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REDUCING MATH ANXIETY IN FEMALE ELEMENTARY TEACHERS IN A SCHOOL SERVING AFRICAN-AMERICAN STUDENTS: A STAFF DEVELOPMENT PROJECT

A Dissertation Presented

By

PERLETTER WRIGHT

Submitted to the Graduate School of the
University of Massachusetts in partial
fulfillment of the requirements for
the degree of

DOCTOR OF EDUCATION

February, 1989

School of Education

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by

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DEDICATION

The completion of this study is due to the many family members, friends, colleagues, church members ,and professors who gave me unwavering support from the very start of my odyssey to the completion of my journey.

The greatest support came from my Higher Power, God, who in His infinite wisdom paced me through each phase of this endeavor without hurt or harm. When circumstances were tough, I remembered this verse in particular from Romans 8:31, "What shall we then say to these things? If God be for us, who can be against us?"

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ABSTRACT

REDUCING MATH ANXIETY IN FEMALE ELEMENTARY TEACHERS
IN A SCHOOL SERVING AFRICAN-AMERICAN STUDENTS:
A STAFF DEVELOPMENT PROJECT

FEBRUARY 1989

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Directed by: Dr. Byrd L. Jones

This case study examined the development, implementation, and assessment of a staff development project designed to reduce discomfort related to math anxiety among experienced elementary school teachers. By following sound staff development procedures within an action research framework, the researcher tested the processes and strategies for improving schools serving African-American students without major costs or restructuring. Specifically, successful, low-cost staff development depends on voluntary participation by teachers who believe the lessons are usable in their classrooms. The detailed descriptions illustrate how general procedures and processes must be adapted to meet idiosyncratic needs and/or strengths of the staff and students.

This case study demonstrated a comprehensive cycle of school improvement activities. First, the researcher gathered information about teachers' needs and then examined a range of studies about math

anxiety and possible solutions. Seven workshops dealt with math anxiety, problem-solving strategies, special education, and computer anxiety, and the teachers responded positively to the lessons and their impact on classroom behaviors. Thus, the activities showed teachers how to gain empowerment by engaging in planned staff development.

Staff development workshops that focused on the reduction of math anxiety among elementary teachers worked because of support from administrators, the building principal, auxiliary staff, and the participants. Good staff development processes allowed 1) individual teachers who feared math to attend workshops, 2) a school-based project to involve volunteers, 3) peer-group interactions and a sharing of ideas among colleagues/administrators/experts, 4) problem-solving strategies that entailed cooperative activities, 5) activities that addressed the school's curriculum, 6) increased morale among teachers, administrators and students, and 7) professional growth of teachers.

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CHAPTER I

INTRODUCTION

Math anxiety perpetuates a cycle of poor math skills in schools among groups of individuals such as women, Blacks, and Hispanics. The negative effects of math anxiety stymy the economic and scientific contributions of these groups of individuals who are a major part of the labor force in the United States. Sustained roles as second class citizens are maintained by the lack of adequate math performance and achievement among females, Blacks, and Hispanics. Choice of careers are limited; educational opportunities reach a certain level and cease; and individual growth is hindered in achieving higher goals.

Elementary school teachers, according to research, are among the major groups of individuals that fear mathematics.[1] Recent studies indicated that it is possible for generations of students, especially young girls to have had the fear of math instilled in them from an early stage starting at the elementary level and continuing through the secondary and collegiate level, by teachers who convey the fear of mathematics.

To assist in the reduction of math anxiety among elementary teachers and thus to help improve students' performance levels, staff development projects can provide a means by which certain individual as well as group needs and concerns are met in a non-threatening and caring environment. Staff development projects have been found to enhance sustained efforts at change, to improve instructional techniques of

teachers and thus to provide for increased subject-matter knowledge of both teacher and students, to improve the educational curriculum, and to provide for overall school improvement reforms.

This study reports on the development, implementation, and evaluation of a staff development project designed to reduce math anxiety in female elementary teachers and to improve the mathematics achievement levels of students in a predominantly African-American school. The staff development project detailed in this study followed an action research approach. After reviewing relevant literature, the researcher surveyed the needs of teachers in the Theodore Roosevelt School in Roosevelt, New York, who agreed to participate in the project. Based on that input, the researcher designed and documented individual and group staff development activities. Those activities did not depend on securing additional financial resources. Participants provided on-going feedback through formative evaluations, and workshops were modified to address specific concerns.

Workshops for assisting an experienced staff of teachers in the reduction of math anxiety focused on problem-solving strategies as a means to reduce math anxiety. Teachers shared practical classroom methods that centered around enhancing both teaching and problem-solving techniques and built support groups to recognize how fears had discouraged explorations of areas beyond straightforward computations.

This project was a component of the Roosevelt/University of Massachusetts Staff Development Project. The Roosevelt/University of Massachusetts Project is a collaborative program designed to improve

schools and to increase student achievement.[2] Teachers, administrators, and other staff in Roosevelt expressed a need to grow both personally and professionally. With encouragement from Ulysses Byas, superintendent in Roosevelt from 1977 to 1987, and support from the Staff Development Concentration of the School of Education in Amherst, this program began in September 1982.

One component of ongoing staff development efforts in the district attracted potential leaders who could combine meaningful school improvement with a graduate degree program. Teachers and administrators studied characteristics of effective schools, cooperative and collaborative learning and teaching styles, and school improvement efforts that addressed identified needs in Roosevelt.[3] Through this project, staff learned to work collaboratively and supportively to implement school changes. The emphasis was on the school climate and teacher empowerment as these factors influence the culture of a school.

Despite repeated and partially successful attempts to emphasize student achievement in mathematics in the Roosevelt Public Schools, specifically at the elementary levels, test scores have remained below the national norms. Exascerbating the low achievement levels of students, there are well-established patterns of math anxiety among women and minorities who comprise the majority of the teaching staff at the elementary level in Roosevelt. The elementary teaching staff is 95 percent female and 45 percent minority.[4] Ultimately, sustained improvements will depend on the quality of instruction delivered to the students. A substantial body of literature suggests that staff develop-

ment activities focused on improving instruction within a building can foster a positive school climate and elevate teacher morale. The Rand study indicated that school climate was just as important to a project as establishing good working relationships among teachers. The project's methods and materials were enhanced and implemented by the teacher when the environment maintained a positive school climate.[5]

Statement of the Problem and Purpose

Few teachers will admit to one another, to the principal, or to themselves that they fear teaching math.[6] A fear of math results in a continuous cycle of poor teaching skills being perpetuated on the part of the instructors, inadequately prepared students, low results on standardized and statewide testing, fault-finding among teachers and low expectations of students and self. Consequently, the growth and creativity of the teacher and student are impeded in many classrooms.

William Kelly and William Tomhave concluded that if their study indicated current perceptions of elementary teachers, then experienced elementary teachers will perpetuate math anxiety in their own classrooms with young girls.[7] If another generation is to learn differently, then teachers must be helped to understand and learn of ways to help reduce their math anxiety. Change then may depend on reducing math anxiety among existing elementary teachers.[8]

Elementary schools need better instruction in mathematics especially for minority students. Teachers who experience math anxiety can learn ways of helping themselves become better teachers of math in

order to help bring about better understanding of mathematics for students. Teachers who serve minority students have an additional responsibility to overcome math avoidance and understand the reasoning, computational, conceptual, and problem-solving skills that are necessary for all students. The educational system has failed for the most part to circumvent continual failures of Blacks and Hispanics in mathematics. Yet, as Ron Edmonds and a Phi Delta Kappa study have documented, some schools serving low-income and minority neighborhoods have been effective, and students have learned basic skills.[9]

Studies have shown that negative experiences concerning the avoidance of math can take place as early as the elementary level. A recent issue of NEA Today cited some factors that influence the performance of females and minorities in the area of mathematics. The influence of significant others such as teachers and counselors was deemed to have strong positive effects on students' attitudes toward mathematics, and students asked for extra help from teachers in the area of mathematics understanding and sought encouragement from them in their studies. Other studies have shown that females tend to avoid higher forms of mathematics as do Blacks and Hispanics. Math avoidance can especially affect the career choices of women and minorities.[10]

Effective programs are needed to help poorly prepared teachers in the reduction of math anxiety. These programs should be designed to help teachers explore the reasons for their discomfort with mathematics in an effort to effect a reversal of teachers' negative attitudes. Experienced teachers, however, seldom opt for ordinary inservice courses

because the general content seldom addresses particular needs and individual concerns. A combination of small workshops based directly on needs and individualized professional growth can be responsive. If a district is paying for staff development those practices appear very costly and may become a hindrance to the implementation of the project. The voluntary program designed for this study used teaching skills, on-hand resources, and in-house personnel to carry out staff development activities.

In both academic achievement and employment, females and minorities have not achieved the degree of success that White males have in the mathematical and scientific fields. That gap started in elementary schools and it may reflect math anxiety among elementary school teachers. Grace Burton's citation of Maita Levine's work stated that "many elementary school teachers for the most part are women and are terrified of mathematics: they feel that a mathematician must either be a genius or a lunatic. This attitude, spoken or silent, can affect how young girls view the study of mathematics."[11] This statement also has strong implications for minorities as well. Unless staff development efforts can overcome math anxiety among elementary teachers, especially those serving Black and Hispanic populations, this gap is likely to perpetuate itself among their students.

Recent surveys have shown a narrowing of the gender gap in respect to the number of math-related courses females and minorities are taking at the secondary and college levels. But performance level disparities have widened for males and females in mathematics.[12] Test

results from nationwide organizations attest to the decrease in females' math scores--especially on Scholastic Aptitude Tests. Since the early 1970s, the gap between the average number of points scored by males and females has grown.[13] As a result, females have suffered in competition for major scholarship awards and later for employment in technological fields.

Although elementary teachers may devote considerable class time to computational accuracy, they can scarcely convey the excitement and utility of computation for solving real problems if their own understanding is limited.[14] Most elementary teacher-training programs have focused on two primary aspects of the mathematics curriculum for the elementary child: computation and concept development. Methods courses and textbooks have devoted attention to addition and subtraction, multiplication and division. Problem-solving skills usually require a simple algorithmic procedure or combination of procedures. Written problems seldom include extraneous details or anything other than straightforward procedures, assuming teachers and students are familiar with standard textbook problems.[15]

Elsie Moore described three levels of math competency: level one involved simple addition and the like requiring minute training; level two involved memorizing basic axioms and principles, such as how to divide fractions; and level three involved the ability to solve word problems which was true math competency. According to Darrell Bock and Elsie Moore, "Arithmetic word problems require active interplay of words and image that puts non-visualizers in which women are in the majority at a disadvantage."[16]

Basic teacher training programs for elementary teachers usually are designed to meet the needs only of the first two levels of Moore's math competency. Most elementary teachers were exposed mainly to these two levels during preservice or inservice training in arithmetic programs designed for the elementary curriculum with limited exposure to problem-solving techniques that go beyond straight-forward computation.[17]

Whether cause or effect, limited training and math anxiety are highly correlated. Research by Kelly and Tomhave with preservice elementary teachers demonstrated that over 50 percent of prospective teachers exhibited math anxiety. Sheila Tobias stated, "excessive anxiety inhibits women more than it does men. Men experience math anxiety, but it disables women more."[18] There is a need to help reduce math anxiety among women in general; however, it is imperative that elementary teachers, who have learned to fear arithmetic through their training and the mind set of American education, be helped to reduce math anxiety.

Setting

According to the 1980 Census, Roosevelt, New York, was a residential community with a small commercial district located along the main thoroughfare, Nassau Road. With only a handful of industrial firms, Roosevelt lacked a substantial tax base. Thus, schools faced a chronic struggle to keep taxes down to levels competitive with neighboring communities in Nassau County while offering teachers' salaries that were also competitive.

The statistical data from the 1980 census reported that there were approximately 15,559 residents in Roosevelt with 13,647 of them African-Americans. The community was surrounded by towns that have their own local government, police, fire, and sanitation departments, hospitals and other community support groups. However, Roosevelt did not have these services and depended on the county to meet its needs. It lacked access to major services and facilities that helped to bind a community together. Additionally, rebuilding of the commercial structures, including a new shopping mall, represented efforts aimed at community revitalization.

The high cost of housing in Roosevelt challenged both poor and middle income families to pay rent or mortgages. Many elementary students came from homes that were designed for single families (4-6 people) but are now occupied by as many as three families. An estimated 32 percent of Roosevelt's population was considered below the poverty line with an average income of $5,000 or less. Many of Roosevelt's poverty-stricken to barely surviving middle-income families lived a day-to-day existence in overcrowded conditions. An established middle-income population resided in the northeast and northwest sections of Roosevelt divided by Nassau Road. The average yearly income in that area was estimated at $49,000.

Roosevelt's public schools represented the largest organized institution in the community, and as such it bore the burden of maintaining community cohesiveness. Many residents viewed the schools as their only hope for breaking a cycle of poverty and hardships. The

school system included a pre-kindergarten program, four elementary schools that served approximately 1,983 students from grades kindergarten through sixth and one junior/senior high school that enrolled approximately 1,365 students from the seventh to the twelfth grades.

Theodore Roosevelt Elementary School was built in 1929. Prior to 1971, when the district changed to a neighborhood school system, the schools followed the Princeton Plan which designated each school in the district for a particular grade level. The Princeton Plan was short-lived in the district. In 1986-87, the school enrolled over 450 students from low-income to middle-class neighborhoods in grades kindergarten through sixth grade. The student population was approximately 98 percent Black with 2 percent of Hispanic or other ethnic background. It employed 20 classroom teachers including a math coordinator, a reading teacher, a resource teacher, a librarian, two part-time music teachers, a nurse, a part-time social worker, a part-time speech teacher, a part-time psychologist and three teacher assistants. Of the 20 classroom instructors, 12 were female and Black. The other classroom teachers were 7 White females and 1 Black male. The principal had been head administrator for 17 years, and he supported programs that enhanced both teacher and student growth.

Methodology

This study explores many facets of math anxiety and its negative hold on individuals who experience this fear. The group of

individuals observed in this study were elementary school teachers. The implementation of problem-solving techniques as a means of helping teachers to reduce their math anxiety was a major part of this study. The goals set for the project overlapped or interacted with each other. Assisting an experienced staff in the reduction of math anxiety and implementing problem-solving strategies that would benefit the staff, the students, and the overall curriculum goals of the district, would have the additional benefits of improving student achievement and performance levels in mathematics.

The activities conducted in this study were shaped by two principles of action research. One principle involved drawing on the work of others. Thus, the staff development program incorporated as many research-tested features as possible. The other principle involved collecting data both to evaluate the wisdom of past decisions and to guide the process of decision making. This researcher conducted staff development workshops which focused on female math avoidance and which focused on developing techniques that would help teachers to help themselves and others in dealing with math anxiety.

This study utilized action research procedures in the planning, implementation and assessment of workshops that incorporated group and individual activities aimed at reducing math anxiety and broadening competencies in mathematical content and problem-solving strategies. Workshops were constructed based on the needs of participating staff members as determined by the results of a survey dealing with math anxiety. (See appendix A)

Interviews were conducted as part of group and individual meetings. The workshops incorporated flexibility to allow for current and relevant needs, change in conditions or unforeseen events which might occur over the course of the project. Individual interviews were conducted in order to determine how teachers viewed their own anxieties and efforts to cope with them in their classrooms. (See appendix K).

The following steps were employed in the process by the researcher/presenter to aid both in designing workshops and the writing of this dissertation: 1) research math anxiety and its relationship to female elementary school teachers; 2) analyze the data from a district needs assessment conducted by the Roosevelt/University of Massachusetts Staff Development Project; 3) develop a needs assessment survey relating to math anxiety and teacher attitudes toward math avoidance [based on research, teacher observation, teaching experience and personal interaction of teacher-student relationships in the area of mathematics]; 4) administer the needs assessment survey to instructors in the selected school; 5) review research data gathered; and 6) develop seven workshops based on the data collected.

During 1987, the researcher presented seven workshops to participants using brainstorming activities, discussions, demonstrations, hands-on experiences, and guest speakers; reassessed participants' needs, planned and developed future workshops based on the results; instructed participants to evaluate individual workshops and the process; reported and interpreted the results of the evaluations; documented modifications in workshops; and determined implications for future research. The

process also included the support of other significant staff members who benefited the project indirectly. Without the valuable assistance of those members and the approval of the principal, this project would not have succeeded.

The study made use of formative evaluation procedures. The procedures employed were described, modified and reassessed based on ongoing evaluations of the outcomes and present needs of the participants. The initial needs assessment consisted of a survey administered to the participants to elicit their attitudes toward teacher fears of mathematics. Participants completed a questionnaire at the end of each workshop, and the workshop facilitator made necessary modifications, recommendations, and determined the content for subsequent sessions based on the feedback provided by the project participants.

Research Questions

A major focus of this study included an assessment of the planning and implementation of staff development workshops in the area of math anxiety and their effect on an experienced elementary school staff. Based on a review of literature, certain propositions established a context for these specific questions. Specifically, successful low-cost staff development depends on voluntary participation by teachers who believe the lessons learned are usable in their specific classrooms. Hence, the key questions set forth were, will participants:

1) Agree to attend math anxiety sessions on a voluntary basis?

2) Actually attend sessions?

3) Believe after attending math anxiety workshop sessions, that the information, exercises/activities will be of use to them in the reduction of math anxiety?

4) Use or further develop their problem-solving strategies as a measure of reducing their math anxiety?

5) Feel better prepared to teach problem-solving strategies?

6) Implement more problem-solving strategies in mathematics instruction?

7) Become more sensitive to the needs of students/women/minorities who experience math anxiety?

8) Improve their attitude toward mathematics?

9) Show an improvement in their teaching techniques/styles in the area of problem-solving strategies?

These specific research questions directed attention toward collecting data and feedback about the interactive processes entailed by staff development among experienced teachers in a particular setting. The detailed description presented in this case study supports how general procedures and processes must be adapted to meet idiosyncratic needs and/or strengths of staff. For instance, because the project focused attention on mathematics where few positive role models for Black women can be cited, the project struggled continually to foster a non-threatening and supportive environment. A focus on language arts skills might have found more teacher-initiated strengths to draw upon.

Significance

The significance of the study is inherent in its potential usefulness for female staff and students in reducing math anxiety. Such consequences will be important to the long-range goals of improving achievement levels in mathematics and of achieving better job prospects for women and minorities.

The staff development aspect promises that effective change can occur through the collaborative efforts of people working within a school who have subscribed to the project as a result of being actively involved in the planning and implementation phases. Any positive changes that can be achieved will be important in bringing about favorable conditions in which effective staff development can flourish in a structure allowing for continuous modification.

Based on our current understanding of staff development and school improvement projects and of schools as "loosely coupled" systems, other teachers and other school districts cannot directly impose this plan on their school setting and school. However, others can find within it suggestions, experiences and connections with their own situations on a level of reality that would be meaningful. While others cannot borrow directly from this action plan, they can borrow the context and procedures to approach school change realistically.

To help improve urban schools, teachers are needed who are willing to "teach." The word teaching encompasses many fine details. In order for an individual to be an effective teacher in the classroom setting, he or she must be adequately prepared for such a challenging

experience. Teachers can monitor the growth of both their own professional development and their students' achievements. Teachers enhance or diminish an individual's thinking process or creative ability. Teaching encompasses the whole person. Teaching can affect an individual's emotional, intellectual, and social growth. All of these things are intangible elements that affect a student's performance level and potential academic achievement.

Educators have a responsibility of imparting accurate and effective subject-matter knowledge to students. Educators must continually prepare themselves for the changes in the educational field that are the direct outcomes of changes in society. Studies have documented that prospective elementary school teachers experience math avoidance/math anxiety. Other studies have also demonstrated that there are two major groups of individuals that experience math anxiety. These groups are female students and elementary school teachers. In understanding the negative effects of math anxiety on these groups of individuals, one must seek help for those who suffer from this fear. Professional organizations and persons interested in understanding and helping to resolve this problem must research the effects of this fear on the target group--students and elementary teachers.

Staff development projects can provide a valuable service in helping to reduce math anxiety among individuals who experience this phobia. Projects can enhance the personal and professional growth of teachers, encourage a sharing of expert knowledge among colleagues and groups of other professionals, and help individual teachers to work on

deficiencies within themselves without being exposed to group or individual chastisement. Staff development projects help to incorporate subject-matter knowledge to teachers and to students and thus bring about positive attitudes in individuals for whom the project was intended and designed.

