels of fourth graders. It also examined ways to reduce mathematics anxiety by a change in instructional strategies based on recommendations in the NCTM Standards.

Subjects

The population in this study was restricted to 17 fourth-grade students at G.W. Floyd Elementary School in Gadsden, Alabama during the 1996-1997 school year. The class consisted of four non-readers, one severe ADD child, two mild ADD children, nine special education students (two EMR students, six LD students, one EC student). The ethnic background of students consisted of six non-caucasian females, three caucasian females, six non-caucasian males, and two caucasian males. Gadsden's population is 60,000 while G.W. Floyd Elementary has 397 students and is a predominately lower class community. The school has 90% African American and 10% white students.

Instrument

The Mathematics Anxiety Scale (see Appendix A) was the instrument used to gather information concerning the level of mathematics anxiety exhibited by the fourth-grade students. This instrument was developed by Chiu and Henry (1990). The instrument is a mathematics anxiety test for children. The instrument has an internally consistent measure of mathematics anxiety for Grades 4 through 8. There was some construct validity evidence based on its relationship with mathematics grades, test anxiety, achievement, motivation, and academic ability. This instrument was administered in the Fall as a pretest and in the Spring as a posttest. At the beginning of the 1996-1997 school year the Mathematics Anxiety Scale was administered to 17 students. The teacher read the test orally to the students, while the students circled the response that best described their beliefs.

Analysis of Data

In order to determine if a change in instructional strategies based on the NCTM Standards would reduce mathematics anxiety in fourth-grade students, the Mathematics Scale by Chiu and Henry was administered as a pretest. Then, instructional changes based on the NCTM Standards were implemented. Next, a post test was administered. A t test was used to analyze the difference between the pretest and the posttest. The t test was performed to determine if there was a significant difference between the pretest and the posttest. A Cronbach alpha was used to determine internal consistency. Changes in instructional strategies were recorded daily in a journal by the researcher. The changes in instructional strategies were based on the researcher reading educational materials for ideas, keeping a journal, and collaborating with colleagues.

Instructional Strategies Implemented

Unlike strategies used in the past, such as worksheets, lectures and boardwork, a more hands-on approach was implemented by the researcher. Instructional strategies were coordinated with the NCTM Standards Based on changes in instructional strategies, the following are activities that serve as examples of each of the NCTM Standards. Each of these activities were used in the study.

Mathematics as Problem Solving

During an Around-the-World Vacation unit, students pretended they had a $2,500.00 budget to travel anywhere in the continental United States. They used travel catalogs. The students made a list of the items they needed for vacationing, and gathered expenses including transportation, lodging and foods. Calculators were used to total their vacation package. Computers were used to further explore their chosen destination. The students actively discussed, and worked at managing their budgets. This was a real-life situation that most of the students had never experienced, therefore, the task demanded extended effort to stay within the budget. The calculators made the process easier. Throughout the year students used calculators to solve word problems.

The students utilized classroom computers to experience problem solving, reasoning, and logic. The software programs were used with the whole class working together, with cooperative learning groups, and by individual students. The software provided a wide range of problems for the students to solve. Math Facts Tracker, Banking on Facts, Infobank, Mental Math, Mission Possible, Turbo Math Facts, Shuttles of Space Facts, Computer Maze, Logo Turtle, Math-Go-Round, Decimal Dungeons, and Math-My-Self are examples of some of the software that was available for the students. Students kept a daily journal in which they expressed solutions to word problems. The students were encouraged to determine which of the following strategies would be the best approach for each particular problem: guess and check, make a list, estimate, make and use a drawing or model, and look for patterns.

Mathematics as Communication

Students worked daily in cooperative learning groups. The approach eliminated competition and fostered cooperation. Students received support from each other through communication of the mathematics tasks. Students were taught cooperative learning guidelines to function orderly. The guidelines were also posted in the room. The groups were heterogeneously arranged, with never more than four students. Each group contained an extremely low, low, medium, and high ability student. In each group, there were four roles for the students to perform. The students wore nameplates with their role written on it. First, there was the manager who was responsible for researching material and gathering supplies. Second was the monitor who was responsible for making sure that all of the students understood the assignment and to keep the group on task. Third was the time keeper/recorder, who was responsible for keeping the time remaining and record information. Fourth, the encourager would periodically say something positive to different group members and help the manager gather the necessary materials for the mathematical task. If a student had a question, they were to ask group members. If the entire group had difficulty, the monitor raised his/her hand. These procedures helped students to communicate with each other.

During a four-digit multiplication activity, the students were challenged to communicate with each other in a relay game. Each group had a multiplication problem with regrouping on the board. Group members took turns working out each step of the problem. The groups worked together to reach a common goal successfully. Throughout the year, the students were rarely quiet, instead there were sounds of voices sharing ideas, explaining, debating, negotiating, and evaluating. The students enjoyed the freedom of communication that enhanced their ability to think, write, talk, read, and construct mathematical ideas. In problem solving tasks, the students reasoned mathematically and communicated their ideas through the language of math. The students became confident in their ability to meet mathematical challenges.

<u>Mathematics as Reasoning</u>

The students used inductive reasoning to identify patterns during the school year. They learned to generate, organize, and look for patterns, and make connections. A fraction unit was introduced with geoboards. Students reasoned and determined the fractional parts of a whole using the geoboards. The teacher used an overhead geoboard to model fractional parts. Students then constructed various fractional parts of a whole using rulers, colored pencils, and paper. Computer games were used to reinforce the concept of fractional parts of a whole. The class examined with fractions that needed to be simplified. The game required the students to change improper fractions to a mixed number, and mixed numbers to improper fractions. Pattern blocks were used to understand the reasoning process by allowing the students to identify patterns, which was a powerful problem-solving process. Pattern block were also used in adding and subtracting fractions.

Mathematics Connections

During the year, the students became more aware of the world among them. Probability and statistics became important connections to the world around them and the classroom. Weather forecasting, the use of money in advertising, graphs of business profits, fractions in recipes, and the use of statistics in sports were areas in which students investigated the role of mathematics in our culture. For example, students were placed in cooperative learning groups and established a classroom bank. This was a simulation that demonstrated a connection with real-life. The students practiced counting back currency with play money and practiced writing numerical amounts on checks and in computing a current balance following deposits or withdrawals. Checks and checkbooks were made and students recorded transactions.

The students brainstormed about a list of expenses and sources of income. While working in small groups, the children took turns drawing cards from a pile, writing checks from their account as needed, and made appropriate deposits. Following each transaction, a new checkbook balance was entered using paper-and-pencil calculations. At the end of the period all deposits and withdrawals were totaled using a calculator, and students' balances were checked. As a related homework assignment, children were asked to interview their parents to discover what methods were used to balance their checkbooks. The children compared varying styles used by those parents who balanced their checkbooks to the penny to those who rarely calculate a balance and hope for the best. Students frequently described helping their parents learn how to use a calculator to balance monthly statements. This assignment promoted lively discussions in class. The unit utilized such skills as addition, subtraction, multiplication, counting back currency, and the need for accuracy.

Estimation

The class was given the task of estimating the periphery of the classroom. Each group was given a collection of supplies; calculators, paper, meter sticks, string, pens and cans. Students were asked to use all, or none of the supplies to estimate and measure how many pieces of paper they would need to cover the outer boundary. Part of the challenge was for students to figure out which tools they would need to complete the task.

Once students met the challenge students became motivated and enthusiastic about covering the entire floor. When the children realized the amount of paper needed to cover the entire area, they began to fully understand the need to recycle and conserve. Students were excited about their experience and eagerly wrote about it in their journals.

The students were taught paper and pencil computations, however, the use of calculators, computers, estimation, and mental math were emphasized. Once the students were able to demonstrate paper and pencil algorithms, calculators were used to speed up the process. This allowed higher mental processes and content. The students were encouraged to estimate or guess and check whether the estimations were correct.

Number Sense and Numeration

A number sense and numeration unit was designed to help students expand their knowledge of reading and writing numbers to hundred millions. Students practiced writing large numbers in standard form and naming the digit in a given place.

Once the students were familiar with place value-concepts the lesson was extended. Science was integrated into the lesson by having each group take an imaginary space trip to the solar system. Students selected a destination, calculated the distance by paper and pencil computation then checked their work using calculators. The students used computers to further explore the solar system then presented their space exploration to the whole class. Students were excited about their experience, and eagerly wrote about it in their journals.