Limitations

The limitations posed in this action research study were determined by individual teacher needs, teacher willingness to implement and resolve problems dealing with his/her individual fear of mathematics, the time frame needed by each instructor to overcome his/her fears, the approaches teachers select in combatting their fears, a willingness to change from one approach to another, limited resources and the researcher's biases in the construction of the workshops.

Other limiting factors were as follows: 1) Any decision regarding the number and schedule of sessions depended on released time provided for the staff. 2) The selection of activities was contingent on the available resources. 3) Choices made concerning the workshop topics were dictated by local conditions, time frames, and personalities. And 4), follow-up studies would have to be conducted over a sufficient period of time to determine the extent to which the project affects student achievement levels in mathematics. An additional factor of this study reflects on the staff implementing a new math program for the school year 1987-1988. Also, the implementation of a new standardized test will affect any change in achievement

level, thereby affecting indirectly instructional methods used in the teaching of the mathematics curriculum by participants.

The staff development project could not yield a straight-forward cause-effect diagnosis where modifying one input yielded a specific outcome. The causes of "math anxiety" are complex. Although studies have documented a math anxiety among elementary school teachers, and it often seems intuitively obvious, the causes involve a number of possibly interconnected factors: 1) biases against females, 2) low regard of elementary teachers, and 3) expectations that elementary teachers should be equally adept at language development and general science, social studies, child development, arts and crafts, and mathematics.

Changes in math curricula--such as the "new math" reforms of the late 1960s, are difficult to implement, as documented in the first edition of Seymour Sarason's The Culture of the School and the Problem of Change (1971). Recent emphasis on computer literacy has demonstrated evidence that math skills are cumulative and related to what is taught in schools. Perhaps relation of math (as verbal problems) with science, technology, engineering and accounting, all of which have been traditional male fields in the United States, presents another barrier to change. Finally, certain patterns have been replicated through schooling. Hence, low expectations discourage active teacher/student interactions so that reduced achievement then "verifies" initial attitudes.

There remain issues about the researcher's role in initiating implementing and assessing this staff development process. As a Black female teacher (with over fifteen years experience in the school) and with responsibility as Chapter I Math Coordinator, the researcher continually balanced the possible biases of her role as active participant/observer with staff relationships that were both personally and professionally more extensive and lasting than this project. Because so few minority female elementary teachers have taken leadership for school-based processes to overcome math anxieties among teachers serving low-income and minority children, the advantages seem to outweigh any disadvantages.

As with any case study, and especially those involving participant/observers, the researcher has an obligation to reflect on biases and outcomes that affect the interactions shaped by the researcher's views and motivations. The first safeguard, of course, is to develop a self-awareness of one's own commitments and interactive patterns. Because so much of school improvement and the creation of a positive school climate relates to staff agreement around the mission of the school and high expectations for student achievement, that understanding is key for all meaningful staff development efforts.

A second safeguard against the researcher's limited perspective has revolved around a continual emphasis on the underlying process. A multitude of educational situations have shown that a curriculum designed and pushed by an evaluator can almost always demonstrate some observable positive impact, although other schools or teachers find

difficulties in replicating the curriculum or its effects. This suggests that the process of implementation may matter more than the content of the proposed innovation. Thus, the content of workshops and evaluative responses are reported, not as a proof that others could or should imitate the researcher, but in order to suggest how other teachers in other buildings might organize and implement professional development and school projects by utilizing resources and skills ordinarily available in any school and local district.

Outline of Chapters

Chapter I describes the need for a staff development study on math anxiety reduction among elementary school teachers and how to assist elementary school teachers in the reduction of this problem. Specifically, the chapter details the purpose of the study, describes the setting in which the study took place, delineates the significance of the study, explains the methodology and the development of a needs assessment survey to ascertain teacher attitude toward mathematics, denotes the limitations of the project, and outlines each of the five chapters included in the study.

Chapter II reviews selected literature surrounding female elementary teachers in relationship to teacher attitude toward mathematics, math anxiety among women, math anxiety among elementary school teachers, math anxiety among minorities, unintentional and intentional cues of math deficiency toward minorities, transferences of biases, computer anxiety and teachers, problem-solving techniques,

and staff development as a vehicle for school improvement.

Chapter III describes the surveys used to evaluate project participants' attitudes toward math anxiety and their willingness to be a part of school improvement in the implementation of this project, and it reports on the planning aspect of the study, the assembly of support, the needs assessment procedures, the examination of available resources and the workshop design.

Chapter IV details the workshops held in connection with the project. Topics include--(1) What is Math Anxiety? (2) Assisting An Experienced Staff in the Reduction of Math Anxiety. (3) What is Problem Solving? (4) Instructional Motivation, Math Anxiety and the Special Child, (6) Problem-Solving Strategies, (7) Hands-on Correlation of Problem-Solving Strategies to Newly Adopted Mathematics Textbooks, (8) Problem-Solving Strategies and High-Order Thinking Skills, and (9) Computer Anxiety and Teachers.

Chapter V chronicles the procedures employed in the study as they followed an action research approach. Much of the reporting includes data from the ongoing assessment to illustrate the opinions, as well as to gain feedback for purposes of planning future sessions. In this chapter research questions that were set forth in Chapter I are answered. The researcher documented and reported on the objectives, procedures, and activities, as well as evaluations of each session. Also reported are the results of the workshops as evaluated by the participants as well as outcomes of individual case studies from the perspective of the project

researcher. Conclusions, implications, and suggestions for modification and future research are included.

Chapter I

Notes

1 Maita Levine's Identification of Reasons Why Qualified Women Do Not Pursue Mathematical Careers cited in Grace M. Burton, "Regardless of Sex," The Mathematics Teacher 72 (April 1979): 261-270.

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CHAPTER II

REVIEW OF SELECTED LITERATURE

In American society, math anxiety seems to be prevalent among both females and minorities. Although men may experience math anxiety, many fewer men than women are disabled to the point where they avoid mathematics on a personal or professional level. Studies have shown that females and minorities avoid academic contact with higher level math courses. A fear of mathematics influences their career choices, thereby affecting their future earning power. Math anxiety has limited personal and professional goals and growth for women and for Black and Hispanic Americans. Some responsibility for this handicapping condition rests with elementary teachers, especially those serving minority students.

The following review of the selected literature in math anxiety covers studies related to 1) attitudes of elementary teachers toward mathematics, 2) math anxiety among women, 3) math anxiety and female elementary teachers, 4) math anxiety and minorities, 5) computer anxiety as an extension of math anxiety, 6) problem-solving techniques, 7) school change, and 8) staff development.

Teacher Attitudes Toward Mathematics

Attitudes are mental positions or feelings with regard to an object or idea. Negative attitudes involve a denial or refusal on the part of an individual to consider an object, idea, or situation

affirmatively. Families, friends, peer groups, and communities—including organizations such as churches, professional groups, and schools—shape an individual's attitudes. Professional groups such as lawyers, doctors, social workers, and teachers bring to their professional roles certain attitudes formed by their environment and personal experiences. Ordinarily, people learn to like or dislike activities based on their schooling and their associations.

Ruth A. Meyers reported that the most important factor embedded in the causes of students' negative responses to mathematics was the attitude of teachers, with the most insecure teachers dreading or disliking the subject.[1] For them, mathematics was largely a matter of computation and rote memory. Because teachers had difficulties camouflaging their aversion, they often conveyed their negativism to students. Conversely, secure and confident teachers exhibited the interest and enthusiasm necessary to reinforce positive attitudes toward mathematics.

Marilyn Suydam listed several suggestions to help teachers reinforce positive attitudes of students toward mathematics, including demonstrating a fondness for the subject and adopting meaningful methods of teaching.[2] Students identified subject areas that teachers favored, and they responded to their instructor's enthusiasm. These young students were directly influenced by the teacher's attitude toward the subject and usually emulated their positive or negative attitude.

In a study of female elementary teachers, Meyers documented that teachers' attitudes toward certain subject areas such as math affect students' attitudes toward math. More than half the teachers surveyed disliked math, and Meyers attributed their aversion to the fact that teachers are inadequately prepared in mathematical content and methodologies. While teachers complained about their own condition, they felt competent to teach mathematics to elementary students, and therefore, were unwilling to change their attitudes.[3] Stanley Kogelman and Joseph Warren warned that negative attitudes toward mathematics may be transmitted by others besides teachers, including parents or siblings in the household.[4]

Math Anxiety Among Women

Math anxiety among women has been clearly influenced by social values, mores, and beliefs. From a time when most families lived on farms through industrialization, to the technological and service era of the 1980s, women have helped build a solid economic, social , and academic basis for this country but typically in subordinate jobs. Women have been stereotyped in contexts that involved sustaining relationships rather than constructing, managing and making hard-nosed decisions. Current estimates that 64 percent of the new employees from 1985 to 2000 will be female suggest that the national economy cannot afford limitations placed on almost two-thirds of its new workforce.[5]

Academic studies by mathematicians and others interested in female avoidance of math have shown many causes for the negative

attitudes of females toward mathematics. For example, Sheila Tobias reported that attitudes were formed by experiences and expectations. In our society, males are assumed to have an affinity for mathematics. According to Stanley Kogelman and Joseph Warren, Americans typically assume that males will have the primary career and handle the finances. Meanwhile, women have been sanctioned by society, parents, and significant others to avoid mathematics and to pursue roles that help keep the family and society intact. Echoing this view, Tobias asserted that the female gender has been programmed by society to assume and accept fixed role models.[6] Some mathematics instructors have imposed this belief on their students.

In a study conducted by Mike Dellens at the University of Austin, methods were formulated that developed ways of dealing with math anxiety. In this particular study, the main goal was to discover ways in which a learning center could help people who were described as "math anxious."[7] Research related to this study showed that the beginning of math anxiety occurred before a student entered college for the majority of individuals. The Learning Center began to deal with this problem through the following outlets:

> (1) Offering one hour focus groups covering study techniques for entering college-level mathematics and science courses; (2) Offering a non-credit basic mathematics review class; (3) Sponsoring an informal group dealing with math anxiety; (4) Creating math anxiety desensitization tapes and making them available to a self-help lab; and (5) Development of a positive linkage with the faculty of the mathematics department.[8]

There is no single isolated cause, but rather a combination of various factors working in conjunction with bad experiences which produce

"math anxiety" among some individuals and not others.

Lack of positive role models, feminine stereotypes, parental and peer influences, lack of encouragement from significant others, and different learning styles represent some of the factors that reinforce a fear of mathematics in females. As they mature, girls have assumed a less competitive posture in academic arenas. Mathematics performance declines among females between the ages of ten to fifteen. Most negative experiences with mathematics occur between seventh and tenth grade, although some students may have had painful experiences in elementary school.[9]

In elementary school, female students often out-perform males in computational skills. They make fewer careless errors. Males seem better able to visualize problem-solving procedures from verbal descriptions. Spatial visualization has been deemed as one of the most important skills necessary to the achievement of success in solving higher order math problems.[10]

Current research studies have reinforced an emphasis on visual or spatial perception as a harbinger for females in the area of mathematics. Tobias's exploration of spatial visualization impediment concerning females delved into the topic of right/left brain specialization. She pointed out that researchers have attempted to provide evidence that because girls mature into left brain specialization earlier than boys, the growth of the spatial capabilities needed to perform higher levels of mathematical skill is hindered.[11] However, a recent study reports that thirteen year

old girls actually performed better than boys in spatial visualization tasks and in computation tasks.[12]

Math Anxiety and Female Elementary Teachers

Early intervention in schools at the elementary level is seen as setting the foundation for higher math achievement at the high school level.[13] Thus, programs and curriculums at the elementary level should have as one of their primary goals the teaching of math as a firm foundation for later student success in higher forms of math and not just mastering the basic operations.

Americans believe in education as a means of developing the whole person and promoting unity among its citizenry. As such, the education of the masses has to have some formal beginning point. Usually at the nursery through the elementary years children are taught by individuals who have formally prepared themselves to become instructors and impart some of their subject-matter knowledge and expertise to their students. Who are these teachers? They are usually women. Research in recent years has mainly focused its time and energy on math anxiety and women, math anxiety and girls. Seldom has research delved into the problem of math anxiety and its existence among elementary teachers.

Most elementary teachers are female, and some of them bring into the profession a fear of math. In a recent study, a principal opined that "only a relatively few elementary teachers have an adequate, much yet solid background in mathematics."[14] Teachers are less

comfortable organizing curriculum about which they are inadequately prepared. Knowing that one is not fully prepared to guide or to teach students in any subject matter area is enough to produce anxiety itself. Also, not catching on as quickly to new methods or concepts in the field of mathematics can produce anxiety among veteran teachers. Seymour Sarason cited the new math of the 1960s as a case in point of teacher rejection of new innovations. Memories of unpleasant experiences lead to avoidance, and thus limit opportunities for a different kind of experience. Kogelman and Warren concluded that difficulties in teaching mathematics might be partially traumatic when they reinforced and perpetuated earlier phobias. As a result, many teachers have a long-term hatred and avoidance of math. William Tomhave and William Kelly's study on prospective elementary teachers demonstrated that those projected teachers experienced a great deal of math anxiety/math avoidance. If this is the case now, then experienced elementary teachers may perpetuate the cycle of math anxiety among the young girls in their own instructional setting.[15]

Do females choose elementary education as a major because it does not require higher mathematics prerequisites to get into a teaching program or college in general? Tobias cited Lucy Sell's Berkeley study of the entering class of 1973, and noted that 92 percent of the women in the first-year class were ineligible to take calculus or intermediate level statistics courses. Moreover, all but five of the twenty majors at Berkeley in the early 1970s required calculus or statistics. The women opted to enter the remaining five fields—

humanities, music, social work, elementary education, guidance and counseling. Sex-role socialization and math avoidance reinforced each other.[16]

Kelly and Tomhave recommended that prospective elementary teachers who were found to be math anxious receive help from support groups directed by professional mathematics teachers who understand math anxiety and some of its causes. Math anxious teachers should be encouraged to trace the beginning of their fears and to work at conquering them through the exposure to mathematics concepts and processes in an environment that does not threaten them.[17]

Taking remedial math courses was not one of the suggestions given by Tobias because the problem itself is not that simple to solve. Many generations of students have been indoctrinated by such beliefs as, "math is a masculine characteristic; women are not supposed to do well in math, and that an individual that performs well in math must possess a mathematical mind."[18] These features contribute to the math anxiety problem.

In a recent study on math improvement, the author noted that, "Attitudes toward teaching in general, and teaching math in particular, will have to change dramatically before schools will have the benefit of really good math instruction."[19] Portia Elliott recommended that teachers of mathematics restructure the curriculum in order to stimulate more right brain involvement, as this hemisphere deals with creativity, imagination, and other aptitudes and/or skills necessary for advanced mathematics. Elementary school math curriculums generally focus on

computational skills mainly engaging left brain activity, only partially using the brain's capacity for more process thinking.

Eliott recommended that teachers utilize some of the suggestions offered by the National Council of Mathematics for enhancing the function of right brain specialization. Specifically, those skills were "applying mathematics to everyday situations, problem solving, altering results based on their reasonableness, prediction, graphing, estimation, computation, geometry, measurement, and computer literacy."[20]

A variety of teaching styles and techniques help develop all of a student's math interests and skills. Shaping and molding, teaching an individual to judge for himself or herself, to evaluate, and to process are powerful skills that an individual will continue to use during his or her lifetime in various settings. Elliott cited the advantages of involving the child in higher order mathematics skills to include bringing about an integrated approach to learning and fostering all elements related to the total math experience such as intuition, creativity, imagination, convergent, and divergent thinking.[21]

Dealing with the whole child requires involving students in higher forms of problem-solving skills and strategies. Marilyn Burns reported that elementary grade children spend an estimated 90 percent of their school mathematics time on paper and pencil computation practice.[22] Students' success with computation skills often camouflaged a lack of understanding and reasoning skills. Educators have not helped students develop higher level cognitive skills and understanding beyond rote memory learning.

Burns argued that teaching priorities and procedures must change. She reasoned that teachers dealt with computational skills because 1) no one pushes for understanding to be taught, 2) the pressure of standardized tests, and 3) not all teachers understand the differences between teaching procedures and teaching reasoning in arithmetic, emphasizing right answers rather than algorithmic reasoning. While teachers are proficient with the computational procedures for solving numerical problems, they often do not understand the reasoning behind them. As Burns noted, the implication is that it is impossible for teachers to teach effectively what they do not clearly understand themselves.[23]

Mary Ryczek has suggested that the curriculum itself and the delivery system have great impact on the development of higher level mathematics skills.[24] With the emphasis on stronger math skills for all students, many of our schools still fall short of higher achievement for students in the area of mathematics. Curriculums have been revamped--technological tools have been added, and more inservice teacher training in mathematics have been implemented. Professional organizations and institutions of higher learning, as well as state agencies, have assisted local school districts in implementing and setting in place effective programs and curriculums with the expected outcome of helping to raise student achievement in the mathematics areas.

Math Anxieties and Minorities

Math anxiety does not distinguish between an individual's race, gender, nationality or economic background. Most research has documented math anxiety itself but not math anxiety and minorities in particular. Minority students experience math anxiety the same as their White counterparts as discovered by a group of researchers at Bronx Community College. Minority students there were found to be deficient in basic arithmetic skills and algebra. Minority students were stressed by their weak mathematics performances in basic skills areas. Indeed, minority students recognized that the concepts and ideas in the remedial arithmetic class replicated the curriculum being taught to their children at the elementary level.

Desiring to see a change and to help the minority students at Bronx Community College, planned intervention sought to help minority students overcome their math anxiety. Math anxiety workshops were scheduled to focus on student attitudes to aid them in the reduction of this fear. Techniques applied were the same as Kogelman and Warren used with White middle-class students. An outcome of the workshops helped the minority students to realize that they could control their mathematics performance. The workshops also increased the confidence levels of minority students in mathematics and other aspects of their lives.[25]

Orr's Twice as Less study, described a group of minority students' deficiencies rather than differences that were interfering with math performance for the majority of students attending Hawthorne, a private school in Washington, D.C. Again, the problem is replicated with the students who had entered

Hawthorne poorly prepared or who had experienced difficulties in their previous schooling. Various teaching approaches that were successful in the past had no effect on improving student math performance in the algebra area. Orr's study of the students' work indicated underlying difficulties in the language the students spoke.

Teachers discern student performances inside academic settings, and they either enhance or diminish the performance level of students. Typically, minority students have not been encouraged, praised for positive academic performance, or recognized as being capable of achieving good academic performance. Teacher judgment of minority student performances is based on low expectations, cultural, racial, or gender biases. In Leacock's study of middle-income and lower-income White and Black school settings, the following is stated:

> What we have been trying to reveal is the way a pervasive atmosphere, stemming from the very structure of our society expressed in the organization of the school system and embodied the teacher's assumptions about different groups of children, adversely affects the teacher-student relationship and the teaching function. Of the many ways that doubtless exist, we have explored three which have made themselves sharply evident in our material: (1) derogation of children through negative evaluation of their work; (2) negation of the children through failure to respect contributions offered from their own experience; and (3) relating to the children in ways that prepare them for subordinate social roles in which they are not expected to show initiative or take responsibility.26

Teacher expectations of students are critical in the educational life of a student. Some teachers intentionally demean and criticize the performance and achievements of minorities. Others are complacent, caring mainly about their salaries. Some teachers who find themselves instructors of Blacks or minority groups have a stereotypical attitude

about the limited abilities and performance levels for these groups. Some teachers avoid critical diagnostic evaluation of where their students are in terms of subject-matter knowledge and thus have no basis for determining how to meet the needs of the class as a whole.

Different treatments of groups of students and different expectation levels for math have affected achievement levels for both individual students and major groups. Patricia Campbell, in her report to Phi Delta Kappa, urged educators to reject different treatment of groups and encouraged them to learn more about the negative influences that impact on female and minority students and ways to help negate these influences.[27]

Encouragement comes in many forms and styles among the Black culture. Blacks tend to give a lot of verbal encouragement to each other. For example, when a student has performed well in a particular test, that student might hear a Black teacher say "That was bad!" [meaning that was very good]. Also, a student might be given encouragement via a hug or a wink of an eye--this says to the student that his/her performance was on target. However, Maxine Clark and Diane Jones reported that Black females do not receive minimally the same kind of academic encouragement that Whites of both sexes experience.

Research stated that the course experiences of Blacks versus Whites played a vital part in determining respective performance levels. Clark and Jones noted the general consensus that Blacks, females, and disadvantaged students do not achieve at the same levels in science and

mathematics as do White middle class male students. However, as Clark and Jones suggested, race and sex differences in mathematics achievement could be eliminated by encouraqinq both Black females and males, and White females to enroll in appropriate math classes.[28] Blacks and other minority qroups should take more mathematics and science related courses at the secondary level, and that would only touch the tip of the iceberg. Campbell wrote that: "controllinq for the number of mathematics courses taken does not eliminate ethnic and sex differences in mathematics achievement, but it does siqnificantly reduce them."[29]

After Blacks and other minorities have access to these hiqher forms of math and science related courses--what is actually taught should be the concern of these students and those who teach the mathematics and science content areas. Is the content relevant to the needs of the student? Will those courses enable minority students to achieve access into colleqe level fields that require a strong mathematical and scientific backqround? Is the teacher choosinq to teach other than relevant topics or skills needed for such placement in colleqe level courses? The title of a course may be the same from place to place, but the content itself and the delivery of the subject matter may be different.

According to an Institute for Educational Leadership Study, participation and performance of many minority and female youngsters in mathematics began to decline as early as fourth grade. Furthermore,

minorities and women tended not to enroll in advanced secondary school mathematics classes. Performance by race denoted that Asian students out-performed Whites, with both outperforming Hispanics, who outperformed Blacks.[30]

Vicky Lytle asked "why do girls and minority students turn in weaker mathematics performance than White males?" Several reasons were suggested. First, attitudes are critical. Low achievement among women and minorities may result from their believing that mathematics is a White male domain. Second, the influences of "significant others" cannot be overstated. Teachers and counselors often positively affect students' attitudes toward mathematics. Students cited the need for teachers who offer extra help, explain things carefully, and encourage their studies. Third, minority and female students often are not encouraged at an early age to persist in the face of conflict—a prerequisite for success in science and mathematics. Fourth, students' perception of the utility of mathematics may be off-base. Minority students and girls are less likely to understand "how" mathematics will be useful in their future jobs or post-secondary schooling. Fifth, teachers, counselors, or parents seldom encouraged minority and female students to follow science related career paths. Sixth, standardized

test data may be misused in predicting achievement and assessing ability, resulting in many minority students being tracked into classes for which teachers have low expectations.[31]

America's minorities, especially Blacks and Hispanics, have struggled to obtain equity in the field of mathematics. Although women comprise a bare majority of Americans, they represent a special category in terms of affirmative action in many occupations that have previously discriminated against women. The opportunity to become scholars of mathematics has eluded Blacks and other minorities, who are faced with overt and covert discrimination within higher education. The impact of discrimination in education permeates all areas of learning, filtering down from administrative heads, to instructors, parents and students. Schools themselves can be considered a cause and a transmitter, not only of racial discrimination, but also of gender discrimination. Historically, schools have offered White males more options in an environment that is conducive to their needs while females and members of minority groups sought their education in institutions that were at their best apathetic and at their worst antagonistic toward them.[32]

Women and members of minority groups learn that schools are neither responsive nor sensitive to their concerns, their lives, or their culture. Schools were established to enhance and prepare White males to enter public life, and they continue to promote White male images. This

situation is reflected in the way schools are structured beginning with the goals of educational systems, to compositions of schools, and instructional and curriculum materials.[33]

Interaction denotes a mutual or reciprocal action or influence; however, many Blacks and minorities have experienced instruction that intentionally isolated them from positive interactions between teacher and student, or among students. Teachers transmit this isolation as well as other students. Academic isolation is another vehicle by which schools help to undermine academic success among minority students. Social, instructional, and academic isolation are all forms of intentional biases against minority students.

Keith Geiger suggested that the relationship of teacher-student interaction should be looked at to include all of the students, not just the ones that come up with a correct response and at a faster rate than the rest of the class. He suggested some remedies. Try to get full participation of students, not just from the select few. Teachers need to incorporate more "wait time" into their mathematics classes, which research has shown leads to better responses from students. Manipulatives can be adapted for all types of students from the visually perceptive to the highly kinesthetic learner. Review mathematics textbooks that contain the biases of predominately White male authors. Develop methods that relate to the varied racial, ethnic, and gender make-up of classes, and create and adapt word problems that are nonsexist and culturally relevant.[34]

Studies have shown that Blacks in particular tend to learn better in a socially interactive environment.[35] Many of the teachers,

however, are unfamiliar with their learning styles or cultural background. Teachers in general, as indicated by research, tend to bring into their classroom cultural biases and teaching styles from their previous educational environment and use this as a basis for teaching Black students.[36] Jones and Clark stated that Blacks are treated differently in classes because teachers do not expect intellectual competence in Black students.

Some instructors intentionally fail Black students or decrease their grades even though they are capable of handling the math curriculum as well as others. This crippling of the Black student is done out of pure prejudice which is really a way of teachers saying that they do not like themselves or the teaching environment.[37] Schools have perpetuated and instigated misnomers toward Blacks at all levels. These levels range from the post-graduate level and filter down to the elementary and pre-nursery levels. Such biases are continually reported by parents and students themselves. Some instructors embarrass students in front of the class--especially if the student was not capable of handling the problem at that time and noting the student's ethnic background by saying, "you West Indians can't do this type of problem." Some teachers fail almost the entire class of students and require most of the students to attend summer school in order to pass a required course. Others associate one's math ability with an individual's race, gender, or socio-economic background. Some teachers exhibit a complacent or negative attitude toward students' inquiries.

Racial and gender biases are inherent in some programs designed for teacher growth and enrichment. Some teachers have commented that workshops designed for elementary mathematics teachers have a negative tone. Teachers found that some of these workshops also purveyed prejudices among the teaching profession. The researcher has also experienced each of these types of biases in the classroom and workshop setting. This researcher shared with the group personal and professional experiences regarding teacher biases in educational settings. When discussing some of the overt and covert things said and done to participants, the following comments were noted:

1) seating arranged so as to isolate groups according to racial background,

2) workshop leaders highlighted the more intellectual responses,

3) intentional downplaying of minority participation,

4) questioning a minority's right to be a participant—even though the program was funded by the state for all elementary teachers,

5) downplaying questions when minority participants asked: "How could a particular concept or technique be applied for the "at risk" student and not just for the "talented and gifted," and

6) responding to the participant who offered a quick and correct response—when other participants needed time to digest the information.

Computer Anxiety an Extension of Math Anxiety

In the 1980s, the United States experienced a rapid increase in computers. Computers are used by adults in the workplace, students in schools and various organizations such as hospitals, fire departments, and police departments. Computerized typewriters, televisions, car components school attendance records and a host of other products

abound. Current literature on teachers' use of computers reported that 85 percent of United States elementary schools have purchased one or more computers for instructional purposes. However, findings raise questions about how effectively these computers are being used. Despite increased computer purchases, only about 25 percent of the teachers in some schools reported that they used computers on a regular basis. More discouragingly, Henry Becker reported on a lack of teacher expertise concerning computers--only one in ten elementary teachers thought of themselves as experts.[38]

Other studies have associated math anxiety with computer anxiety because computers are viewed as an extension of the mathematics curriculum in general. Again, research has focused on computer anxiety's affect on females. Only 10 percent of elementary teachers use computers on a regular basis and perhaps once a week or once a month. Many questions can be posed from this study as well as others. Questions such as: 1) Is the lack of computer use by elementary teachers a result of computer anxiety? 2) Is the lack of proper training/preparation a contributing factor in the discomfort that teachers may feel in the utilization of this new technology? Furthermore, other studies suggested that a computer gap will manifest itself in the form of sophisticated technology and unsophisticated teachers. Following a pattern of those who are math anxious, they may continue using the few skills they know but never try newer and potentially more powerful applications. Also, teachers may become overwhelmed, and teacher burn-out may follow from their discontinued involvement with computers.[39]

Individuals are introduced to new technology via their jobs or for personal/professional growth. Microcomputers made a big splash on the American school scene in the early 1980s, and they have become a major component of the instructional curriculum in some areas. Yet few teachers had any prior training or preparation for this new instructional tool. Few teachers knew how microcomputers could be utilized in the school-based curriculum other than for practice review work by students. How then were most instructors introduced to computers? Some were exposed to computers through administrative intervention. Others through a desire for professional and personal growth, and still others as part of district-wide inservice workshops.[40]

When teachers have applied this new technology as an extension of their teaching expertise, they have created a power source for their students as well as for themselves. However, when teachers have exhibited computer anxiety they have adversely disabled themselves as well as their sudents. Computer literacy has been especially lacking among elementary teachers serving low-income and minority neighborhoods.

Time and practice are two components for an individual's learning of new ideas or skills. In order to become familiar with a new idea or skill, appropriate training is also essential to the professional life of a teacher. Research by Clarice Gressard and Brenda Loyd suggested that the more computer experience one has the more computer confidence is built up and computer attitude improves. Gressard and Loyd applied those concepts to a study of three groups. The three groups were composed of junior and senior high schoolers, a small group of liberal

arts students, and students from a community college.[41] All these groups benefited in direct proportion to the amount of time they were exposed to computers.

Problem-Solving Techniques

Advocates for the improvement in math achievement levels and performances of students have concentrated on problem-solving skills. Problem-solving skills refer to those skills that require higher order thinking on the part of an individual. Two points continually appear in educational research on this topic. First, males perform well in this area of learning. Second, females perform less well than males do in this area of learning.

Research related to the male dominance of this area heralds many of their advantages, such as (1) game playing—boys are encouraged to compete both physically and mentally; (2) risk-taking—boys are encouraged to try new approaches; (3) visual perceptions encourage seeing relationships through the toys and games characteristic of boys starting from the infancy stage; (4) schools remediate or intervene with the deficiency found in males in regard to verbal and written capabilities at an early stage; (5) once males lock into the verbal and written domains of learning, they usually connect this with mathematical aptitude and attitude and succeed in other disciplines that require a background preparation for math and science; (6) males excel in timed tests and instructional games, and (7) males' verbal aggression works to their advantage more than females.

Females seem to take the brunt of many of the studies concerning poor performances of American students. However, research studies are now questioning teacher attitudes and teaching styles to help resolve some of the problems that are plaguing the female gender of this nation in relation to the math and science fields. Research recently has focused on the factors affecting the performance of females in the scope of problem-solving abilities. Some questions reflect on the methods and teaching styles of instructors, the interaction of teacher and student, and parent involvement in the initial differentiation of sex-role attitudes.

Ursula Casanova stressed that a balance of interaction time should be viewed by the teacher to see if she/he is contributing to the low performance of girls in mathematics achievement. Casanova suggested that 1) teachers may need to vary their teaching styles, 2) teachers should set aside days for cooperative team activities, which research has found to be more advantageous to girls, and 3) praise seems to motivate females more than males.[42]

Studies suggested that teachers generally view problem-solving in a narrow perspective. Generally students are given specific kinds of tasks to perform in relation to the disciplines of mathematics, science, and some social studies courses. Robert J. Marzano and others cited Frederiksen's observation of math instruction in problem solving with an emphasis on well-structured problems:

> . . . the kind of problem which is clearly presented with all the information needed at hand and with an appropriate algorithm available that generates a correct answer, such as long-division, areas of triangles, Ohm's law, and linear equations."[43]

Orr's mode of operation in helping her students to resolve problems with quantitative relationships utilized what she called the "divided page technique." The divided page technique involved the students with higher order thinking skills. The technique required the students to discuss in written form the steps used to find a solution. This approach helped the students to analyze each component of the problem, enhanced their thinking process, and increased their awareness of the importance of words in understanding concepts and relationships in mathematics. This approach aided the teachers in understanding how the students were thinking and connecting relationships.[44]

School Change

As Sarason described educational change in American society, he emphasized that educational change is not independent of other institutional or social changes. Cultural determinants affect educational changes. To alter or make over an organized institution usually results in the same kind of implementation, processes, and outcomes associated with efforts at change. Sarason noted that from the outset of teacher training programs, elementary teachers were thought to be inferior. "Normal" schools were considered just a few steps above secondary schools. The intellectual and academic tone that sets a profession apart from others was not formally grounded in relationship to schools that developed training programs for teachers.[45]

Other studies focused attempts at educational change on individual school districts. David Neale and others stated that even

within the same school district individual schools develop their own history, traditions, and ways of functioning. Each school is a human community with its own distinct culture. Attempts at educational reform usually fail because reformers ignore the uniqueness of individual schools. For this reason, innovations must be adopted and adapted to each local site and its climate.[46]

Teacher training programs can introduce new approaches, methods and materials. Neale and others cited many variables for consideration for implementating effective teacher preparation programs, such as characteristics of the local school site, its size, the community, parents, students, teachers, financial resources, and culture.

Teachers and administrators must be directly and continuously involved in any process of school improvement. Without their support important changes most likely will not occur. These key role models must revamp their own skills, habits, attitudes, and relationships if the school organization is to change. Neale and others stated that there must be a willingness to seek and to accept help from others, whether peers, colleagues in other school districts, or state education departments. Implementing change must come from the reassignment of existing staff and in changes made by staff members themselves. The focus must be on changes in the duties, skills, and relationships of existing staff members.[47]

In any effort at change, there is a desire to be successful and to see an idea or program followed through by the ones who implemented it, or for whom it was designed. Evidence exists that local change

efforts produce desired change in pupils and that dramatic changes are attainable through systematic and conscious efforts at improvements. Local schools provide optimal units for educational change. John Goodlad adopted this primary change strategy principal:

> The optimal unit for educational change is the single school with its pupils, teachers, principal--those who live there every day--as primary participants. The interactions of these people, the language they use, the traditions they uphold, the beliefs to which they subscribe, and so forth, make up the culture of the school.48

Russia's launching of Sputnik in 1957 raised self doubts about America's educational system. Sarason stated that one reaction was that our educational system was not training enough scientists and perhaps more important, that its teaching techniques and curricula were effectively extinguishing student interest in science and scientific careers. Prior to 1957 many educators had urged reform and upgrading of the mathematics and science curriculum. A number of individuals and groups had voiced dissatisfaction with the teaching of mathematics. University professors had worked on new math and a more hands-on science curriculum (SCIS).[49]

Sarason explained that those who sought change in content and techniques did not realize that they would be involved in a problem of institutional change.[50] Apparently, they thought better ideas would simply gain converts. The format used by the change agents involved developing, testing, and revising a new curriculum for mathematics. Along with these basic changes, teacher's manuals would be undergoing a similar process, and training and retraining institutes

for teachers and other school personnel would be developed.

The curriculum was designed as a guideline for teachers, administrators, parents, and state educational agencies without much concern for teacher participation or willingness to use a new approach. Sarason described teacher/pupil/curriculum interactions in behavioral terms:

> 1) The relation between teacher and pupil is characteristically one in which the pupils ask very few questions.
>
> 2) The relation between teacher and pupil is characteristically one in which teachers ask questions and the pupil gives an answer.
>
> 3) It is extremely difficult for a child in school to state that he does not know something without such a statement being viewed by him and others as stupidity.
>
> 4) It is extremely difficult for a teacher to state to the principal, other teachers, or supervisors that she does not understand something or that in certain respects her teaching is not getting over to pupils.
>
> 5) The contact between teacher and supervisor is infrequent, rarely involved any sustained and direct observation of the teacher, and is usually unsatisfactory.
>
> 6) One of the most frequent complaints of teachers was that the school culture forces them to adhere to a curriculum from which they do not feel free to deviate, and as a result, they do not feel they can, as one teacher noted, "use [their] own heads."
>
> 7) One of the most frequent complaints of supervisors or principals was that too many teachers are not creative or innovative, but adhere slavishly to the curriculum despite pleas emphasizing freedom.50

Sarason's view of teacher-student interaction noted that the taught curriculum is most likely teacher-centered in respect to feedback or questioning of students' subject-matter knowledge. Student-centered inquiry is seldom the norm. Research has suggested that it is

the very nature of schooling itself and not the subject-matter that sets limitations on higher order thinking skills.

If the behavioral regularities are consistent with Sarason's view of teacher-student relations, then very little higher order thinking is transmitted to the student via the taught curriculum. Then teachers must utilize thinking skills that enhance students' critical/creative capacities. This preparation aids the student in mastering more than basic algorithmic procedures in the derivation of "right answers." The capacity to solve problems is vital to human survival. The everyday textbook problems set limitations on students' ability to deal with real life situations. Research has suggested that "the problems of the real world are "fuzzy" and "ill-structured" and that problems can be classified into two broad categories, well-defined and ill-defined, and advocated that students receive practice in both types."[53]

The National Science Board Commission Pre-College Education in Mathematics, Science, and Technology stated in its report, Educating Americans for the 21st Century that:

> we must return to basics, but the basics of the 21st Century are not only reading, writing, and arithmetic. They include communication and higher problem-solving skills, and scientific and technological literacy—the thinking tools that allow us to understand the technological world around us. . . Development of students' capacities for problem-solving and critical thinking in all areas of learning is presented as a fundamental goal.[54]

Ronald Havelock's Problem Solving Orientation is part of a three principal strategy plan for innovation in education. The Problem Solving Strategy applies to individuals in groups and focused on the problem-solving process of the user. This strategy began with a need

or problem of the user who sought outside resources in diagnosing problems, designing solutions and applying solutions. Outside consultants or change agents were often used in this approach.[55]

Havelock's guide to the roles of the change agent had several stages: 1) Building a relationship—This step involved the process of establishing a good relationship between the change agent and the client, or user. Havelock's description of what good relationships consisted of were—reciprocity, openness to new ideas, realistic expectations, clarity, equal power, low threat, and willingness to confront differences; 2) Diagnosis—The change agent helped the client to identify problems and opportunities with special attention to understanding the client as a system; 3) Acquiring relevant resources—A most important step in this process was getting information and other resources related to each step of the client's change process; 4) Choosing a solution—This step included developing implications from research to generate a number of solution ideas. This is followed by a period of feasibility testing and adaptation of promising solutions to the local situation; and 5) Gaining acceptance—Clients would accept new practices gradually.[56]

Staff Development

Traditionally, inservice has usually involved a lecture type format to introduce new ideas or embellish old ones. Little interactive effort was placed on participants' involvement in the process. Recent research recommended that collaborative or cooperative approaches be

utilized to enhance participants' involvement. Approaches vary according to the need, time frame, and audience for which the staff development workshop is designed.

Studies that addressed staff development procedures made note of the importance of including staff members in the decision-making process during the creation, implementation and evaluation process of staff development. Staff development took the posture that there is desire for change. Change took in two natures, first individualistic and the second organizational.[57]

There was no set guideline or blueprint that could be utilized to make change happen or staff development successful. Flexibility was an attribute of staff development procedures and the process. Flexibility was a quality that enabled staff development processes to be addressed which involved meeting the needs of individuals and the organization in an ongoing manner. Successful staff development included a number of factors related to the local school site. For successful staff development projects, the following are true:

1) Successful implementation was dependent upon the organizational climate.

2) The leadership of the school--active support of the principal more than likely provided for project success and the continuation of the program.

3) Implementation strategies provided staff with new skills and information.

4) Extensive teacher participation was necessary to bring about change and teacher sense of "ownership."

5) Continuation of the project helped to maintain changes in teacher practices.

6) Financial factors were less important than district and school-site organizational factors.

7) Collaborative planning by all members of the project was necessary for both short-term and long-term success of a change effort.

8) The more effort required of the teacher by the project served to enhance teacher professionalism.

9) School based staff development provided easier teacher accessibility to the program and more teacher involvement.

There is still grave concern among the professional, scientific, and technological organizations as to the effects of math anxiety on women, the lack of good role models, the relatively small number of women and minorities entering into the technological fields, and the overall performance of our nation's students in math and science related courses. Because of this grave concern many organizations and institutions of higher learning have organized and implemented many programs to draw women and minorities into the math-and-science related fields. The "Equals Project" at Berkeley was designed to help educators increase the participation of girls and women in school mathematics courses. Its primary goal was to increase educator awareness of the issues related to math avoidance among females, and the consequences of such avoidance. The secondary goal was to provide educators with teaching strategies and materials to engage students in both doing mathematics and understanding its relevance to

their career options. Two major principles were established by the Equals teacher education program--First, it is hard to force people to change, but if they are motivated and want to tackle a problem they can be encouraged to acquire new information and use what they need; Second--people learn best through active involvement, and remember and act upon that which is personally important. They expressed the concern also that the problem of math avoidance is shared by both minority and majority communities, but minority and women students are most severely affected.[58]

Other programs have discovered that teachers want well-organized inservice programs on topics they have defined as relevant, a variety of usable classroom materials and a chance to benefit from the rich experiences of other teachers. Teachers also want time to reflect, to plan and to integrate the new materials and ideas into their teaching. Equals suggested that the major components of change needed to increase significantly the participation of girls and women in mathematics are: course requirements, teacher preparation, new curricula, parent education and industry-education linkage. To increase significantly women's access to advance fields traditionally dominated by males, these components were necessary.