Concepts of Whole Number Operations

The students extended their understanding of comparing and ordering whole numbers to fractions, decimals, integers, and rational numbers. In comparing numbers on an number line, the students found that -3 and -5 were different from comparing whole numbers. The fourth grade students were not accustomed to the concept of intergers. The students discovered that 15 - 4 = n means the same as 4 + n = 15. This gave the students a comparison of subtraction in terms of addition.

Students worked with number lines by entering the number 100 into their calculators and write the number 1 on a sheet of paper. They then added 100 until they reached 1,000. The recorder in each group marked 1 on their paper to see how many hundreds there are in 1,000. The procedure was then repeated starting with 1,000 and adding 1,000 until they reached 10,000. The students' understanding became clearer that the numbers on the number line increased as the line was extended to the right. The students also practiced using greater than and less than by writing number sentences.

The students worked with number lines to see the difference between whole numbers, and to discover the difference between positive and negative intergers. The students also discovered that numbers are infinite, and there is no smallest number or largest number. They explored connections between prime numbers and factors of a number.

Whole Number Computation

During the year, students learned to view mathematics as a series of related skills. Rather than view fractions, decimals, monetary amounts, and measurement as isolated topics, students saw how these mathematics skills appear together in real problem situations. For example, students were asked to calculate the cost of a business advertisement by using a formula to determine the area and then to calculate the cost on the basis of the area of the advertisement. Students applied what they have learned about measurement, monetary amounts, and arithmetic to find an effective way to solve the problem.

Once students determined the cost of the advertisement, they designed an advertisement and menu for the restaurant. Students would place an order, use the calculator to determine the total cost, then count money with play currency. Afterward, they changed roles, and repeated the procedure. Students practiced column addition by calculating the average costs including taxes to eat a meal at their new restaurant.

This unit utilized such skills as addition, subtraction, multiplication, counting numbers using paper and pencil computation, and using calculators to check for accuracy. The students also learned about jobs of cashiers, waiters/waitresses, cooks, patrons, and managers.

Geometry and Spatial Sense

The students learned to identify, describe, compare, and classify geometric figures during a geometry unit. Students constructed three-dimensional geometric figures such as cylinders, pyramids, cones, spheres, and triangular prisms out of paper. Students counted vertices, edges, and faces. They looked for a relationship between the vertices, edges and faces of each figure. Geoboards were also used to discover different types of triangles. Students made geometric designs on laminated paper, and then hung them on the class Christmas tree.

Measurement

For hands-on experience, students traced their footprints on centimeter paper to determine the area. The results of the measuring was reported in square centimeters. Students explored area and perimeter on the geoboards. In cooperative groups, the students measured and determined the volume of various grocery boxes (cereal, jello, crackers, raisins, poptarts, milk cartons, etc.)

In a metric unit, the students measured various objects throughout the school. They worked in cooperative groups and each student had certain responsibilities to perform. The manager gathered the needed materials and supplies, the monitor directed the group assignment, the encourager made positive comments and measured the objects, and the recorder recorded the measurements on paper.

The students weighed and then recorded their weight in kilograms, and then converted their weight in customary units. The students examined various containers to work with conversions within the customary system. They worked with half-pint, pint, quart, half-gallon, and gallon cartons.

Statistics and Probability

Throughout the year, students worked with graphs in order to read information about data. The students became familiar with circle, line, and bar graphs. They learned how to construct, read, and intrepret graphs, charts, and tables.

Students explored real world situations in which they constructed a graph of the different colored eyes, hair, and height in science class. Students also learned about mean, mode, median, and range by observing their test scores in different subject areas.

The students learned to appreciate the power of using probability by comparing results taken from working with number cubes. The students regularly played mathematical number games and openly discussed the probability and odds of the number cubes landing on certain numbers. Students also used M&Ms in an activity in which they predicted the most common color, and which color they would have the most and least of. A game was also played in which the students picked the colors from a bowl, recorded their findings on a graph, and then ate them. The students enjoyed this activity and wrote eagerly about it in their journals.

Fractions and Decimals

Students were able to use their experience in estimating during a unit on fractions and decimals. The children were asked to estimate how many patches would be needed to cover their desks completely with seven-inch-by-seven-inch patches made from wallpaper samples. The estimates, ranging from six to numbers in the twenties, were recorded by the recorder in each group. The goal was to find out exactly how many would be needed to cover the entire desk. No directions were given to accomplish the task. Some students tried moving a single patch and keeping track of how much surface had been covered, but they found this task too difficult. Soon groups were pooling patches and covering their desks. Some students asked if they could cut or fold the patches. Their reasoning for doing so was pursued. They explained that they did not need a whole patch to cover the areas that were left. They soon had six whole patches and five half patches covering their desks, but part of the desks remained uncovered. Students were asked to explain why they used a one-half patch and how they knew it was one-half. One-fourth patch fit the uncovered surface perfectly. One student was able to write the symbol 1/4.

After some discussion, the students agreed that 8 3/4 patches covered the desk. Some children were able to relate 3/4 was an appropriate name because 1/2 is the same as 2/4; hence, together the 1/4 and 2/4 made 3/4. The children posed such questions as "What would happen if the patches were larger or smaller?" and "How many patches might be needed then?"

The students were further challenged by converting the fractions to decimals. Students wrote decimals from models, fractions as decimals, mixed numbers as decimals and decimals as words. Students used fraction models for representation and wrote decimal equivalents on a place-value chart. Students used calculators and computers to compare and order decimals through hundredths.

<u>Patterns and Relationships</u>

Identifying patterns is a powerful strategy in inductive reasoning. The students used calculators, computers, and geoboards to experience problem solving, reasoning, and logic. They learned to generate, organize, and look for patterns.

Students were asked to make and identify three and four sided figures on the geoboard or dot paper. They were also asked to find the areas of different triangles and quadrilaterals, and explore the relationships between triangles and quadrilaterals. Each student needed a geoboard, rubber bands, and dot paper to record his or her discoveries. Students shared the shapes they identified with other students, discussed how the shapes were similar and how they were different. As the students identified shapes on their geoboards, they recorded the shapes on dot paper and begin to look for patterns. Students were encouraged to explore, identify triangular shpaes, make two different quadrilaterals with areas of 4 square units and two different triangles with areas of 2 square units. Students continued practicing counting squares and partial squares to find the areas of the figures labeled on the geoboard. Students also gained a better understanding of perimeter and area.

Summary

This chapter presented the design of the study, a description of the population was given. The testing instruments were described. The procedure was discussed.

CHAPTER IV

Analysis

This chapter presents an analysis and interpretation of the data based on the Mathematics Anxiety Scale that was administered to 17 fourth-grade students at G.W. Floyd Elementary School, in Gadsden, Alabama during the 1996-1997 school year.

A *t* test was selected as the statistical test to determine the results of the data. The *t* test was run on the pretest and posttest scores of the Mathematics Anxiety Scale. The statistical conparison on the pretest and the posttest means are shown in Table 1 below.

Table 1

t-test Comparison for The Mathematics Attitude Questionnaire

Grade	N	Pre		Post		Diff		
		Mean	SD	Mean	SD	Mean	SD	*t*
4	17	66.176	9.64	27.294	4.05	38.882	16.44	4.95

Note. The observed *t* statistic of 4.95, with 16 degrees of freedom, indicates that there was a significant decrease in anxiety from the pretest to the posttest. $p < .001$, two-tailed.

The statistical comparison was formulated with a dependent or correlated *t* test. Students who were low on the pretest tended to be low on the posttest, and the students who were high on the pretest tended to be high on the posttest.

Analysis of Instructional Strategies

The following strategies were implemented between the pretest and the posttest: cooperative learning groups, journals, use of manipulatives, problem solving with real-life situations, calculators, and computers. The students enjoyed working in cooperative learning groups. They viewed each activity as a team effort. A student wrote, "I have always been scared of math because it seemed so hard to do. Now with all of the fun things we do in class it is a lot easier for me to do in class and at home." Their confidence and motivation increased as they worked regularly together. Another student wrote, "I enjoyed doing all the activities with my friends and learning together. It has been easier and lots of fun. I don't mind doing my homework anymore." Collaborative and cooperative learning activities were a part of the everyday mathematics class. The students worked with peers in small groups or in pairs to satisfy the need and desire for social interaction while requiring them to be active learners. They learned to articulate what they did and did know.