There are many programs designed to meet the needs of all professional groups that make up the educational community--programs designed for students, teachers, administrators, parents and auxiliary support groups that operate within the confinement of schools. An early intervention program designed by educators in inner-city Houston is

gearing minority students into an early appreciation of math skills that they will be able to utilize throughout their lifetime. The Houston project is a three-phase pilot program designed to develop the mathematics and science skills of Black, Hispanic, Native American, and female students.[58] Another project that was started in 1985 by the National Urban Coalition sought to integrate provocative approaches to mathematics and science into public school curriculums for kindergarten through sixth grade.[59] This effort is supported by the Shell Oil Company Foundation.

Conclusion

There is no single isolated variable that can be identified as causing math anxiety. Studies have documented that bad experiences with math, different learning styles, poorly prepared teachers, negative attitudes of teachers, peer pressure, and many other contributing factors lead to an individual's avoidance of mathematics. Some individuals may experience math anxiety at the elementary level and others at the secondary or collegiate levels. According to research done on those math phobic individuals, most are women and Black and Hispanic students.

Educational institutions and organizations have sought the causes of this phobia and established programs that a) should help reduce the fear of math, b) serve as early intervention in enhancing minority representation in the math and science fields, c) increase women and minority participation in math and science courses, d) increase women and minority participation in mathematics and related technological fields, and e) cater to the needs of teachers--such as training and

retraining teachers in developing problem-solving strategies. Studies documenting math anxiety among prospective and veteran elementary teachers herald a need for personnel that can help reduce the fear of math through staff development techniques and programs.

Based on this review of pertinent studies, certain propositions appeared highly significant. First, a high level of math avoidance/ math anxiety would probably be found among the teachers in the Theodore Roosevelt Elementary School. Second, their phobia probably contributed to low student achievement levels among Roosevelt's predominantly Black student population. Third, a school-based staff development project developed with careful attention to the needs of teachers, and research studies of math anxiety and subtle cues that discourage women and minority participation in math workshops might redress some of these problems.

Chapter II

Notes

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CHAPTER III

THE PLANNING PROCESS

Elementary school teachers needed opportunities to share concerns about mathematics and their attitudes toward math anxiety. Believing that many teachers in her school had experienced math anxiety, the researcher/presenter wanted to verify this attitude within a context of positive options. The researcher/presenter had generally observed clear signs of math anxiety among veteran teachers. In some instances, their presentation of lessons was fragmented with unclear directions, non-explanation of appropriate technical terms, and no follow-up procedures to check students' understanding of new ideas or concepts. Some lessons were delivered in a non-motivating manner that left some students tuned-out or disengaged. Students gained little understanding of the mathematics content to which they had been exposed.

When experienced teachers grappled for precise and clearer ways of making themselves understood to students, there seemed a likelihood that they feared the subject themselves. One would hope that experienced teachers would be effective in their delivery of arithmetic concepts, reasoning, and procedures. Their ineffectiveness surely hindered students' learning. In turn, low performance on achievement tests by students discouraged teacher interest in the subject.

Observations of this kind generated a desire to share concerns about math anxiety and its negative effect on a staff of veteran teachers. Not only should there be concern for the teachers who

experienced math anxiety, but there should also be concern for those who received direct instruction from these experienced teachers. To assist an experienced staff in the reduction of math anxiety a plan was needed that directly concentrated on the specific teacher fears and blocking points. Staff development workshops offered a way to share concerns--a helping attitude, a self-discovery mode, a self-helping belief, and a non-threatening atmosphere.

In a review of the literature, math anxiety was described by Stanley Kogelman and Joseph Warren as an intense emotional reaction to math based on past experiences.[1] The impact of this intense emotional reaction does not isolate itself among individuals of any particular race, gender, nationality, socio-economic, or professional background. Teachers of elementary school children are included among those afflicted with math anxiety.

A need manifests itself among the people on an experienced staff of teachers. The manifestations of such a need were demonstrated in individual or group presentations of mathematics topics at general faculty meetings that related to teaching techniques or styles used in the instruction of mathematics. General observations of mathematics lessons presented to students, their content and their delivery indicated math avoidance among teachers. Some observable teaching styles and techniques remained the same year after year even though each group of students had different needs and learning styles from the previous groups.

Most of the instructors were dissatisfied with the program that had been set in place for the past ten years without an

update in student textbooks or supplementary aids. The curriculum had become routine and teachers complacent. Most of the teachers used commercial materials to enhance the mathematics curriculum in general and overall student interest in particular.

An alternative program designed by Professor Everard Barrett of the State University of New York at the College of Old Westbury was utilized by some veteran teachers to enhance the mathematics curriculum in the area of computational skills. Professor Barrett's program dealt strictly with a computationally based format that enhanced student understanding of "why" rather than "how."

In order to provide the staff with current and relevant information and resources concerning math anxiety and problem-solving strategies, the researcher attended a number of workshops that focused on those two areas. Some of them were:

1) Math Anxiety and Effective Schools Research sponsored by Chapter I and Houghton Mifflin Publishing Company, winter, 1984.

2) Math Anxiety Workshop sponsored by the Nassau County Association of Math teachers--Elementary Level, conducted by Mr. John Ernest, Nassau Community College instructor, winter, 1984.

3) Math Anxiety and the Special Child, sponsored by the Board of Cooperative Education, fall, 1985.

4) Problem Solving Strategies, sponsored by UMASS/Roosevelt Staff Development Project, November 1986, conducted by Professor Portia Elliott.

5) Math Anxiety and Females/Problem Solving Strategies, sponsored by the New York State Education Department, conducted by Mr. Michael Moon, November 1986.

6) Problem Solving Strategies for Elementary School Teachers, sponsored by the New York State Education Department, College of Old Westbury, conducted by Dr. George Lencher and Mrs. Sandy Cohen, summer 1986-spring 1987.

7) Problem Solving Strategies: Is it a part of the Whole Language Curriculum? conducted by Fred Paul, New York State Education Department, winter 1987.

8) Math Anxiety Workshop, sponsored by Nassau County Association of Mathematics Teachers, College of Old Westbury, conducted by Sheila Tobias, winter 1987.

9) Sex Stereotyping in the Teaching of Mathematics, sponsored by Nasssau County Association of Mathematics teachers, conducted by Patricia Lund Casserly, Educational Testing Systems, Princeton, winter 1987.

Involving Others in Planning

In reviewing the literature on staff development procedures and requirements, the researcher noted that there were essential elements that helped to set in place effective staff development programs, such as teachers taking an active role in the project, involving teachers with direct interaction in the planning and implementation process, and providing resources that are adaptable and applicable for classroom use.

Conceptualizing a plan did not require reinventing the wheel. Focusing on previous studies concerning staff development, the researcher/presenter sought to share and to receive information concerning teacher attitude toward math anxiety. Workshops were designed to impart viable data from experts, to share experiences concerning math anxiety both professionally and personally and to encourage positive classroom strategies. In the workshop conducted by Sheila Tobias during the winter of 1987, Tobias stated that new studies should focus on the relationship of math anxiety to elementary teachers because there is a need to study this specific relationship in the educational field.[2] There is a need to help those who introduce subjects to younger children. Another aim of the staff development project was to provide hands-on activities in the development of problem-solving strategies. Problem-solving strategies gave staff specific alternative instructional approaches that both strengthened skills and demonstrated a variety of approaches to real life problems.

In providing for shared experiences, the researcher/presenter sought the expertise of others by asking members of the staff and other district personnel to speak on certain topics, such as math anxiety and the special child, while others shared their expert knowledge about creating manipulatives for classroom use in the area of arithmetic , and others shared their knowledge of computer instruction. Another aim was to provide openess among the staff on a professional and personal level. The researcher/presenter believed a secondary outcome of this project would provide the staff with less of a

feeling of isolation and helplessness in coping with math anxieties.

The workshop presenter/researcher involved teachers in workshop training sessions dealing with math anxiety as a need for the experienced staff members based on research, personal experience, and empirical observation of teacher interaction and delivery of topics in arithmetic programs. During the formation of the project, the presenter/researcher sought to determine whether individual members of the staff 1) would consent to being a participant directly or indirectly in the project, 2) would concur with a need for staff development training in the reduction of math anxiety, and 3) would support the staff development project. In order to set the tone for the prospective teacher volunteers in the project, two surveys were formulated, disseminated and analyzed. Survey One dealt with teacher attitude toward math anxiety. (See appendix A). Survey Two dealt with teacher training in the reduction of math anxiety (See appendix B).

All members of the Theodore Roosevelt faculty were surveyed. This included twenty classroom teachers. The grade levels taught ranged from kindergarten through grade six. The researcher/presenter felt that the topic of math anxiety and the ways that it can affect an experienced staff of elementary teachers was pertinent to the research on

math anxiety. Hypothesizing that math anxiety disables females and minorities more, that women were the majority of elementary teachers and that a fear of math could inherently be a trait that females bring with them into the profession, led this researcher/presenter to delve into the topic of math anxiety and math anxiety reduction in elementary teachers.

The study of math anxiety among elementary teachers was pertinent because teachers serve as role models and are the ones who have the best avenue for influencing students' attitude toward math the most. An added factor in this study was the fact that the teachers were serving students from a minority population. Teachers' attitudes toward mathematics, had such a great impact on how students viewed arithmetic that teachers became the target group for this project. A survey was distributed among the teaching staff and collected within a two-day time frame. Ninety percent of the surveys were completed and returned.

The survey was composed of nine main groupings in order to gain a wider view of math anxiety in relationship to choice of careers, teacher preparation, mathematics instruction, math anxiety, instructional aids, content area, teacher expectation, subject-matter/methodology, and teacher-student interaction. The following report is a summary of the teachers' responses to Survey One.

1) Math Anxiety	Agreed	Disagreed
Those who give instruction in arithmetic experience some form of math anxiety.	56%	44%
Those who give instruction in arithmetic negatively influence the attitude of students toward mathematics.	72%	44%
Women and minorities fear mathematics more.	60%	40%
2) Career Choice		
Elementary education majors choose this career because teacher training programs require less coursework in mathematics.	50%	50%
3) Teacher Preparation		
Teachers worried about receiving other grade level assignments because they lacked mathematical preparation of a higher nature.	56%	44%
Teachers gravitated toward other subject areas as their strong points because they felt inadequately prepared in the mathematics domain.	68%	32%

4) Content Area	Agreed	Disagreed
Teachers who have a fear of math have not developed their subject-matter knowledge of various arithmetic topics.	64%	36%
Teachers fear mathematical topics beyond the computational level such as base theory, probability, and spatial visualization skills.	70%	30%
5) Subject Matter Knowledge/Methodology		
Teachers who experience math anxiety mask their lack of mathematical reasoning skills via computational expertise.	68%	32%
6) Math Instruction		
Teachers rely greatly on teachers' manuals to give instruction in arithmetic.	70%	30%
Teachers rely greatly on answer keys to score students' work.	72%	28%
Teachers emphasize computational skills more so than problem-solving skills.	72%	28%
Teachers develop conceptual understanding and problem-solving skills.	62%	38%

	Agreed	Disagreed
Teachers spend less time on task with students in the mathematics area.	60%	40%
Teachers who are math anxious do not understand the difference between teaching procedure and teaching critical thinking skills.	64%	36%
7) Instructional Aids		
Teachers use manipulatives to teach mathematics concepts.	66%	34%
8) Teacher-Student Interaction		
Teachers have more intellectual contact with males than females.	48%	52%
9) Teacher Expectation		
Teachers have different expectations for minority students than the majority students.	58%	42%

Survey Two/Teacher Training

In Survey Two the questions were designed to focus on the amount of training teachers had received in the area of math anxiety reduction. The survey focused on teacher willingness to attend workshops dealing with the reduction of math anxiety. Another area pertaining to this survey was the amount of teacher training in the development of problem solving strategies. Teachers were also asked to participate on a voluntary basis in individual case studies of math anxiety. (See appendix B for survey on teacher training preservice and inservice in the reduction of

math anxiety). The survey was distributed to twenty-seven staff members. The participants in the survey were twenty classroom teachers, the school librarian, nurse, resource teacher, instrumental music teacher, gym teacher, reading coordinator and the principal. The survey was returned within a time frame of two days and completed by 90 percent of the respondents. The results were as follows:

1) Math Anxiety Training	No Training	Training
	58%	42%
2) Willing to Attend Math Anxiety Workshops	Non-Attendance	Attendance
	8%	92% *
3) Training in Problem Solving Strategies	No Training	Training
	42%	58%
4) Willing to be a participant in Individualized Case Study on Math Anxiety	Non-Consent	Consent
	45%	55%

*Attendance increased to 100% by the teaching staff (classroom teachers).

Survey Two results dovetailed into Survey One's questions and confirmed the researcher/presenter's belief that experienced teachers are affected by math anxiety, that veteran teachers would like assistance in the reduction of math anxiety, and that staff development workshops would be a viable vehicle to approach this topic in a cooperative and collaborative manner. It was also an opportunity to view problem-solving strategies and their roles in the math curriculum and to show how instruction in problem-solving strategies with the aid of manipulatives

could greatly increase teacher and student confidence in this area. An added factor to using problem-solving strategies was to enable teachers to view this as a vehicle to reducing their own math anxiety.

The results of the math anxiety surveys indicated to the researcher that the workshops should focus on the identification of math anxiety, how to deal with math anxiety, and the negative effects of math anxiety on one's performance in the educational, economic, and real life situations of the world. Another aim was to increase teacher awareness of the disabling effects math anxiety has on minority groups, especially Blacks and Hispanics.

An incentive that promoted a receptive climate for teacher participation was the initial workshop on Math Anxiety and Females presented by Michael Moon from the New York State Education Department: Division of Sex Equity in Education. Moon helped to pique teacher interest in the topic of math anxiety by employing the following techniques: imparting information related to female participation in high technological fields by teacher to teacher interaction--teachers had information pinned to their backs that gave startling information concerning female participation in various fields such as engineering and professional organizations and the use of problem-solving strategies to solve various types of problems that required cooperative and collaborative participation by the teachers.

The researcher/presenter's follow-up projects called for various role changes in the construction of the workshop format. The workshops required that the researcher serve as presenter, coordinator, initiator, resource person, and catalyst for effective implementation of the goals

set in the project. The presenter used the eclectic background of the staff as a guide in the assessment of the types of approaches used for implementing the project, for the differentiated needs of the staff, for the various teaching/learning styles of the participants, and the scope and sequence of the workshops.

The principal of the Theodore Roosevelt School had ardently supported training for teachers. Programs that he encouraged were: The Right to Read Project and The Barrett Pilot Math Program. The principal had initiated and directly participated in many new ideas and concepts for teachers at the Theodore Roosevelt School. The principal allowed wide latitude in trying new programs for the benefit of both teachers and students. The principal advocated cooperative/ collaborative sharing for teachers, parents and students, and many in-house programs involved teacher/parent/student interactions such as Grandparent's Day, Student Council Projects, Plays, Open House by grade level, and Adopt a Grandparent Program. The mid 1970s faculty meetings at Theodore Roosevelt School were intertwined with staff development projects designed for teachers to share their expert knowledge of various content materials and to demonstrate how they were implemented in classroom settings.

In the fall of 1977, the superintendent of schools addressed a need for a common textbook series in mathematics throughout the district. Prior to his coming, teachers were not using the same instructional material as a guideline to implement a successful mathematics program, although there was a successful pilot mathematics program

in place at the Theodore Roosevelt School. Teachers delivered program instruction by any means possible throughout the other schools in the district. Students received arithmetic instruction via various classrom materials and textbooks. A conglomerate of materials was more the norm, rather than district-approved guidelines and a common textbook. The superintendent of schools was initially the catalyst for the linkage between the University of Massachusetts/Roosevelt Staff Development Project. The superintendent consistently supported staff development and school improvement. He encouraged teacher training workshops in the district and offered incentives for new projects by the teaching staff.

Project Goals

The researcher/presenter used data from the faculty, other research dialogue with colleagues, teaching experience, and personal experiences to formulate the goals of the staff development project. The goals were: 1) to increase staff members' awareness of the negative impact of math anxiety among women in general and among experienced teachers specifically, 2) to assist in the reduction of math anxiety, 3) to develop problem-solving strategies as a means of helping to reduce the fear of math avoidance/math anxiety, and 4) to increase awareness of the disabling effects of math anxiety on the performance of women and minorities in the field of mathematics. School change/improvement is a desired outcome of many

mandates. A modern labor force needs individuals proficient in science and mathematics. Many programs have been implemented to assist females and minorities in the pursuit of these areas.

The optimal unit for change as stated by Goodlad is the school.[3] The outcome of most positive school change efforts is the improvement of student achievement. The change agents that affect student achievement the most are teachers. The interaction between student and teacher can be positive or negative depending on the expectations of the teacher. High expectations and the achievement of those expectations are vital to the self-esteem of an individual. Individuals continually want to learn and to work on deficits that they may encounter. Effective school researchers and practitioners concurred that "expectations--either positive or negative--have a profound effect on the achievement of low-income children." Furthermore, research stated that "schools can make a difference in the achievement of low-income students."[4]

Teachers are key for implementing change. Teachers enforce new guidelines or innovations in the classroom setting. Robert Maloy and Byrd Jones stated that "most educators enter their career with a desire to help all children learn and to become independent thinkers and productive adults."[5] Teachers may have negative attitudes toward change because of isolation, lack of respect, or because of no intrinsic or extrinsic reward given to them. Thus, teachers adopt a critical, wait-and-see

attitude toward school improvement and cooperative activities. Also educational change sometimes faces sabotage from teachers because they passively resist "buying in" to a particular proposal. Furthermore, isolation and conservatism can become salient characteristics among experienced or veteran teachers who have established routine behavior and seldom reconsider what or why they expect students to learn.[6]

School improvement involves all levels of academic learning and all subject areas. This study focused on improving mathematical instruction and reducing math anxiety among an experienced staff of elementary teachers. As stated by Sheila Tobias earlier, "men experience math anxiety also, but it disables women more." Sheila Tobias reported that math anxiety disables minorities more so than it disables their majority counterparts.[7]

The needs assessment data found in this study encompassed: 1) results of a district-wide nature that provided general information from a broad basis of elementary school teachers, and 2) surveys and interviews from the Theodore Roosevelt School staff to obtain information on specific needs and attitudes. Initially, informal interviews were conducted in the district and surveys were given out to ascertain teacher concerns in the areas of teacher salary, relationship to students, involvement in curriculum, programs, and teacher morale. From the needs assessment survey, teachers had a written as well as vocal voice in school matters. This process has continued.

A study entitled, "A Report on Roosevelt Public School Strengths and Potential Improvements," compiled by Byrd L. Jones and distributed in January 1983, noted that there were areas that needed professional development. They also indicated a need for inservice training in all curriculum areas in general and computers specifically. Other areas noted were motivational techniques and the use of manipulative aids. In response to a question about how to sustain staff development, a majority of the staff replied that teacher workshops would be the viable approach for teacher inservice.[8]

The researcher/presenter evaluated the cost factor of conducting the workshops and found that human help and materials were the prevalent needs. Due to the support of the school principal, the researcher/presenter could set up staff development workshops for teachers during the school day.

The coverage of teacher classrooms while they participated in the workshops was of prime importance. Material resources were needed to carry out activities and goals of the project. The creation of manipulatives for the development of problem-solving strategies was also crucial to the implementation of the program.

Based on the two surveys administered to the Theodore Roosevelt staff, the researcher/presenter organized a tentative list of topics to be included in the workshops. The primary topics were: a) What is Math

Anxiety? b) Assisting an Experienced Staff in the Reduction of Math Anxiety, and c) What is Problem Solving? Integrated into the Workshop format were topics dealing with motivation, the special child and math anxiety. A major concern that was unexpected by the researcher/presenter was the acknowledgement of computer anxiety among teachers and the need for more hands-on involvement as a means of assisting a staff in the reduction of this fear.

Logistical concerns that were essential to the design of the program included: length of the sessions, days of the week on which the workshops would be conducted, and the location of the workshop. The workshop presenter assessed that the pre-introductory session, which served as an overall introduction to the entire staff would be ninety minutes long; the remainder of the sessions (six) would be one hundred twenty minutes. The researcher/presenter also decided that in order to include all volunteer participants during the school day, Fridays would be the most suitable day for workshop sessions. This was due to the fact that ample coverage could be provided for participants by the support staff of Theodore Roosevelt School. In discussing a suitable area for the presentation of the workshops, the first pre-introductory session was held in a colleague's classroom, and the remainder of the workshop sessions were conducted in the reading lab because of its mobility of furniture, proper outlets for the setting up of audio-visual equipment, displays, attractiveness, and overall tone of friendliness to individual and small group instruction.

Having assimilated the data from the surveys, and conducting informal interviews with teachers and other staff members, the researcher/presenter designed the workshops. Encompassing the design procedures were: a) the creation of the workshop format, b) the development of objectives, procedures, and evaluation questions which composed the workshops, c) the setting regarding the procurement, maintenance and transportation of materials, equipment, facilities, and personnel, and d) organizing a schedule that would meet the needs of the volunteer participants and the coverage of classrooms during the workshop presentations.

In order to put the workshop project into effect, the matter of time, coverage, and day was very important to this program working smoothly. The workshops had to be planned for a day that ample coverage could be provided for the prospective participants. The researcher/presenter discussed possible coverage, time frame, and dates of workshop sessions before any plans were set in place. After consulting with the principal and getting his approval, the researcher/presenter then sought the support of the auxiliary staff in covering the classes for the project participants.

Because Theodore Roosevelt School was a kindergarten through sixth grade neighborhood school, the needs of the teachers were different for instructors at the primary and intermediate levels.

Taking into account the various grade levels, the math curriculum in respect to problem-solving strategies, the teaching styles of the participants, the learning styles of the students, and the learning styles of the participants also, there was a need to break up the volunteer participants into three groups. The groups were arranged according to grade level assignment, scheduled lunch periods, and the type of students taught by the instructors. The following list is a general outline of how each group was subdivided for workshop participation:

Group A	Group B	Group C
Third Grade Teacher	Fifth grade Teacher	Special Education Teacher
Third Grade Teacher	Fifth Grade Teacher	Special Education Teacher
Third Grade Teacher	Sixth Grade Teacher	Special Education Teacher
Fourth Grade Teacher	Sixth Grade Teacher	Kindergarten Teacher
Fourth Grade Teacher	Reading Coordinator	Kindergarten Teacher
Reading Coordinator	District Coordinator of Compensatory Education	First Grade Teacher
		First Grade Teacher
		First Grade Teacher
	Writing Coordinator	Second Grade Teacher
	District Computer Coordinator	Second Grade Teacher
		Second Grade Teacher
		Gym Teacher

Classroom coverage was done by the auxiliary staff composed of the school's resource teacher, librarian, three teacher assistants, part-time music teacher, and reading coordinator. Some classes were combined by grade level and were covered by one or two auxiliary staff personnel. The following is a general listing of classroom assignments which served as a guide in structuring the coverage of each participant's class.

Teacher Assistant - alternated among grades three, four, five, and six;

Teacher Assistant - alternated among grades three, four, five, and six;

Librarian - Third and first grade coverage;

Reading Coordinator - covered combined classes of fifth grade and first grade students

Part-time Music Teacher - covered grades three and four

The time frame for each workshop session consisted of an hour, and two to three groups were scheduled on Fridays. The workshops started at 9:00 a.m. and ended at 11:00 a.m. On those days that three groups were scheduled, the last group met from 1:00 p.m. to 2:30 p.m. All auxiliary staff covered those classes scheduled for the afternoon sessions.

The workshop schedule was as follows:

Schedule of Math Anxiety Workshops

Theodore Roosevelt School

Dates	Title	Group(s)
November 18, 1986	Math Anxiety and Females	Entire Faculty 2:30-4:00 p.m.
February 13, 1987	What Is Math Anxiety?	Group A--9-10 a.m. Group B--10-11 a.m.
March 3, 1987	What Is Math Anxiety?	Group C 2:30-4:00 p.m.
March 6, 1987	Assisting an Experienced Staff in the Reduction of Math Anxiety and What Is Problem Solving?	Group A--9-10 a.m. Group B--10-11 a.m.
March 13, 1987	Assisting an Experienced Staff in the Reduction of Math Anxiety and What Is Problem Solving?	Group C 1:00-2:30 p.m.

March 13, 1987	Instructional Motivation and Math Anxiety and the Special Child	Group A—9-10 a.m. Group B—10-11 a.m.
March 27, 1987	Problem-Solving Strategies—Hands On Correlation of Problem-Solving Strategies to Newly Adopted Mathematics Textbooks	Group C 9-10:30 a.m.
April 3, 1987	Problem Solving/Higher Order Thinking Skills	Group A—9-10:30 a.m Group B 10:30 a.m.-12:00 p.m
May 1, 1987	Computer Anxiety and Teachers	Group A and B 9-11 a.m.

Conclusion

This chapter sought to bring about an overall cohesiveness to the planning aspect of presenting staff development workshops and the preliminary requirements that are essential in order to have some degree of manageability, flexibility, and cooperation in carrying out a study of this nature. In designing a study of this nature, well-organized but flexible plans best serve as an organizational tool in implementing various stages of the project. Preliminary background work served as a tool in formulating resources that helped the project to move smoothly. The gathering of relevant data and analyzing the data provided one with a guideline for also developing many aspects of the project. Surveys and formal and informal interviews served as a beginning point and foundation for working with prospective participants and knowing their needs. Working and discussing plans with colleagues, administrators, and those interested in the project gave the project a broader base for obtaining

different perspectives on the study and served as added "input," "buying in," and support of the project goals.

Chapter III

Notes

1 Stanley Kogelman and Joseph Warren, Mind Over Math (New York: McGraw-Hill, 1978), 9-10.

2 Interview with Sheila Tobias, State University of New York at the College of Old Westbury, Westbury, New York, 20 March, 1987.

3 John Goodlad, A Place Called School (New York: McGraw-Hill, 1987), 23.

4 Jean S. Chall and Vicki A. Jacobs, "Writing and Reading in the Elementary Grades: Development Trends Among Low SES Children." Language Arts (May 1983): 617-626.

5 Byrd L. Jones and Robert W. Maloy, "Teachers, Partnerships, and School Improvement," Journal of Research and Development in Education 20, Winter 1987.

6 Ibid.

7 Sheila Tobias, Overcoming Math Anxiety (Boston, Houghton Mifflin Company, 1978), 98, and Nancy Kreinbert, 1000 Teachers Later: Women, Mathematics, and The Components of Change (Berkeley, University of California, [1981]) 4.

8 Byrd L. Jones, comp. "A Report on Roosevelt Public Schools: Strengths and Potential Improvements" (University of Massachusetts/ Roosevelt Public Schools Staff Development Project, 1983), 45-46.

CHAPTER IV

THE IMPLEMENTATION PROCESS

Each of the workshops was designed to help reduce math anxiety and train school personnel in problem-solving strategies. An extension of the workshops dealt with individual teacher interviews related to their personal experiences with math anxiety. In developing each workshop session and presenting it, some ideas and themes functioned as expected, while others followed specific concerns of teachers. Some workshops were repeated a number of times in order to include all the volunteer participants and to reach the project's goals of meeting the participants' needs.

Pre-Session Workshop--Math Anxiety and Females

During the month of September, the researcher contacted Michael Moon, New York State Education Department Representative for Division of Civil Rights and Intercultural Relations. She discussed plans with the building principal regarding potential staff development meeting and informed the District Director of Compensatory Education the contact which she had suggested was fruitful and would help initiate potential workshops with the staff. Then, the researcher notified other district coordinators of mathematics about plans for a workshop presentation on November 18, 1986. Finally, certain logistical details had to be worked out: arranging a meeting place, negotiating with the building principal to present this workshop during a regular faculty meeting, and preparing refreshments for pre-session activities.

The workshop on Math Anxiety and Females started at 2:30 p.m. with opening comments from the building principal. The building principal introduced Moon to the staff as a specialist in Sex Equity in Education. Moon's subject would be the relationship of Math Anxiety and Females in the work place and the educational factors related to it. That theme was linked to a planned series of workshops by the researcher/ presenter sponsoring the workshop. This workshop was presented once to provide projected participants and others with a broader view of the planned series of topics on Math Anxiety. In attendance were thirty-one participants, including two principals, a Director of Compensatory Education, twenty-one classroom teachers, seven support staff members--resource room teacher, two part-time music teachers, a librarian, school nurse, a part-time psychologist, and a computer assistant. The workshop came to a close at 4:00 p.m.

The following agenda served as a guideline for the workshop on Math Anxiety and Females.

AGENDA 1

Math Anxiety Workshops--Pre-Session Introduction Agenda
Theodore Roosevelt School--November 18, 1986
Michael Moon--Workshop Presenter
Topic--Math Anxiety and Females

I. Pre-Session Warm Up Exercises

A. Startling Statements

B. Spatial Visualization Problem

II. Refreshments (Peer Group Interactions)

(cont.)

Agenda 1, cont.

III. Introduction by building principal

A. Purpose of Moon's workshop

B. Sponsored by math coordinator to introduce a planned series of later workshop presentations.

IV. Presentation by Michael Moon--New York State Education Department Representative for the Division of Civil Rights and Intercultural Relations

V. Closing Remarks

VI. Feedback Evaluation Forms

The first activity that Moon engaged the teachers in was concerned with heightening their awareness of the problems that math anxiety can cause females in their pursuit of professional and technological careers that involved higher-order math preparation. The presenter affixed cards bearing "Startling Statements" to the backs of the workshop participants. The participants were given information about women in the professional and technological areas of Mathematics that documented Math Anxiety among females. (See appendix C).

Moon asked each person who had a startling statement pinned to his or her back to read the statement to the entire group. He then gave three multiple choice answers to the questions and chose a participant to guess which one was the correct response. The group went through a series of 19 statements. (See appendix C). The participants guessed the correct response each time a statistic was given. Moon concluded that phase by reiterating the absence of

women in many professional and technological fields considered to be the domain of the male gender.

The second activity engaged the participants in solving a spatial visualization problem, a much needed skill in the development of higher-order thinking skills. Research has suggested that women have difficulty "seeing" geometric relationships. The activity involved a pattern cut out of a figure placed on the chalkboard, and the participants were required to duplicate the pattern. The participants were allowed to use a pair of scissors and a 3x5 index card provided for this activity in order to reach a solution.

No one correctly solved the perceptual visualization problem. Moon commented that the answer was given in a resource package to be distributed. He chose not to reveal how the problem could be solved because he wanted participants to work on this challenge. Moon stated that not all answers should be given immediately to someone if they were not able to reach a solution at that particular time. Such puzzles encourage the creative and thinking abilities of a person when they can find a solution in their own time frame. Moon reiterated that this particular task involved a key focus of many researchers in their discussions about why women fail as problem solvers and exhibit math anxiety.

In order to encourage discussion about math anxiety, the workshop presenter gathered information from the participants based on their general knowledge of the topic. Moon posed three questions to the staff and encouraged the group to respond through brainstorming techniques.

The first question posed was, "What are some reasons for math anxiety?" The staff offered such ideas as lack of good math preparation, poor teachers, distrust of self, and insecurity in working with math.

In response to "How does math anxiety affect girls?" the staff proposed limits on choice of careers or profession, reduced earning power and exclusion from certain technological fields. Question three concerned itself with how the problem can be solved, especially with girls. The staff addressed this question with, "Girls should be encouraged to take more math courses," and, "Workshops should enlighten girls about the various career choices in math and related technological fields."

Problem-Solving Activities

Next, Moon introduced various problem-solving activities that called for specific strategies or a combination of strategies to solve the problems presented. The activities either involved a partner or groups of three to six participants. Some of the exercises were Ballooning and a group of Cooperative Logical Reasoning Activities.

Nim is a strategy developed by the Chinese that develops thinking skills and involves the individual in deductive reasoning. Nim requires that an individual search for a strategy to use himself or to find the strategy used by an opponent. It involves finding a pattern to win by choosing a number of items at each participant's turn to play. Ballooning utilized the Nim strategy of selecting objects during a player's turn and leaving the last item or

items for the opponent in the activity. The "winner" got the chance to take a "balloon ride." Colored paper clips were used as the objects. By picking either two or three clips at a time, the winner had to leave one paper clip for the loser to pick. The cooperative logical reasoning activities, such as "Apartment," "Salaries," and "Who Has What Job?" posed a problem and required the participants to deduce information, construct a chart, and organize their thinking.

Summary-Pre-session Math Anxiety and Females

Receptive to the workshop presented by Michael Moon, the staff showed interest in learning more about the topic of math anxiety and its effect on females. Moon involved the teachers in many cooperative learning activities that utilized various problem-solving strategies. Those activities increased the participants' subject-matter knowledge and their sensitivity to a pattern of slighting women's skills with regard to mathematics.

The staff development workshop session enabled teachers to gain information on a) the topic of math anxiety, b) the relationship of math anxiety to career choices, c) the effect math anxiety has on an individual's earning potential, and d) areas of mathematics that can help reduce the fear of math such as the development of problem-solving strategies. The workshop also built support for a project about the study of math anxiety among a veteran staff.

The time frame allotted for Moon's presentation was contingent on a negotiated agreement between the Roosevelt School District and its

classroom teachers. The workshop was held from 2:30 p.m. until 4:00 p.m. following district guidelines for faculty meetings. Moon concluded by distributing handouts containing problem-solving activities as extra resources for the staff. An evaluation-post-assessment questionnaire was distributed to determine whether the information and activities were relevant to the needs of the staff.

Post-Assessment Evaluation

Several participants stated that they "could have spent all day" in a workshop of that nature. The workshop provided a needed awareness of the problem of math anxiety and females. The problem-solving, hands-on activities proved stimulating and generated interest in problem-solving strategies. The problem-solving activities heightened the teachers' interest in the workshops on math anxiety. Participants socialized during a learning experience, added new knowledge to their professional and personal backgrounds, and heightened their awareness of the disabling effects of math anxiety on individuals in general and females specifically.

The peer group interactions and the non-threatening atmosphere involved all participants and utilized various abilities and background subject-knowledge. One participant found the session had "increased the participants' learning to think attitude." Another noted that "the presenter made the group aware of the increased sensitivity towards women as a minority in their educational experiences." The day after the workshop presentation by Moon, some teachers commented at the Superintendent's Conference Day that they would have welcomed the

opportunity to continue with the math anxiety workshop presentation and hands-on activities at this district-level meeting.

Workshop 1—What is Math Anxiety?

In preparing for Workshop I, first the researcher/presenter reviewed two surveys previously conducted and analyzed (See Chapter III and appendix A and B). Survey One pertained to elementary school teachers' attitude toward math anxiety. The data gathered from Survey One informed the researcher/presenter of the need to construct workshops on the topic of math anxiety and to provide hands-on experiences in developing problem-solving strategies for the prospective volunteer participants. Survey Two pertained to the amount of preservice and inservice training in the areas of math anxiety reduction and problem-solving strategies. Information obtained from Survey Two indicated that the prospective participants would welcome workshop sessions addressing individual and group concerns dealing with math anxiety identification and its causes, problem-solving strategies and personal interviews that dealt with reducing and sharing a fear of math. Survey Two also indicated to the researcher/presenter that the teaching staff was "buying in" to the project goals, and saw the need to become a part of this study.

Second, the researcher/presenter reviewed the literature with particular emphasis on the identification of math anxiety, math anxiety and elementary teachers, and math anxiety and minorities. Based on those studies, she prepared materials to be used in the workshop session. She discussed workshops with the building principal in order to inform him of

the progress of the workshop sessions, to confirm the next workshop session, and the coverage of classrooms for participants.

Third, the researcher/presenter handled the necessary logistics. She organized coverage for participants who volunteered to attend workshop sessions and notified participants of the scheduled time and place of the workshop session. She set up a room for the workshop session in the reading lab of the school. The reading lab provided ample outlets for various audio-visual equipment. A tape recorder was required for this session. The lab also provided ample space for displays and center set-ups for small group interaction as well as large group interaction. And she prepared refreshments in order to encourage a social-learning type environment that made peer group interaction more relaxed. Fears are first addressed within a supportive and friendly school setting. This workshop was presented three times in order to accommodate all of the teachers who volunteered for this project and to meet the individual needs of the participants. (See Chapter III for schedule of workshop presentations).

AGENDA 2

Math Anxiety Workshop 1 Agenda
Theodore Roosevelt School--February 13, 1987
Perletter Wright--Workshop Presenter
Topic--What is Math Anxiety?

I. Pre-Session Warm-up Exercise

II. What is Math Anxiety?

III. Some Causes of Math Anxiety

IV. Some Negative Effects on Math Anxiety

V. Twelve Math Myths

(cont.)

Agenda 2, cont.

VI. Math Anxiety and Teachers

VII. Math Anxiety and Minorities

VIII. Some Symptoms of Math Anxiety

IX. Feedback Evaluations

Pre-Session Warm-up Exercise

Participants were asked to find a solution to a problem entitled "A Father's Will." The problem was obtained from "Problem Solving Strategies: UMASS/Roosevelt Staff Development Project" conducted by Dr. Portia Elliott, November, 1986.[1] The purpose of the warm-up exercise was to involve the participants in a hands-on experience using various problem-solving strategies in seeking a solution for this somewhat tricky problem.

The participants were given a worksheet entitled "A Father's Will." Participants were asked to complete the activity within a five to eight minute time frame. Each participant was to work alone to find a solution or solutions to the problem. The researcher/presenter went over the solutions with the group to elicit methods that individuals used in ascertaining the solution(s). "A Father's Will" served as an ice-breaking technique for participants then, and at future workshop presentations. The problem was:

> Farmer John told his three daughters that when he died they would all get a different proportion of the remaining horses on his farm. When he died, there were seventeen horses left. According to the will, the oldest daughter was to receive half the horses, the second daughter a third of the horses, and the youngest daughter was to receive one-ninth of the horses. The only stipulation was that none of the horses was to be killed to satisfy the requirements of the will. How was the will carried out?

Summary

Pre-warmup exercise results: Most of the participants found a solution to the problem, "A Father's Will."[6] Some of the comments made by participants as they worked on a solution were as follows:

"How could you do this to us on the day before vacation?"

"I'll never be able to finish in five minutes."

"This isn't clear."

"I did it my own way."

When asked to qive their solutions, these were some of the responses:

"Oh! Oh! No--kill the daughters."

"I was unable to do the problem."

"I threw away the fraction."

"I estimated the answer."

Some participants offered two solutions. A few could not start the problem after readinq the statement. Some participants who solved the problem used paper and pencil computation. As different responses were elicited, others listened for clues that they miqht have used. Some participants found a fractional portion of the whole number for each daughter and rounded off to the nearest whole number. Others had one of the horses give birth to a colt and then proceeded to find the inheritance for each daughter.

What is Math Anxiety?

The topic of this workshop focused on helping participants understand the meaning of math anxiety. The researcher/presenter distributed a worksheet that required participants to fill in the blank spaces as the definition for math anxiety was given and other relevant information concerning how attitudes and expectations affect an individual's negative fear of math. The informational source used for this activity was Mind Over Math.[2]

Math Anxiety Discussion

The researcher/presenter used a combination of terms to come up with a definition of math anxiety. These terms or phrases were stated by Stanley Kogelman and Joseph Warren, and Sheila Tobias in their studies of math anxiety. The statement given to the participants said that, "Math anxiety is an intense emotional reaction to math based on past experiences." It reflects attitude rather than aptitude. Also, attitudes are based on past experiences that have helped to perpetuate this avoidance of math.[3]

From the definition given, a direct assessment of the participants' attitude toward math anxiety was revealed among the staff. Participants were doubting themselves, stumbling over their responses to the math myths discussion, and showing signs of being under stress. Apparently, this topic addressed the root of "how" some of the experienced staff felt as we proceeded through the workshop session. Also, some of the participants began their own self-acknowledgement about math anxiety. In the discussion others identified

with those who acknowledged their anxieties about math in a caring and non-judgmental atmosphere.

Some Causes of Math Anxiety

The purpose of this topic was to elicit general knowledge from the participants regarding some reasons for the causes of math anxiety. The researcher/presenter used the brainstorming technique as a means of involving participants and sharing ideas. Teachers jotted their ideas on a worksheet and then they verablized their reasoning. The researcher/presenter used the information for discussion and interaction purposes.

Participants listed various possible causes for math anxiety such as learning styles, parents, expected role models, peer influences, lack of good role models, feminine stereotypes, bad experiences—elementary, high school, or college level, and negative attitudes of teachers.

Some Negative Effects of Math Anxiety

This topic of the workshop session asked participants some reasons for the negative effects of math anxiety based on data from previous topics. The researcher/presenter distributed a worksheet that required participants to list some reasons as to the negative effects that math anxiety may have on individuals. An evaluative question from the researcher/presenter to the participants overlapped with the responses that the group gave to the researcher and other members of the

workshop sessions. They offered possible negative effects of math anxiety such as feelings of guilt or shame, reduced goals, lower earning power, limited career choices and lack of cumulative math skills needed to advance on to higher mathematical concepts. Some saw the negative effects on individuals by the self-limiting power it has on individuals in pursuing goals and a higher financial status.