At first, the students were reluctant to write in their journals because they were not confident in their ability to express themselves. However, the writing process seemed to progress daily as they gained confidence and experience, and especially when they were told that the journals would not be graded. Some of the students expressed that math was getting easier, and some said it was fun. Most of the students wrote about how much they liked math. A student wrote, "I like math better this year because of the things we get to do. It has helped me to learn more and much faster."

Most mathematics concepts were introduced by experience with manipulatives. The students viewed the learning experiences as fun. A student wrote, "I think fractions was fun because I like food and we got to eat the pizza." The classroom atmosphere was filled with excitement every time the students used manipulatives. The students referred to using manipulatives as playtime during math. They would regularly ask if we were going to play during math today. After we finished studying a skill the student would ask to work with the manipulatives again. A student wrote, "The best thing now about math is knowing we're going to have fun." The use of manipulatives also brought more meaning to the mathematics lessons, and the students' enjoyment was a pleasure to facilitate.

At the beginning of the school year, the students did not appear to enjoy attempting to work with problem solving activities. However, after teaching the students how to use the calculators in real-life situations, they seemed eager to attempt any problem that needed to be solved. The Around-The-World Vacation Unit brought many challenges to the students, but they diligently worked to stay within a budget that required many revisions. The calculators appeared to ease the stress of problem solving. A student wrote, "I liked using the travel catalogs because it helped me to learn about places I have never been to before. Now I know about these places when I get to visit them." Another student wrote, "I think using calculators has helped me to learn faster. I know it is definitely easier now and it makes me feel better about math."

The students always asked to use the calculators, even when they were doing problem solving on the computers. Their favorite calculating activity was role playing at popular eating establishments using play money. They enjoyed counting back currency. A student wrote, "Pretending we are really doing this in real life sure does make it fun. It helps me learn how to count back change and money. I will need to know this kind of math when I get a job someday." The calculators became powerful tools in the classroom.

Another powerful tool in the classroom was the computer. The students worked independently, as well as in small groups. The students experienced problem-solving, reasoning, logic, and remediation of skills on the computers.

They were always anxious to attempt any situation that the computer software presented. A student wrote, "When I first started to school, I didn't know much about computers. Now that we get to use them almost everyday I get to learn more. Computers are so much fun to play with. Not only can I have fun but I am actually learning. I want a computer." Another student wrote, "I am able to learn to use the computer now so that when I get older I will be able to get a good paying job."

CHAPTER V

Findings,Conclusions,Implications

The purpose of this study was to determine if fourth-grade students' anxiety toward mathematics could be changed by a change in instructional strategies. The instructional strategies used were based on the NCTM Standards.

Findings

At the beginning of the 1996-1997 school year, the students exhibited anxiety toward mathematics as evidenced by the Mathematics Anxiety Scale. After a change in instructional strategies, the students appeared to be more excited about mathematics. The Mathematics Anxiety Scale, administered again as a posttest, showed a significant decrease in mathematics anxiety after a change in instructional strategies based on NCTM Standards.

It is hypothesized that the decrease in anxiety toward mathematics was due in part to instructional changes. The major instructional changes were cooperative learning groups, use of manipulatives, real-life problem solving, calculators, and computers. The students enjoyed working in cooperative learning groups. The students appeared to gain confidence in working on mathematical concepts. The students were empowered to make their own decisions, to find solutions, and determine if they were right or wrong. Slavin (1991) stressed that positive effects of cooperative learning have been consistently found. Dodd (1992) recommended that working with peers in small groups or in pairs satisfies students' need and desire for social action while requiring them to be active learners.

The students active involvement with manipulatives helped them in understanding the hows and whys of mathematical concepts. A variety of materials were used throughout the mathematics program. Rowan and Bourne (1994) stressed that children's mathematics knowledge originates with their action upon objects. The most productive manipulatives were used while studying fractions. When the students manipulated objects in a set, it was easier for them to understand the true meaning of a fractional part.

It was a very exciting and meaningful environment when the students worked on the Vacation Unit. The unit was designed to engage the students in real-life problematic approaches. Pretend vacationing was a means of retaining interest in mathematics. The use of calculators seemed to enhance the students' involvement. They would choose their destination then add up their vacation package, including expenses for traveling, lodging, and food. The students had to recalculate several times to stay within their budget because they were not accustomed to such extravagant vacations. Weidemann (1995) stressed that by providing challenging problems that are relevent to our world and daily living, chances of keeping students interested in mathematics are greatly increased.

Finley (1992) noted that the less capable students were more willing to work on difficult problems and to try out different theories. The process of having correct answers and the instant gratification was a great self-esteem builder. The students boldly attempted any problem solving situation due to the aid of calculators. They regularly expressed how much fun math was with calculators as a tool.

The computers also became a powerful tool for the students in learning mathematical concepts. The students were always eager to work with the computers, even on difficult concepts. As they worked on the computer, they were challenged with a variety of problem solving situations in which they would begin to explain their thinking, give each other their opinions, and exchange ideas. Students expressed their thoughts in journals. A student wrote, "It is so much easier for me to solve problems on the computer. I understand it better." Another student wrote, "The computer tells me when I am wrong without talking out loud. If I get a problem wrong I can always figure it out for myself or the computer will tell me. It's much more fun." Cruikshank and Sheffield (1992) suggested that computers be used to teach programming, as a tool for either student of teacher, for drill and practice, to simulate real life, to give students experience in problem solving, reasoning, and logic.

Conclusions

Teachers who desire to reduce mathematics anxiety by implementing the NCTM Standards in their classrooms must first become familiar with the Standards. It will be up to the teacher to design a curriculum that has NCTM mathematics tasks, tools, and materials to enhance lessons. This will require the teacher to go beyond the textbook, and to look for a variety of activities that will enable the students to actively participate. There must be decreased attention to performing complex paper and pencil computations, memorization of rules and algorithms. Rowan and Bourne (1994) stressed that the classrooms that take the NCTM Standards seriously empower the students by enabling them to feel that they are in control of mathematics rather than the mathematics be in control of them.

Implications

The results of this study indicate that there was a significant decrease in anxiety toward mathematics when the NCTM Standards were implemented. It is hoped that the results of this study can be used to enhance mathematics education in other classrooms.

Teachers who plan to implement the Standards in their classroom need to become familiar with the recommendations of the NCTM. Teachers also need to review current literature for suggestions of what others have done. A library of instructional materials that relate to the Standards are needed to assist in implementing the Standards.

Further research needs to be conducted with a larger number of students at different grade levels and in different schools. Also, there is a need for a study to be conducted over a longer period of time to determine if there would be a greater decrease in mathematics anxiety.

Mathematics Anxiety Scale for Children

1. Getting a new math textbook
2 Reading and interpreting graphs or charts
3. Listening to another student explain a math problem
4. Watching a teacher work a mathematics problem on the chalkboard
5. Walking into a math class
6. Looking through the pages in a math book
7. Starting a new chapter in a math book
8. Thinking about math outside of class
9. Picking up a math book to begin working on a homework assignment
10. Working on a mathematical problem, such as "If I spend $3.87 at the store, how much change will I get from a $5 bill?"
11. Reading a formula in science
12. Listening to the teacher in a math class
13. Using the tables in the back of the math book
14. Being told how to intrepret mathematical statements
15. Being given a homework assignment on many difficult math problems which is due the next time
16. Thinking about a math test one day before the test
17. Doing a long division problem
18. Taking a quiz in math class
19. Getting ready to study for a math test
20. Being given a math quiz that you were not told about
21. Waiting to get a math test returned in which you expect to do well
22. Taking an important test in a math class

4-point scale
4 represents very, very nervous
3 represents very nervous
2 represents a little bit nervous
1 represents not nervous

References

Ball, D., & Schroeder, T. (1992). Improving teaching, not understanding it. Mathematics Teacher, 85, 67-72.

Bass. B.K. (1993). Teacher beliefs and the reform movement in mathematics education. Phi Delta Kappan, 77, 462-469.