A teacher commented that a person could perform well at all levels of mathematics and still sustain feelings of math anxiety. Most participants had never viewed the earning power of females as a barrier to achieving personal and professional potential.

Twelve Math Myths

Next were presented twelve math myths based on a review of literature, Mind Over Math, that had especially dominated the thinking of society concerning its effect on men and women. A second stage involved comparing the participants' views with those identified in the literature.

The researcher designated a participant to distribute the worksheets based on math myths. Participants had to write true or false next to each statement within a five minute time frame. Volunteers then read aloud a statement and offered their answer. The twelve myths were:

1) Men are better in math than women. (false)

2) Math requires logic, not intuition. (both are necessary)

3) You must know how you got the answer. (false)

4) Math is not creative. (false)

5) There is a best way to do a math problem. (false)

6) It is always important to get the answer exactly right. (false)

7) It is bad to count on your fingers. (false)

8) Mathematicians do problems quickly, in their heads. (false)

9) Math requires a good memory. (false)

10) Math is done by working intensely until the problem is solved. (true and false)

11) Some people have a "math mind" and some don't." (false)

12) There is a key to doing math. (false)[4]

To evaluate this topic, the researcher asked if the data provided was relevant and useful to the participants, and if the information stimulated meaningful discussion providing a more in-depth knowledge of math myths that most individuals accept as fact.

During the review of math myths, some of the participants felt that some of the statements were true. Two of the twenty classroom teachers agreed that some people have a "math mind." One who has taught for many years felt that counting on one's fingers hindered students in moving from concrete to abstract thinking, especially in dealing with numberness. Four of the classroom teachers believed that math required both logic and intuition. Most of the teachers on the primary level emphasized right answers, and four agreed that correct answers were always important. However, it is not always important to get the answer right. The researcher noted that teachers have convinced students that every math computation or word problem has a right answer. Furthermore, in the area of problem-solving strategies, a similar reasoning suggests that a

problem has only one method to the solution. In fact, many problems can be resolved in several ways.

Math Anxiety and Teachers

The fifth topic informed the participants of the relationship of math anxiety and its negative effects upon elementary school teachers. The researcher/presenter played a tape recording containing data from the review of the literature concerning math anxiety on preservice elementary school teachers and on an experienced staff. "A Study of Math Anxiety/Math Avoidance in Preservice Elementary Teachers," by William Kelly and William Tomhave and "Attitudes of Elementary Teachers Toward Mathematics," by Ruth Meyers highlighted these points:

half of elementary school teachers exhibit a dislike for mathematics,

teachers are inadequately prepared in mathematical content and methodologies,

teachers are opposed to change although they feel competent to teach mathematics to elementary students,

teacher attitudes cause negative responses by students to mathematics,

mathematics performance declines among females between the ages of ten to fifteen,

negative experiences with mathematics typically occur between the seventh and tenth grade,

and most preservice elementary teachers are math anxious.[5]

Participants, including central office administrators generally agreed with the statements on math anxiety and teachers and had no

further comments on the data given. However, three statements generated some discussion among the teachers concerning teacher-student interaction.

First, boys receive more attention in the classroom environment and more instructional attention than females. In the Theodore Roosevelt School, some of the participants found this to be true although the school served 98.9 percent African-American students. Even though research studies showed that male Whites receive more instructional attention than any group, it seems to hold true for the Black male in a predominately Black school.

Second, minority females receive the least amount of instructional and intellectual attention from teachers. That, too, seemed true at the Theodore Roosevelt School.

Third, Blacks, females and disadvantaged students do not achieve at the same levels in science and mathematics as do White middle-class male students. The researcher/presenter commented that although minority students take science and math courses, the content of the material and expectation levels might allow for significantly different achievement levels.

Math Anxiety and Minorities

This topic was formulated to help the participants understand the effects of math anxiety on African-American students. The researcher presented information gleaned from "Math Anxiety: Help for Minority Students,"[6] The monologue highlighted a group of researchers, counselors and math instructors' work with African-American students who

had some difficulties mastering basic arithmetic and algebra skills. The planned intervention dealt with helping African-American Students reduce their math avoidance/math anxieties. On the topic of math anxiety and African-American students, some participants expressed a desire to discuss this further. Three statements generated extensive discussions.

Some Symptoms of Math Anxiety

Participants next discussed some of the symptoms of math anxiety that are connected to an individual's emotional/physical well-being. The information was obtained from "Math Anxiety: Help for Minority Students."[7] The researcher distributed index cards at random that contained information on some of the emotional/physical symptoms of math anxiety. The participants read aloud from the index cards and then placed each statement on a worksheet under the appropriate heading of emotional or physical symptoms. (See appendix D).

Participants generally believed that some of the symptomatic outcomes of math anxiety that produced physical signs were really attributable to emotional symptoms. A few participants identified with some symptoms and suggested others such as crying during or just before a test or asking the teacher to leave the room when an individual begins to feel uncomfortable with math topics. Some proposed that test anxiety might be a root problem with some students and that math is just another test to be feared.

Feedback Evaluations

The workshop session was designed to help the participants understand the meaning of math anxiety, focus on some of the causes, negative effects and symptoms related to math anxiety, some math myths that are believed to be true, math anxiety and its effect on preservice and inservice teachers, and math anxiety and its effect on minority students. The statements from the post-evaluation questionnaire reflected the following:

Sixty-four percent of the participants found the workshop session to be very useful; twenty-four percent found it to be extremely useful; and twelve percent found it somewhat useful. Participants noted that the information covered was necessary, and it made them realize that math anxiety is common among elementary school teachers. One participant stated that after reviewing the twelve myths, she realized that teachers may have been perpetuating some of these myths in their own teaching. By changing her negative attitude about math she hoped to present math in a more positive light to her students. Three of the participants wrote that they enjoyed the relaxed atmosphere and the peer interaction during the workshop session.

Future topics were suggested by the workshop participants on the post-session evaluation questionnaire. Some topics frequently requested were games or kits to emphasize new skills in the math curriculum, new and creative ideas for math instruction, and sharing of new concepts among teachers.

Workshop 2--Assisting an Experienced Staff in the Reduction of Math Anxiety

The researcher/presenter met with the building principal to discuss plans for the next workshop session. The building

principal was enthusiastic to hear and see that the teachers were enjoying the workshop sessions so far, and that they were gaining information that they thought was meaningful to them in their personal and professional environment. For example, after a Tuesday afternoon session with Group C on "What is Math Anxiety?" the teachers, the following day, were very complimentary concerning the Math Anxiety Workshop that they had attended. This helped to strengthen support for the workshop from the principal, as well as the participants.

The goal of the second workshop session was to assist the participants in learning about ways that math anxiety might be reduced. One of the approaches highlighted the use of problem-solving techniques to reduce the negative effect of math anxiety on an individual.

Pre-Session Preparation

The researcher/presenter handled the usual logistical matters: coverage for classes, notification to teachers, and preparation of refreshments. In addition, she scheduled groups to attend workshop on March 6, 1987 and March 13, 1987 in order to accommodate all participants. The data given at the workshop sessions would be the same but would allow for flexibility in meeting teachers' needs and concerns. This workshop was repeated three times and was attended by twenty classroom teachers and others. (See Chapter III for schedule).

AGENDA 3

Assisting an Experienced Staff in the Reduction of Math Anxiety--Workshop #2
AGENDA
Theodore Roosevelt School--March 6, 1987
Perletter Wright--Workshop Presenter
Topic--Assisting an Experienced Staff in the Reduction of Math Anxiety

I. Research Findings and Learning Math

II. What is Problem Solving?

A. Definitions
B. Some common problem-solving strategies

III. Mathematical Skills Relevant to Today's Students

IV. Problem Solving Readiness Procedures--Primary Level

V. Summary of Workshop Session

VI. Feedback Evaluation Questionnaires

Research Findings and Learning Math

The purpose of this topic informed participants of ways to overcome math anxiety based on the data gained from the review of selected literature. The researcher/presenter distributed copies of the data that contained ten points on assisting individuals in the reduction of math anxiety. The source of the data was Overcoming Math Anxiety [8] (See appendix E).

Summary

The group discussed the list of ten points concerning math anxiety reduction. (See appendix E) In response to point number four which stated, "There are many things about math and your experiences with math that can cause you to get angry. When this anger is

unexpressed and stays inside you, it has no place to go and turns into anxiety. This makes it impossible to work." A participant noted that this particular statement could be applied to everything and not only math. Point number six, which stated that you must face the anxiety, accept that you are anxious, and allow yourself to feel the symptoms and the fears, was reinforced by the researcher/presenter because this seemed to be where most of the math anxious should start—admitting that there is a problem. Most individuals have experienced math anxiety, including teachers. Because of negative connotations that society and others place on this phobia, teachers want to hide it, bury it, but not root it out.

Second, the researcher/presenter set out to demonstrate to the participants the relationship existing between the learning of math and the reduction of math anxiety. Attached to the list of ten points containing information on the reduction of math anxiety was a group of four sentences that highlighted the factors related to learning math. The researcher/presenter distributed information and instructed participants to read aloud voluntarily the points listed from the review of the literature. The group discussed each point's relevance to the reduction of math anxiety based on their opinions. (See appendix E). This topic generated very little discussion.

What is Problem Solving?

This topic focused on the definitions of problem solving from the review of the selected literature and other data gathered from workshops attended by the researcher/presenter. The procedure used in carrying out this topic was to ask volunteer participants to read from a list of three definitions written on an experience chart form which was displayed around the room. The charts listed definitions from the review of the selected literature and from workshops previously attended by the researcher/presenter. The three sources were: Creative Problem Solving in School Mathematics, Use Equals and "Problem Solving Workshop UMASS/Roosevelt Staff Development Project" conducted by Dr. Portia Elliott--November 1986). (See Appendix F).[9] An evaluation question posed by the researcher/presenter was whether participants receive a global view of what professional organizations deem the meaning of problem-solving and also what it entails. This became apparent in the following paragraph.

The researcher/presenter asked three volunteer participants to each read one of the definitions. After the reading of the definitions, one of the participants wanted a clarification of what is a word problem as opposed to a problem-solving strategy. The presenter then used this question as a starting point to get into the problem-solving activities. The participants were given the following examples to make that distinction between a word problem and a problem-solving strategies.

First, three students are working on problems at the chalkboard; two more students join them. How many students are at the chalkboard? Participants were able to see that this problem called for a simple solution by using an addition algorithm.

Second, above a fence a farmer sees eight heads; below the fence he sees 22 legs. How many of the animals are cows and how many are chickens? Some of the participants looked bewildered as to where to start; some asked questions, and some of them proceeded to solve the problem by computational means; some tried to guess at the solution, and others repeated the problem over and over again. After a three minute time span, the researcher/presenter proceeded to solve the problem at the chalkboard using a problem-solving strategy. The strategy employed was drawing a pattern. The researcher/presenter drew eight circles on the chalkboard to represent the heads. Each circle then received two stick legs. The legs then totaled sixteen. The pattern was repeated by dividing the six remaining legs into three sets of two legs each and distributing them (the sets) on three of the eight heads. The participants were then able to see that there were three heads with four legs and five heads with two legs. The solution to that problem was that there were three cows and five chickens. After seeing this as one possible solution to the problem, participants were eager and interested in working with more problem-solving activities that called for the use of different strategies.

The researcher/presenter provided a hands-on experience for participants. The researcher/presenter chose a group of six problem-

solving activities that required participants to work on an individualized basis or in groups. The activities were on tables set up in the Reading Lab to provide easy access. The activities included the following problem-solving strategies: 1) logical reasoning, 2) finding a pattern, 3) spatial visualization, 4) breaking set, 5) finding a general solution, and 6) drawing a picture. The sources for the activities were retrieved from "Problem Solving for Primary Grades Kindergarten-3", Use Equals, and How to Solve Math Word Problems.

Participants chose an activity and decided to work in groups of two or three. These activities took a total of about ten minutes each, with groups averaging one or two activities. The groups then selected a spokesperson to summarize the problem and describe the strategy used to solve the problem.

The researcher/presenter circulated among the groups to offer guidance. One group needed help on a handshake problem, and another on a calculator problem involving the strategy of Nim. The calculator problem caused great frustration among the teachers who tried this particular strategy.

One participant wanted to know, "How could we as teachers learn more about problem-solving strategies and the best way to handle them as classroom teachers?" Teachers need to become very familiar with various problem-solving strategies in their own work. Then, they became a natural part of teaching styles. Teachers will utilize them as tools in their mathematics curriculum and also demonstrate comfort with a variety of approaches.

A fourth topic provided information on mathematical skills required of students today. The researcher/presenter distributed information as a hand-out to participants. Time was drawing to a close so volunteer participants were asked to read aloud data from the list to generate discussion among the group. The data was obtained from Use Equals.[11] (See appendix G).

The hand-out emphasized the types of mathematical skills that would be required of students today. The researcher/presenter noted the sequence of the skills highlighting the point that problem-solving skills were placed first and computational skills placed fifth. A participant stated that she would like to receive more resource materials for mathematical skills relevant to today's students.

Problem-Solving Readiness Procedures

A fifth topic provided data on problem-solving readiness procedures for the primary level. The researcher/presenter distributed index cards with information concerning the readiness procedures needed in problem solving for the primary level student. The researcher requested that volunteer participants read the procedures aloud to evoke comments from the group. The procedures that were listed were 1) create an atmosphere conducive to exploration and learning; 2) pose interesting and challenging oral problems for exploration; 3) present a variety of mathematical problems; 4) encourage children to develop problem-solving strategies; 5) introduce specific problem-solving strategies, for example, model it, act it out, guess and test, make a list, and look for a pattern; 6) emphasize counting activities and

exercises because forward and backward counting exercises are powerful problem-solving tools; 7) supply children with manipulatives; 8) encourage interaction of pupils; 9) have children write, illustrate, role play, and create stories about numbers; 10) use games and game-like situations; 11) offer spatial experiences; and 12) enjoy problem solving with students.[12] The source was "Problem Solving in the Primary Grades."

The primary problem-solving readiness procedures generated wide interest among the group. The procedures were originally placed on index cards to be distributed and read aloud; however, participants wanted a hand-out of the procedures listed to keep for their own personal use. The hand-out was made for each participant who requested a copy.

Post-Feedback Assessment

The feedback assessment evaluation showed that 64 percent of the participants felt that the workshop was extremely useful. (See Table 4)

One participant commented that, "It is helpful to know that others share math anxiety. It helps not being the only one. This workshop has definitely helped me to begin overcoming this problem." Another stated that it helped her to realize the need for math awareness. One commented that she found all of the information and activities useful and highly interesting. Several participants wrote that they liked the group interaction and sharing of concerns.

Some of the topics suggested by the participants for future workshop presentations were a reading anxiety workshop, and a workshop on how to motivate students in mathematics and other subject areas.

In closing the workshop, the researcher/presenter reviewed the agenda and the items or activities covered during that session. A reference to manipulatives for problem-solving development led to expressions of concern about preparing hands-on materials. Because the new math curriculum for the next year included only a textbook and teacher manual for classroom use in the math curriculum, teachers would have to be creative and resourceful enough to make problem-solving manipulatives for their classroom setting. The participants were requested to complete the feedback assessment forms for evaluative purposes and to return them by the close of the school day.

Workshop 3—Instructional Motivation and The Special Child and Math Anxiety

Pre-Session Preparation

The researcher/presenter reviewed the previous workshop session with the building principal and reported that the results of the session indicated that the participants enjoyed the workshop session on problem-solving strategies and felt that the materials and resources were adaptable to their individual classroom settings. Teachers also showed a caring and sharing attitude toward each other in strengthening their personal and professional expertise. The researcher/presenter reviewed the input provided by participants in reference to questions and concerns that they would like addressed in session three. All of the preparation steps for Workshops 1 and 2 were repeated for Workshop 3.

The researcher/presenter selected the topics "Instructional Motivation" and "The Special Child and Math Anxiety" based on previous input from participants. The intermediate level teachers were concerned that their students showed no intrinsic motivation for learning math. In order to focus on math and how to motivate students the researcher/presenter opted to cover all bases and widen the topic in a more global perspective. Previous contact with some of the students and background knowledge of their potentials indicated a need for a more global approach to motivation.

Many special children were mainstreamed into the regular classroom setting for math or reading. In order to expose the regular classroom teachers to some of the difficulties that the special child might experience in understanding math, the researcher/presenter sought the expertise of two of the most knowledgeable and caring teachers concerning the topic of The Special Child and Math Anxiety and invited them to become an integral part of the workshops. Many of the Special Education Teachers had expressed a desire to have workshops that addressed the topic of manipulatives for classroom use in the area of mathematics.

The researcher/presenter met with the guest speakers several times to plan and discuss the format for the workshop presentation. Gloria Donohue was to address the needs of the primary special child and the factors that might influence math anxiety for individuals in that setting. Sara Riley was to address the needs of the special child at the intermediate level emphasizing factors related to math anxiety and

the intermediate level emphasizing factors related to math anxiety and hands-on material used to help reduce math anxiety.

This workshop was repeated twice and was attended by nine classroom teachers and other visitors. (See chapter III for schedule of workshops).

AGENDA 4

Math Anxiety Workshop 3 Agenda
Theodore Roosevelt School--March 13, 1987
Perletter Wright--Workshop Presenter

Topic--Instructional Motivation and The Special Child and Math Anxiety

I. Instructional Motivation

II. Mental Math Activity

III. Presentations--Math Anxiety and the Special Child--Gloria Donohue and Sara Riley, presenters

The first topic of discussion was Instructional Motivation. This topic provided insight to participants as to the relationship of the teacher and student in "Instructional Motivation." Current research indicated that instructional motivation stems from the teacher to the student and that the purpose of instructional motivation is to bring about intrinsic motivation in the students so that they become self-motivators.

The researcher/presenter displayed information using an overhead projector and instructed participants to voluntarily read aloud each point listed. The sources of this information were: "Motivating Children to Learn: What You Can Do," and Student Motivation: The Key to Better Learning.

Instructional Motivation

1) Intrinsic Motivation—developing self-concept, meeting individual needs, and encouraging student progress.

2) Motivation is complex and controversial, but it is also a crucial element in instructional success.

3) Teachers must be the instructional motivator.

4) The role of the motivator is to:

a) Invite success—William Purkey said that "Inviting School Success is a summary description of messages—verbal, nonverbal, formal and informal—being continuously transmitted to students with the intention of informing them that they are responsible, able, and valuable."

b) Promote cooperation—this motivational principle promotes higher levels of self-esteem while also lending itself to "belongingness." The teacher sets clear goals, explains the criteria for success, structures the group for individual (as well as group) accountability, monitors the process and intervenes when necessary, and provides directions for the task, pays attention to the process, and allows groups to evaluate their own effectiveness.

c) High Expectations—Use positive suggestions, such as, "I expect that, with practice, your multiplication will improve each day." Set clear and explicit goals for student learning each day. Goals should be challenging but not too difficult. Communicate these goals as expectations and let students know that—though the work ahead may be difficult—they can achieve.

d) Set induction--This principle relates to teacher behaviors designed to induce "readiness to learn" in students. The idea is to prepare students for learning by grabbing their attention with an activity that is arresting and relevant to the lesson and to the students' experience. Example: "If rain falls out of clouds, why don't clouds fall too?" Set induction provides structure, directions, and relevance that together pique curiosity and promote motivation to learn.

e) Interaction--A key role of a teacher is to generate the kinds of questions that give students every opportunity to possibly show what they know, think, and value. Motivating questions usually involve little risk for the respondents and allow many acceptable answers. Teachers should use "wait time more effectively." When this is done a teacher can expect more answers, longer answers, and better-reasoned answers. Also, the use of questions that even the teacher cannot answer is helpful. Using questions as a means of increasing motivation requires teachers to develop the skills of divergent and higher-order questioning and the skills of redirecting and suspending judgment.

Five major points were used in the sharing of this lesson. Of the five major points shared with the participants, several commented on the factor of wait time. Wait time is the period or span of time that an instructor gives a student or students in order to respond to a question. It allows time for a student to reason and to be creative. Several participants commented that they had often tried this technique, but for several different reasons they did not apply it all the time.

However, the participants thought that it was a good tool for motivating students.

Mental Math

Following the lesson on Instructional Motivation, the researcher/presenter shared an activity with the group that was designed to stimulate mental math abilities that ranged from the simple to the complex. Most of the activities were computational and could be done mentally. They required that the participants listened carefully, read the question, and demonstrated a working mathematical vocabulary. This mental math activity incorporated basic algorithmic procedures and demonstrated that this exercise could be adapted for all grade levels and involved all aspects of math.

The game was called "I have." The source of the information was obtained from a workshop presentation by Fred Paul, a representative from the New York State Education Department. The title of the workshop was "Problem-Solving Strategies: Is it a Part of the Whole Language Curriculum?"[14] The following information was given to each participant: one index card with a question and a response to another question. The researcher started the activity by saying "Who has 8?" The following procedure took place:

Participant's response	Participant's question
1) I have 8.	Who has this number plus 17?
2) I have 25.	Who has the square root of this number?
3) I have 5.	Who has 130 times this number?
4) I have 650.	Who has this number divided by 1/5?
5) I have 3250.	Who has 250 subtracted from this number?
6) I have 3000.	Who has 1/6 of this number?

7) I have 500.	Who has 25 percent of this number?
8) I have 125.	Who has this number divided by 25?
9) I have 5.	Who has the fifth power of this number?
10) I have 3625.	Who has 12 x 7 x 10 minus this number?
11) I have 2785.	Who has this number plus 9?
12) I have 2794.	Who has one half of this number?
13) I have 1397.	

With the last response given by the participant, the activity was brought to a close. The participants were not allowed to use pencil or paper to compute any of the solutions. While the activity was proceeding, participants were moving their hands in the air or showing some facial signs of computing the answer as each question was asked. Some participants looked at their individual cards two to three times to make sure that they were the one that should respond to the question. Some teachers knew who had the correct response and would give each other a nudge to respond to the question. This activity was well received and stimulated interest in the group. One participant made a suggestion that instead of ending with the last person giving his or her answer with "I have," whoever the individual was, could have a rhyme written at the end to add a note of levity.

Math Anxiety and the Special Child

Next, the researcher/presenter offered the participants background information on the two guest speakers, emphasizing their expertise in the area of Special Education. Gloria Donohue spoke on Math Anxiety and the Special Child at the primary level. She gave examples of an adult being upset over a bill that was overdue, or a family problem, or a recent divorce. She related "how" one feels at

that particular time with "how" a special child might feel "all" of the time. Donohue stated that we all, at one time or another, are like these children.

Donohue's presentation centered around the child and developing a readiness for understanding arithmetic. She developed the concept of oneness with the group--how the numeral one is the foundation for understanding math to the special child. She shared lesson techniques that an instructor might use in setting the tone for presenting a mathematical concept. The techniques she demonstrated included the use of the head, as a visual clue indicating to students that a mathematical task was required. Also, the clapping of hands for the same effect. She stressed that all modalities for instruction should be utilized. It was also suggested that if a child had difficulty relating to math concepts, then teach algebra--for example, the concept of adding monomials.

Sara Riley's presentation involved setting a climate for math understanding. She gave an example of a new student assigned to her classroom during the last few days before the Christmas holidays. This child was from a single-parent home and perhaps the mother had trouble financially keeping the household together. Riley would observe the interactions of the child and the parent. Did the parent see that the child came prepared to do work, had paper and pencil, note-books, and other resource materials needed for the child's everyday use in school? This served as an indicator of how the child and parent viewed school, and furthermore, the kind of care and needs the child would have to have in order to become a successful student.

The child was then given a set of instructions to determine how much help the student would require and at what stage of learning he/she may be at that particular time. Along those lines, two personal folders were compiled for the student. The student has direct hands-on participation in the construction of the folder that says, "My Tasks." Handwriting was observed and numberness was also noted. The student's mathematical skills in the area of place value, measurement, and money recognition were some of the concepts taken into account. There was a daily flow of teacher-student interaction. Other disciplines were interwound into the math building concepts such as art. The presenter suggested that many hands-on manipulatives could be made from any type of resource. Some examples that she used were clothes pins, old magazine pictures, cardboard pieces to make games, and scraps of wood pieces. She shared some of the games with the group that she had made such as "Let's Go Fishing" and "Treasure Hunt." These games could be played in a cooperative group atmosphere or on an individual basis.

Post-Session Feedback

The majority of participants felt that the workshop was very useful (63 percent). The participants generally felt that both presentations were very good and gave each one of them a better picture of the special child and the problem of math anxiety, especially those students who are mainstreamed from the special education classes into the regular classroom setting for instruction in the mathematics area.

An individual commented that, "We need to know more about our special students' learning styles and how to teach to the special child needs in the area of mathematical concepts and problem-solving strategies." The Special Education Teachers expressed a need to have teachers share in the creation of mathematics hands-on material for classroom use. The researcher/presenter was familiar with some of the needs of those teachers in respect to using various materials and techniques in the mathematics areas as a way of motivating their students to grasp the various concepts and skills embedded in the discipline of mathematics.

Some future topics suggested by the participants were a workshop on writing anxiety and a workshop on games and teacher-made materials that assist in teaching mathematics concepts. As one teacher stated, "I think the creation of grade-level math kits for hands-on motivation would be useful. One kit for each mathematical concept would be inspirational for teachers and students alike."

Summary

Participants had requested information on how to motivate students to "want" to be better students in mathematics. The researcher/presenter believed that this topic should also be extended to other subject areas. Thus, the researcher/presenter selected the topic of Instructional Motivation to relate its relevance to all disciplines.

Two handouts were distributed to the participants. One highlighted eight points on how to motivate students through the

development of intrinsic motivation as opposed to extrinsic motivation. The other handout pertained to teachers and their motivational practices used to encourage students. (See appendices H and I).

To bring about a sharing of the needs of the Special Child and how math anxiety may affect those individuals, the researcher sought the expert knowledge of two teachers in this field, one a former teacher at the school and the other an intermediate teacher of special education. The guest speakers gave a 10-15 minute presentation showing the relationship of math anxiety to the special child on the primary and intermediate levels.

Workshop 4--Problem-Solving Strategies—Hands On Correlation of Problem-Solving Strategies to Newly Adopted Mathematics Textbooks

Pre-Session Preparation

The researcher/presenter met with the building principal to formalize plans for the next scheduled workshop session. The next workshop presentation required that the researcher/presenter gather resources to present the topic of Problem-Solving Strategies related to the newly adopted math textbook series. This workshop also required the preparation of math "make and take" materials that were correlated to the new math textbook series for grade levels kindergarten through second grade. A source of the resource materials used was gathered from previously attended workshops on that topic. A guest speaker was invited to share her expert knowledge of creating problem-solving hands-on material for classroom use.

The format for reviewing topics for future workshop sessions, assessment of participants' feedback evaluation, and all the other components previously used to set up the workshop session were put in place for this workshop presentation. This workshop was attended by eleven teachers and one ancillary staff member. (See Chapter III for schedule).

AGENDA 5
Math Anxiety Workshop 4 Agenda
Theodore Roosevelt School--March 27, 1987
Perletter Wright--Workshop Presenter
Topic--Problem-Solving Strategies--Hands-On Correlation of Problem-Solving Strategies to Newly Adopted Mathematics Textbooks

I. Mental Math Activity

II. Attribute Blocks

III. Problem-Solving Activities

IV. Hands-on Math Materials--presenter Sara Riley

V. Math Make and Take

Mental Math Activity

The first topic provided the teachers with a mental math activity as a pre-warmup motivation to utilizing problem-solving strategies. This activity was utilized in workshop three. (See workshop three). The "I Have" exercises generated interest and participation among the teachers. The teachers found the exercise very stimulating and adaptable for classroom use.

Attribute Blocks

The next topic introduced attribute blocks as a skill development for logical reasoning. The participants paired off into teams of two. Worksheets were distributed that contained information and directions for completing this exercise. The directions stated that the participants were to choose an attribute block, (circle, square or triangle) in one of two sizes, (large or small) in one of four colors, (blue, green, red, or yellow) and pick three others that were different from the original in three ways. At least two rows were to be completed. The main source of data was obtained from "Problem-Solving for Primary
15
Primary Grades K-3"

At the end of this activity, the participants requested that they keep their packages containing the attribute blocks and that the worksheet be duplicated for them for classroom use. One of the teachers shared with the group her subject-matter knowledge of the various types of attribute blocks and the types of skills that they could introduce or reinforce. After the session was over, she also made available her materials on attribute blocks to the researcher/presenter.

Problem-Solving Activities

Topic number three provided problem-solving activities related to the new mathematics textbook series for kindergarten through sixth grade. This activity was provided to enhance participants' knowledge of various problem-solving strategies.

The researcher/presenter distributed a problem-solving worksheet that contained the following strategies: guess and check, working backwards, making an organized list, finding a pattern, and Euclid's Algorithm. The presenter directed participants to read

problems from the handout and gave participants time to find solutions. The participants shared methods they used and showed what type of strategy could be used to find solutions. Three to five examples of problems were given to participants in order to provide for practice in recognizing the types of strategies that could be used to solve each problem. The researcher/presenter selected volunteers to read a problem. If they desired to give the solution after the teachers were allowed sufficient time to solve the problem, they could do so. Many of the responses were correct, and once a strategy was pinpointed it was reinforced by other problems similar to the original.

Hands-On Math Materials

The purpose of topic four was to demonstrate how teacher-made materials could be used for hands-on experiences in mathematics for classroom use. In order to carry out this objective, the researcher introduced the guest speaker, Sara Riley, who presented and described three teacher-made projects that she created for use in the mathematics curriculum designed for the particular needs of her students. These activities helped stimulate, teach, or reinforce a new math concept. The projects centered around place value, working with money, and estimation development. These games were made from very ordinary materials in everyday use. Teachers were very receptive to the presentation. They wanted to know some of Riley's resources. She told them of various magazines that she used to select pictures

from. Also she emphasized household items such as clothespins and old shoe boxes.

Math Make-and-Take

Topic number five provided participants with math "make and take" materials. These materials were correlated to the new mathematics series and served as hands-on material in working with various problem-solving strategies.

The researcher/presenter displayed "make-and-take" materials for participants' use. The researcher told participants that each of the activities came directly from the new mathematics series and provided hands-on problem-solving strategy for the students. This activity was drawing close to the end of the allotted time, and the participants received copies of the make-and-take packages. They were also given some of the materials in order to make their projects. The make-and-take activities were selected because they reinforced a problem-solving strategy previously used in other workshop presentations.

Summary

The workshop gave participants and the researcher/presenter an opportunity to learn and share new problem-solving strategies. It introduced a number of new strategies to participants and gave everyone an opportunity to see how they could be used in both the old and new mathematics curriculum. It also helped some participants to declare their math anxieties in this area and provided for peer group interaction and sharing of knowledge.

Post-Assessment Feedback

Seventy-three percent of the participants felt that the workshop was extremely useful. Activities that they found particularly useful were the mental math activity, attributes, problem-solving strategies, the presentation by Sara Riley, and the math "make and take." Individual comments included:

"I thoroughly enjoyed the peer learning and interaction."

"Excellent! It is the kind of workshop I find most inspiring. It can be taken right into the classroom and is immediately useful."

"Enjoyable. Should meet to expand strategies often."

"Fabulous Ideas! Stimulating! A real boost! All—I loved it!."

"We need this until anxiety in math is not the issue anymore."

"It was very informative and helpful. I appreciated the cordiality."

More workshops of this nature were suggested for the future.

Workshop 5—Problem Solving—Higher Order Thinking Skills

Pre-Session Preparation

The preparation for workshop five followed the same basic pattern for workshops one through four. The preparation material for problem-solving strategies varied only slightly to meet the needs of the participants. The number of teachers in attendance numbered nine. The participants involved were third, fourth, fifth, and sixth grade teachers. (See Chapter III for schedule).

AGENDA 6

Math Anxiety Workshop 5 Agenda
Theodore Roosevelt School--April 13, 1987
Perletter Wright--Workshop Presenter
Topic--Problem Solving--Higher Order Thinking Skills

I. Problem-solving strategy--group activity

II. Problem-solving strategies correlated to new math textbooks

a. Guess and check
b. Working backwards
c. Making an organized list
d. Finding a pattern
e. Euclidian algorithm

III. Problem-solving strategy using attribute blocks

IV. Summary

V. Feedback assessment

Problem-Solving Strategy

The researcher/presenter reviewed previous definitions of problem solving from the review of the selected literature. The review indicated that problem-solving strategies could be a factor in helping individuals reduce math anxiety. The session began with cooperative problem-solving activities that required hands-on techniques.

The first topic introduced provided a pre-warmup exercise that involved participants with a mental math problem-solving activity that used the strategy of breaking set.

The researcher/presenter read the following problem: "The Smiths went to the hardware store to buy something they needed for their new house. When they asked the prices, the clerk said, "One will cost 10 cents, 7 will cost 10 cents, 16 will cost 20 cents, 107 will cost 30 cents, and 1642 will cost 40 cents." What were the Smiths buying?"

The "Mathematics: Teacher's Resource Packet 3-6" contained the data used for this problem and others. The activity was carried out similarly to "Twenty Questions." As each question was entertained, the researcher/presenter would either give a yes or no answer. Sometimes the questions called for a "maybe" reply. Some questions pertained to where this object could be placed, others as to the color and so on. Finally, one of the participants guessed that it was the numbers for the new house that the Smiths were buying.

Problem-Solving Strategies Correlated to Newly Adopted Textbooks

The second topic correlated problem-solving strategies to the new mathematics textbook series for kindergarten through sixth grade. The researcher/presenter displayed the activities which ranged in appropriate grade levels. The following activities were presented: Space Men, Odd Balls, Hand Shakes, and Sail Away. These activities developed cooperative thinking skills. The researcher/presenter distributed worksheets containing a list of twenty-six problems that utilized the following strategies: trial and error, working backwards, making an organized list, finding a pattern, graphing, finding facts, and the greatest common factor using Euclid's Algorithm. The sources for the data were "Problem Solving for Primary Grades K-3" and Creative Problem Solving in School Mathematics.[17] The data was changed to reflect the needs of the Roosevelt student population. The activities generated great interest and participation from the teachers. Euclid's Algorithm demonstrated finding the greatest common factor and provided the teachers with a new alternative for reinforcing this skill among

fifth and sixth grade students.

Problem-Solving Strategy Using Attribute Blocks

Topic number three developed logical thinking skills. The researcher/presenter distributed worksheets on attribute block categories and attribute blocks. Participants grouped themselves into teams of two. The presenter stated that the participants were to select any attribute block as their original piece, and from then on participants were to choose three others that were different from the original in at least three ways. The same procedure was covered in topic two of workshop four.

Summary

The participants and researcher/presenter experienced peer interaction in a collaborative atmosphere in working with the various problem-solving strategies. Many participants vented their fears and saw that others also experienced math anxiety. Some guidance was provided by the researcher/presenter, but in a non-threatening atmosphere. Participants were cooperative and enthusiastic and followed problems through to their solutions. The session provided participants with a variety of problem-solving techniques, extra resources to use in the present mathematics curriculum and resources for the newly adopted mathematics series. The workshop activities provided for peer group interaction, development of new learning styles, and increased knowledge of various types of problem-solving strategies.

Post-Assessment Feedback

A majority of the participants (55 percent) stated that the workshop was extremely useful and gave no special preference to the order of the activities. Most of the participants commented that the hands-on activities were beneficial and could be applied directly and immediately to classroom use. Individual comments included the following: "Working with a partner helps with the frustration when handling difficult problems. It's been great!"

Workshop 6--Computer Anxiety and Teachers

Pre-Session Preparation

The researcher/presenter followed the same preparational steps for workshop six. In order to prepare for the presentation on Computer Anxiety and Teachers, the researcher/presenter discussed plans with the District Computer Director. A memorandum was distributed to participants to ascertain their particular needs and concerns in working with computers. The researcher/presenter also met with the computer lab assistant to discuss plans for the session. Responses to the memorandum were gathered and analyzed to formulate the project goals.

Originally, the last workshop was scheduled for April 24, 1987, but because of other scheduling conflicts the participants met in the computer lab of the Theodore Roosevelt School on May 1, 1987. The number of participants in attendance were eleven. Seven of the participants included teachers from grades three through six. Central

office administrators included the District Compensatory Education Director, Psychologist, Writing Coordinator, and Computer Director.

AGENDA 7

Math Anxiety Workshop 6--Agenda
Theodore Roosevelt School--May 1, 1987
Perletter Wright--Workshop Presenter
Topic--Computer Anxiety and Teachers

I. Computer Anxiety and Teachers

II. Hands-On Presentation--Ruth Rubin, presenter

III. Feedback

IV. Summary

Computer Anxiety and Teachers

Topic number one discussed the relationship of teachers and computers and the factors that might have brought about this relationship. The researcher/presenter used brainstorming techniques to elicit from participants various factors that might have introduced computers into their lives. Some participants stated that their first encounter with computers came from various sources such as a second job, here at school, or their family purchased one for home use. The sharing of those factors gave participants a broader perspective of computer usage in everyday situations.

Following that topic, the researcher elicited from participants "why" they felt some teachers might experience computer anxiety. Some participants stated such reasons as "lack of typing skills needed to master certain aspects of the computer keyboard," and "no time for training in this area." Many teachers agreed with both factors and

stated that even though the computer lab was available to them, the time factor did not work in their favor.

The next question under this topic dealt with the relevancy of computers to the everyday lives of teachers. The researcher/ presenter used brainstorming techniques to elicit from the group reasons that teachers might have to use computers in their lives. Some reasons given by the group were, "Micro-computers are used at home for personal use such as record-keeping and also to help teachers prepare materials for classroom use." One of the participants expounded the usefulness of computers especially for projects that she designed for her class and the school.

Following that question, the researcher continued with the next which was, "What are some negative results of not learning to work with computers?" A volunteer read the question aloud to the participants. The participants then responded to the question. Some teachers suggested limited knowledge of how to work computers, feelings of inadequacy, especially if your students know more than you do concerning computers, and the inability to tell what programs might be of use to you and your students in teaching or reinforcing a skill.

The next question elicited suggestions from participants concerning ways to help reduce computer anxiety. The researcher/ presenter used brainstorming techniques to elicit from participants ways to help in the reduction of computer anxiety. Some responses were to provide access to computers during the times most convenient to teachers and to conduct workshops that would strengthen teacher skills in this

area, or working with students who already had some background knowledge in operating computers.

The next question demonstrated that computers were a vital part of the world for which we are preparing our students. The researcher/presenter asked that question number six be read aloud. The researcher stated that because our students will be involved in every aspect of society and that society will be utilizing computers in all fields, we should prepare them for this fact. The teachers then added that areas such as business, government, schools, and so on will one day conduct their business via computers.

The last question asked participants to state some of the benefits of learning to use computers. Some of the responses were increased knowledge of how to operate a computer, the various ways to utilize computers, such as programming, or for basic drill, and to increase both their personal and professional skills as teachers/ individuals.

Hands-On Presentation

Topic number two provided a hands-on experience related to computer use. The researcher/presenter introduced Ruth Rubin to the group. The computers were then loaded with Newsroom data. Rubin then gave the group instructions concerning the program and what would be created from the hands-on experience. Directions were given for each step as the group created a one-page newsletter. The presenter circulated around the room to give guidance as needed following each step that was given to the participants. The workshop was originally

scheduled for two hours, but due to the interest and the involvement in the project, the time was increased half an hour in order to complete the project. The data used was the Newsroom.[18]

Summary

The workshop was a direct outcome of the participants' request to know more about computers and to deal with some of the participants' fears of computers and their usefulness to instructional leaders. The goals were: 1) to demonstrate the vitalness of computers in everyone's life, 2) to show that computers will be directly and indirectly a part of students' lives, as well as our own, 3) to show participants that there is a need for training or retraining in this area in order to enhance their professional/personal growth with this new learning tool, and 4) to make participants aware that they are not the only ones with a fear of computers and that this fear can be reduced.

Post-Feedback Assessment

A majority of participants felt that the workshop was very useful. Most of the participants found that the discussion on Computer Anxiety and Teachers was a topic that was needed and relevant to the staff. This topic opened peer interaction and the sharing of problems to a wider degree among the staff—those who are relatively new teachers, and to the experienced staff who face this problem. Most participants stated that they had only come in contact with computers to a limited degree and gave some examples. Not only was their

experience limited, but due to the fact that some could not type, this seemed to be an added factor in feeling overwhelmed with computers. Prior to the workshop, a participant commented on a survey that, "I dislike computers; I feel that a computer teacher should teach it to the children, because I know very little about computers." Other individual comments were: "We need more hands-on activities with computers." "The only way to deal with computers or math anxiety is to have hands-on workshops such as today's." "The connection made between computer anxiety and math anxiety provided fresh insight into both areas." "More practice time needed." "For a novice such as myself, I found the computer hands-on activity exciting but too advanced. However, my computer anxiety has drastically lessened. I think I might even like to own one." Most teachers expressed a need for more practice time with computers.