Battista, M. (1994). Teacher beliefs and the reform movement in mathematics education. Phi Delta Kappan, 77, 462-469.

Blum-Anderson, J. (1992). Increasing enrollment in higher-level mathematics classes through the affective domain. School Science and Mathematics, 92, 433-436.

Borasi, R. (1994). Capitalizing on errors as springboards for injury: A teaching experiment. Jounral for Research in Mathematics, 25, 166-201.

Brush, L. (1981). Some thought for teachers on mathematics anxiety. Arithmetic Teacher, 29 (4) 37-39.

Campbell, L. & Langrall, L. (1993) Making equity a reality in the classroom, Arithmetic Teacher, 10, 110-112.

Carpenter, T.P. & Moser, J.M. (1984). The aquisition of addition and subtraction concepts in grades one through three. Journal of Research in Mathematics Education, 15, 179-202.

Cauley, K. M. & Seyfarth, J. T. (1995). Curriculum reform in middle level and high school mathematics. Bulletin, (1), 22-29.

Chiu, L. & Henry, L. (1990). Development and validation of the mathematics anxiety scale for children. Measurement and evaluation in counseling and development, 23, 121-127.

Clements, D. (1990). Constructivist learning and teaching. Arithmetic Teacher, 6, 34-36.

Clute, P. & Reyes, L. (1984). Mathematics anxiety, instructional methods and achievement in a survey course in mathematics. Journal for Research in Mathematics Education, 15, 50-58.

Cruikshank, D. & Sheffield, L. (1992) Teaching and learning elementary and middle school mathematics. New York: Macmillan.

Dodd, A. (1992). Insights from a math phobic. .Mathematics Teacher 85, 296-298.

Dossey, J. (1989). Transforming mathematics education. Educational Leadership, 31, (2), 22-24.

Fennema, E. (1977). Sex-related differences in mathematics achievement, spatial visualization and affective factors. American Educational Research Journal, 14, 51-71.

Finley, K.W. (1992). Calculators add up to math magic in the classroom. In J. T. Frey & C.R. Hirsh (Eds), Calculators in mathematics education (pp. 195-199). Reston, VA: National Council of Teachers of Mathematics.

Gravemeijer, K. (1994). Educational development and development research in mathematics education. Journal for Research in Mathematics Education, 24, 442-469.

Greenwood, D. A. (Ed.) (1992). Handbook of research on mathematics teaching and learning. New York: Macmillan Publishing Company.

Grouwns, D. A. (Ed.) (1992). Handbook of research on mathematics teaching and learning. New York: Macmillan Publishing Company.

Hauserman, C. (1992). Seeking an effective cooperative learning strategy. Contempary Education, 63(3), 185-190.

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. Jounral for Research in Mathematics Education, 21, 33-46.

Hodges, H. (1983). Learning styles: Rx for mathematics. Arithmetic Teacher, 30(7), 17-20.

Johnson, D. & Johnson, R. (1986). Effects on cooperative learning, competitive and individual learning on student achievement. Journal of Research in Development in Education, 22, 197-205.

Jong, C. & Hawley, J. (1995). Making cooperative learning groups work. Middle School Journal, 27, 45-48.

Kantowski, M. (1974). Processes involved in mathematics problem solving. PhD. Dissertation, University of Georgia.

Kennedy, L. M. (1986). A rationale. Arithmetic Teacher, 33(6), 6-7.

Krubik, S. (1980). Problem solving handbook for teachers. Boston: Allyn and Bacon.

Lappan, G. (1993). What do we have and where do we go from here? Arithmetic Teacher, 40, 534-526.

Lazarus, M. (1974). Mathematics: some personal specifics. National Elementary Principal, 53(2), 16-22.

Lindquist, M. (1993). Tides of change: Teachers at the helm. Arithmetic teacher, 41, 64-67.

Morris, J. 91981). Math Anxiety: Teaching to avoid it. Mathematics Teacher, 74, 413-417.

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

National Research Council. (1989). Everybody counts: A report to the nation on the future of mathematics education. Washington, DC: National Academy press.

Pejourhy, N. (1992). Teaching math for the 21st century. Phi Delta Kappan, (8), 76-78.

Resnick, L. (1987). Education and learning to think. Washington D.C. National Academy Press.

Reyes, L.H. (1984). Affective variables and mathematics education. The Elementary School Journal, 84, 558-580.

Rosenbaum, L. (1989). Step into problem solving with cooperative learning. Arithmetic Teacher, 77, 9-11.

Rowan, T., & Bourne, B. (1994). Thinking Mathemtics. Portsmouth, NH. Heinemann.

Schroeder, T. L. (1989). Developing understanding in mathematics via problem solving; new direction for mathematics. National Council of Teachers of Mathematics. Reston, VA.

Scott, P. (1987). Perceived use of mathematics materials. School Science and Mathematics, 87(1), 21-24.

Shann, M. H. (1976). Measuring problem solving skills and processes in elementary school children. Boston: Boston University.

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

Slavin, R. E. (1991). Synthesis of research on cooperative learning. Educational Leadership, 48(5), 71-82.

Stanic, G. & Kilpatrick, J. (1988). The growing crisis in mathematics education in the early twentieth century. Journal for Research in Mathematics, 17, 190-205.

Stenmark, J. & Hall, R. (1983). Anxiety disorder and phobias. New York: Basic Books.

Stodolsky, S. S. (1985). Telling math: Origins of math aversion and anxiety. Educational Psychologist, 20(3), 125-133.

Swetman, D.L. (1994). Fourth-grade math; The beginning of the end? Reading Improvement, 31, 173-176.

Tankersley, K. (1993). teaching math their way. Educational Leadership, 50(8), 12-13.

Tobias, S. (1976). Math Anxiety. Ms, 5(3), 56-59, 92.

Tobias, S., & Weissbrod, C. (1980). Anxiety and mathematics: An update. Harvard Educational Review, 50(1), 63-70.

Weidemann, W. (1995). problem solving in math class: Word problems were never like this. Middle School Journal, 27(1), 11-17.

Wheatley, L. & Shumway, K. (1980. Research in mathematics education. Reston, VA: National Council of Teachers of Mathematics.

Williams, V. W. (1988). Answers to questions about math anxiety. School Science and Mathematics, 88, 95-102.

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
Educational Resources Information Center (ERIC)

ERIC

SE061139

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: Reducing Mathematics Anxiety in Fourth Grade "At-Risk" Students

Author(s): Gina Gresham, Tina Sloan; Beth Vinson

Corporate Source: University of Alabama

Publication Date: Nov. 12, 1997

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic/optical media, and sold through the ERIC Document Reproduction Service (EDRS) or other ERIC vendors. Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following two options and sign at the bottom of the page.

Check here **For Level 1 Release:** Permitting reproduction in microfiche (4" x 6" film) or other ERIC archival media (e.g., electronic or optical) *and* paper copy.	The sample sticker shown below will be affixed to all Level 1 documents PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) Level 1	The sample sticker shown below will be affixed to all Level 2 documents PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN OTHER THAN PAPER COPY HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) Level 2	Check here **For Level 2 Release:** Permitting reproduction in microfiche (4" x 6" film) or other ERIC archival media (e.g., electronic or optical), but *not* in paper copy.

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but neither box is checked, documents will be processed at Level 1.

"I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic/optical media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries."

Sign here→ please

Signature: Gina Gresham

Printed Name/Position/Title: Gina Gresham

Organization/Address: 891 Higdon Rd SW Hartselle, AL 35640

Telephone: (205) 751-0052

FAX:

E-Mail Address: csloan@earthlink.net

Date: Nov. 12, 1997

(over)

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, *or*, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:

Address:

Price:

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:

Address:

V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:

ERIC Clearinghouse on Assessment and Evaluation
210 O'Boyle Hall
The Catholic University of America
Washington, DC 20064

However, if solicited by the ERIC Facility, or if making an unsolicited contribution to ERIC, return this form (and the document being contributed) to:

ERIC Processing and Reference Facility
1100 West Street, 2d Floor
Laurel, Maryland 20707-3598

Telephone: 301-497-4080
Toll Free: 800-799-3742
FAX: 301-953-0263
e-mail: ericfac@inet.ed.gov
WWW: http://ericfac.piccard.csc.com