Conclusion

The workshop sessions on the reduction of math anxiety were brought to a close with the last workshop presentation on Computer Anxiety and Teachers at the Theodore Roosevelt School on May 1, 1987. What the staff and the presenter had gained from the workshops is difficult to measure. The staff development project opened many avenues for teachers in their participation in the educational process. Teachers began to address their needs and tried to solve problems within the confines of educational change and the ramifications that go along with efforts at change. Teachers learned

to admit that there were certain weak areas of their professional preparation. Teachers shared their problems and concerns and sought the help of others to solve their professional lives.

Math anxiety exists among experienced school teachers. Teachers are facing their negative attitudes toward mathematics. Teachers are aware of the fear that computers are placing on them in applying this new tool to their professional and/or personal background. The outcome of the workshops demonstrated that teachers were willing to buy into the project. Teachers saw the workshops as an extension of improving the performance and achievement levels of their students in mathematics, and of improving both the math curriculum and overall school program of the district.

Chapter IV

Notes

1 Portia Elliott, "Problem-Solving Strategies UMASS/Roosevelt Staff Development Project," (workshop presentation), 14 November 1987, Roosevelt, NY.

2 Stanley Kogelman and Joseph Warren, Mind Over Math (New York: McGraw-Hill, 1978), 10.

3 Sheila Tobias, Overcoming Math Anxiety (Boston: Houghton Mifflin Company, 1978), and Kogelman and Warren, Mind Over Math.

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[13] Edward L. Deci, "Motivating Children to Learn: What You Can Do" Learning 11 (March 1986): and Marion Leibowitz and Richard Sagor. "Student Motivation: The Key to Better Learning (K-12)" Learning Institute, 1987.

[14] Fred Paul, "Problem Solving Strategies: Is it a part of the Whole Language Curriculum?" (Workshop presentation), winter 1987, Huntington, NY.

[15] Cohen, "Problem Solving for Primary Grades K-3."

[16] Ernest R. Duncan, "Mathematics: Teacher's Resource Packet 3-6." (Boston: Houghton Mifflin, 1980).

[17] Cohen, "Problem Solving for Primary Grades K-3" and Lencher, Creative Problem Solving in School Mathematics.

[18] Newsroom (Minneapolis: Springboard Softward Inc., 1985).

CHAPTER V

MAJOR FINDINGS, ASSESSMENTS OF WORKSHOPS AND STAFF DEVELOPMENT PROCESSES, RECOMMENDATIONS FOR STAFF DEVELOPMENT, AFTER EFFECTS, FUTURE IMPLICATIONS, AND CONCLUSIONS

Major Findings

This study described the design and implementation of school-based, collaboratively planned workshops for the reduction of math anxiety of an experienced staff of elementary teachers. The project applied research findings concerning staff development and its usefulness in developing positive relationships with teachers and schools as organizational systems. Included in the staff development procedures were staff based activities using problem-solving techniques as a means of helping teachers reduce their discomfort with teaching mathematics. This study looked at the changes in the participants' attitudes toward teaching mathematics as a result of seven workshops based on staff needs.

This low-cost, voluntary project demonstrated that teachers wanted to participate in inservice workshops based on sound practices, identified needs, and individualized concerns. Elementary teachers wanted to learn more about reducing math anxiety and improving problem-solving strategies. Teachers preferred school-based, small sized, and concrete workshops.

Based on experiences and insights gained from the study, a major portion of the activities entailed working with teachers. Teachers were assisted in reducing math anxiety and developing problem-solving strategies.

This dissertation has described the design and implementation of a series of workshops for experienced elementary school teachers that responded to an expressed concern with math anxiety as an inhibitor to new curriculum using problem-solving strategies, manipulatives and micro-computers. By assessing the responses to these workshops that were based on a senior and largely female staff serving a predominately Black and low-income neighborhood, the study sought insights into staff development processes--what worked or did not and why. Better ideas for teaching have little effect unless they are practiced; and innovations are not always welcomed by already overburdened teachers. As Sarason, Lipskey, Lieberman and Miller among others have noted, teachers ordinarily feel isolated from each other.

These workshops are described as a case study in school-based, collegial staff development. In that spirit, the processes and group dynamics experienced throughout this series of workshops are examined in light of the literature about successful staff developoment procedures as documented by McLaughlin's and Marsh's Summary of the Rand Studies.

In a sense this case study demonstrates a comprehensive cycle of school improvement activities. At one level or stage, the researcher gathered information about teachers' needs and then examined a range of studies about math anxiety and some possible solutions. At that level there were important questions about the accuracy and usefulness of information about math anxiety and about how the teachers received that information. At another level, the activities were designed to show how

teachers in a building might gain empowerment by engaging in planned staff development based on their understanding of the group dynamics and a knowledge about ordinarily successful staff development procedures.

These two stages are necessarily related because one's understanding of staff development procedures depends on whether the workshops succeeded in their own terms to attract teachers to learn more about math anxiety and problem-solving strategies. A positive assessment of the workshops, combined with a good match between the dynamics of staff development and the relevant literature provides powerful evidence for the accomplishment of the ultimate goal to improve the achievement levels of students in mathematics also enhancing the overall school climate by demonstrating teachers working together.

Assessment of Workshops

Workshop assessments plus a summative evaluation revealed positive responses to problem-solving techniques and generally more enthusiasm about mathematics. Furthermore, observations of teachers and normal standardized test scores of students indicate better instruction in mathematics. In order to assess the effectiveness of the particular staff development workshops in this case study, certain research questions were posed in the opening chapter:

Will participants

1) Agree to attend math anxiety sessions on a voluntary basis?

2) Actually attend the scheduled sessions?

3) Believe, after attending math anxiety workshop sessions, that the information, exercises/activities will be of use to them in the reduction of math anxiety?

4) Use or further develop their problem-solving strategies as a means to reduce their math anxiety?

5) Feel better prepared to teach problem-solving strategies?

6) Implement more problem-solving strategies in mathematic instruction?

7) Become more sensitive to the needs of students/women/ minorities who experience math anxiety?

8) Improve their attitude toward mathematics?

9) Show an improvement in their teaching techniques/styles in the area of problem-solving strategies?

The answers to these research questions were based on the outcomes and conclusions drawn from the responses of volunteer participants to surveys they completed during, immediately after, and one year after the conclusion of math anxiety staff-development sessions. Participants' input and feedback, either written or oral, or both were encouraged during and following the presentation of each workshop. Specific feedback was reported in the summary and post-assessment sections following each workshop. The input was reported in the post-assessment section following each workshop and the pre-session preparation section before the workshops in Chapter IV. General data and feedback will be expounded on in this chapter.

Attendance was based on a voluntary system and was a sign of the interest that the teachers had in the particular topic on which the staff development program was proposed. The attendance of the participants was contingent on three factors: a) the time frame for

conducting the workshop sessions (teacher contract negotiations stipulated that teachers were not to attend any meetings other than contracted faculty meetings, which could only be held twice monthly and only between 2:30 p.m. and 4:00 p.m.), b) the choice of days to conduct the workshop sessions so that ample coverage could be provided for the participants, and c) class coverage of students while the teachers participated in the workshop sessions.

Of the twenty classroom teachers on the Theodore Roosevelt staff, nineteen volunteered for workshops on math anxiety. Three of the auxiliary support staff members, the reading coordinator, gym teacher, and resource room instructor attended when they could. The auxiliary support staff members' attendance was sporadic due to their schedules and their coverage of classrooms for other participants.

Results reported in Tables 1-4 were based on participants' attendance and feedback of the workshops' usefulness to them during and directly after the math anxiety reduction workshops were given. Staff development documentation on teachers "buying in" to the process noted that teachers will attend only if they find the workshops useful and adaptable for classroom needs. Other features embedded in teachers attending workshop sessions are the reduction of isolation and the sharing of ideas among others.

The first research question asked, "Would teachers agree to attend staff development sessions that focused on math anxiety reduction?" The answer was an overwhelming "yes." The pre-marketing and gathering of workshop support was effective--they agreed to attend.

The first workshop was a required session because it was held in lieu of a faculty meeting. Although the staff consisted of other faculty members, the classroom teachers were the individuals for whom the planned series of workshops were designated.

In the remainder of the six workshops, the classroom teachers were grouped into sections A, B and C. This grouping helped the researcher/presenter to meet the needs of the participants by providing for small-group interaction, ample coverage of classrooms for volunteer participants, and served as a guideline in preparing the number of workshop presentations for this project.

TABLE I

Attendance of Theodore Roosevelt School classroom teachers at math anxiety reduction workshop sessions

Total number of eligible classroom teachers--20

Session	Number of teachers in attendance	Percent of teachers in attendance
Introductory	20	100%
1	20	100%
2	20	100%
3	10	50%
4	13	65% *
5	9	45% *
6	7	35%

* Workshops 4 and 5 dealt with the same topic of problem-solving strategies and represents other members of the school besides the classroom teachers. Those other members consisted of auxiliary support staff.

Attendance at session three shows a decline in attendance. The workshop topic dealt with math anxiety and the special child and was only presented to groups A and B. The decline in attendance for sessions four and five also reflected their special focus. The theme of both workshop presentations was problem-solving strategies and involved basically the same needs and teacher concerns, and in total the two workshops attracted the twenty classroom teachers, plus members of the auxiliary support staff.

In workshop session six, the number of participants was limited to eleven based on the limited number of computers available for the workshop presentation, the instructor's desire to accommodate each participant's needs and to provide for a more personalized hands-on experience. Finally, the researcher believed that only seven participants showed signs of computer anxiety or lacked training in working with computers for their own personal or professional growth.

Contingent on the outcomes regarding attendance of the Theodore Roosevelt classroom teachers the math anxiety reduction sessions, it was concluded that 1) 100% of the classroom teachers were exposed to a minimum of one session, and 2) attendance showed a decline in percentage because the number of eligible classroom teachers were grouped into mini-workshop groups in order to accommodate all participants. Two primary level groups were formed and one intermediate level.

Other participants

The category "other participants" includes administrative personnel, coordinators, psychologist, teachers from other schools and central office. The purpose for including other members of the school district staff was to expose them to the information, techniques, and activities utilized in the math anxiety reduction workshops thereby aiding them in planning, implementing and conducting math anxiety reduction sessions in their school or particular setting. The attendance of participants other than Theodore Roosevelt classroom or auxiliary support staff is listed in Table 2.

TABLE 2

Attendance of other participants at math anxiety reduction workshop sessions

Total number invited to participate--5

Session	Number in attendance	Percent in attendance
Introductory	3	60% *
1	2	40%
2	2	40%
3	2	40%
4	2	40%
5	2	40%
6	4	80%

*Introductory session was opened to all central office staff, principals, and coordinators (reading, math, writing, and computer).

The outcomes regarding attendance of "other participants" at the math anxiety reduction workshop, demonstrated that 1) there was representation from one other school site in the district, central administrative staff, and coordinators; and 2) the attendance of participants remained constant.

The author of this study had an opportunity to present the workshop "What is Math Anxiety?" on two different occasions after the formal conclusion of the workshop sessions at Theodore Roosevelt School. Table 3 reports the results of those two workshop presentations.

TABLE 3

Presentation of math anxiety reduction workshop at other school district sites

Session	Number in attendance	Percent in Attendance
1	9	75% *
2	10	100% **

*Teacher inservice workshop--Junior-Senior High School
May 19, 1987, 2:30-4:30 p.m.

**Math alignment committee--Central Office
July 17, 1987, 11:00-12:00 a.m.

The second research question queried, "Will participants actually attend sessions? Based on the information reported in Table 1, the response was "yes." The need to focus on usable ideas resulted in

smaller attendance (overall) on focused workshops. Some workshops were presented more than once in order to accommodate the participants' needs.

The third research question pertained to the usefulness of the data and the activities to the participants. As reported in Table 4, the majority of the participants found the information and activities very useful to extremely useful. The activities utilized in the workshop sessions generated strong interest among the participants, and the attendance of those participants remained constant.

Perceived Usefulness of Individual Sessions

Following each workshop session, participants were asked to indicate how useful they felt the information and activities included in the sessions would be to them. Tables 4 summarizes those results. The summarization of the participants' responses to the usefulness of the information and activities ranged from somewhat useful to extremely useful. A majority of the ranking indicated that the usefulness of the workshops' information and activities fell into the very useful to extremely useful category.

TABLE 4

Participants' ranking of the utility of information and activities included in the individual sessions

Session	Number in Attendance	Ranking: Minimally Useful #	%	Somewhat Useful #	%	Very Useful #	%	Extremely useful #	%
Introductory	31	0	0	3	10	27	87	1	3
1	25	0	0	3	12	6	24	16	64
2	24	0	0	2	8	15	63	7	25
3	12	0	0	0	0	6	50	6	50
4	15	0	0	0	0	4	27	11	73
5	11	0	0	0	0	5	45	6	55
6	11	0	0	0	0	7	64	4	36

The feedback relating to the utility of the data and activities included in the sessions indicated that a large majority of the participants believed that 1) the data gleaned from the sessions would be useful to them, and 2) all sessions seemed useful. Table 4 also indicated that there were a number of other participants attending te workshop sessions. The other visitors included teachers, principals, or coordinators from other sites in the district.

Classroom Behavior

Results reported in Tables 5-10 reflect a general consensus among the participants concerning the remaining six research questions and

classroom behavioral regularities of the participants. Feedback was obtained through surveys, observations, and personal interactions over the following year. The survey distributed to participants is included in appendix I.

The fourth research question was "Will participants use or further develop their problem-solving strategies as a measure of reducing their own math anxiety?" Table 5 is a summary of those results.

TABLE 5

Further use or development of problem-solving strategies in reducing math anxiety

Number of respondents--19			
Rating Categories			
Number of yes responses	%	Number of no responses	%
18	95	1	5

The data reported in Table 5 indicates that a large majority of the participants used and further developed their problem-solving strategies as a measure of reducing their own math anxiety.

The fifth question posed was "Will participants feel better prepared to teach problem-solving strategies?" Table 6 summarizes the results.

TABLE 6

Preparation to teach problem-solving strategies

Number of respondents--19					
Number of yes responses	%	Number of no responses	%	Remained the same	%
14	74	4	21	1	5

The data reported that a large majority of the participants felt better prepared to teach problem-solving strategies after attending the workshop sessions on math anxiety reduction. Participants provided evidence of this need by writing some of the following responses to research question five: 1) "The workshops were extremely helpful in helping me to overcome my own anxiety and recognizing it in my students. This helped me to be better prepared," 2) "I feel that the workshops have shown me many creative and imaginative approaches in teaching math," 3) "The hands-on approach in the workshops were helpful as a vehicle in conveying concepts to children," and 4) The mystery or myth that math was difficult was removed. I found that there were many ways of looking at a problem and arriving at a solution."

The sixth research question posed was "Will participants implement more problem-solving strategies in mathematics instruction?" Table 7 reports the results.

TABLE 7

Implement more problem-solving strategies in mathematics instruction

Number of responses--19

Number of yes responses	%	Number of no responses	%
18	95	1	5

The data reported in Table 7 demonstrates that a large majority of the participants believe they will implement more problem-solving strategies in their mathematics instruction. Supporting evidence showing that participants actually implemented problem-solving strategies was given by many of the respondents in reply to research question six. Some representative replies were: 1) "I used many of the activities discussed during our sessions. They were well received by the class," 2) "I have found some strategies from the workshop to be useful. When activities were made into games rather than tasks, the responses were better," 3) "I have used suggestions and ideas from our workshops and have made a few of my own," 4) "I have read aloud several of the problem-solving strategies and was surprised with the cognitive abilities of my lower-functioning non-reading students," 5) "I used the problem-solving strategies and integrated them with other subjects such as science and social studies," and 6) "I employed various methods and techniques as a result of the workshops. I learned to use games, charts and other methods to unlock or guide one's thinking."

The seventh research question posed was, "Will participants become more sensitive to the needs of students/women/minorities who experience math anxiety?" Table 8 summarizes the results.

TABLE 8

Sensitivity to the needs of students/women/minorities who experience math anxiety

Number of responses—19					
Number of yes responses	%	Number of no responses	%	Remained the same	%
18	95	0	0	1	5

According to the respondents' report, a large segment of the participants stated that they have become more sensitive to the needs of students/women/minorities who experience math anxiety. Supporting evidence given by the participants was: 1) "I have experienced the same anxieties as some children do;" 2) "I have become more sensitive to the needs of students and am able to see that the anxiety is reduced in my present class;" 3) "I feel that because an atmosphere of defeat and failure can lead to negative feelings that the students may have about themselves in relation to the study of math, it is my responsibility to establish a positive atmosphere in which students can develop;" and 4) "I knew that I was handicapped by not being taught from elementary school. I realized that those teachers hindered my growth and potential

to this day. I would not do this to any student that I am privileged to teach. Teachers should have workshops to keep them in touch with what is new in the field of mathematics and materials. We must observe students, build confidence, and monitor their progress so that they will be ready for the new world of technology."

The eighth research question expounded was, "Will participants improve their attitude toward mathematics?" Table 9 reports the results.

TABLE 9

Improved attitude of participants toward mathematics

Number of responses--19					
Improvement in attitude	%	No improvement	%	Already positive	%
11	58	3	16	5	26

The summarized report indicated that more than half the number of respondents stated that their attitude had improved toward mathematics. Evidence was supported by participants as follows: 1) "My attitude has improved considerably. I would now attempt to enroll in math courses and feel comfortable;" 2) "Yes, it has become keener; there is more of an emphasis on motivating thinking processes to 'do' math"; 3) "My attitude toward math has improved enormously. I am even able to help

my daughter with algebra! Imagine that:" 4) "The workshops helped me to attempt projects that I probably would not have tackled;" and 5) "Yes, I have a more favorable attitude toward math, because much of learning is an emotional experience. The enjoyment derived from being part of a math class can be a strong motivating factor in the life of your students."

Ninth, "Will participants believe they show an improvement in their teaching techniques/style in the area of problem-solving strategies?" Table 10 summarizes the results.

TABLE 10

Self-perception of Improvement in teaching techniques/styles in the area of problem-solving strategies

Number of responses--19

Self-Perception of improvement in teaching techniques/styles	%	No improvement	%	Remained the same	%
16	84	2	11	1	5

From the information reported by participants, a large majority of the teachers stated that there was improvement in their teaching techniques/styles in the area of problem-solving strategies. Not all of the participants felt that their attitude toward math had improved. Sixteen percent of the classroom teachers stated that it had not improved. The respondents' statements reflected some doubt. Some

of the statements were: 1) "No, I guess it's due to the demands of the new curriculum," and 2) "The workshops were informative. They brought about an awareness of strategies and techniques in dealing with math anxiety. However, after many bad years of experiences with math, it is difficult to change these old habits overnight. An ongoing demonstration of new processes would be beneficial."

A summary of the self-perceptions of the teachers related to research questions 4 through 9 are reported in Table 11 on Teacher Self-Perception.

TABLE 11

Teacher Self-Perception Summary

Number of Respondents--19

Self-Perception Belief	Percentage
Further used or developed problem-solving strategies in reducing math anxiety	95
Felt better prepared to teach problem-solving strategies	95
Implemented more problem-solving strategies in instructional program for mathematics	95
Sensitive to the needs of students/women/minorities who experience math anxiety	95
Attitude toward mathematics has improved	58
Teaching techniques/styles has improved	84

Results of Table 11 demonstrated that a majority of the teachers felt that certain areas had improved or had better prepared them or had increased their sensitivity to the needs of others by their participation in the math anxiety workshop sessions. During the course of the year following the math anxiety presentations, the researcher/presenter had many opportunities to observe the participants' attitude toward mathematics and the teaching techniques/styles the teachers employed in their math instruction.

The attitudes of some teachers toward mathematics had generally improved as observed by the researcher/presenter in the following ways: a) the amount of time spent on math instruction increased, 6) various approaches were used to convey understanding by students, c) better planning in presenting math topics, d) teacher enthusiasm in conducting a lesson, e) encouraging students to do their best, and f) letting students know that they expected them to perform and achieve at a higher level in mathematics.

Improvement in teaching techniques/styles was indicated by: a) the use of manipulatives in the math curriculum to either introduce or reinforce math topics, b) use of suggestions by the math coordinator or teacher manual to introduce or reinforce math topics, c) some participants presenting at district-wide staff development workshops that addressed teaching styles/techniques in using problem-solving strategies, d) some participants presenting, at other sites outside the district, their subject-matter knowledge of problem-solving strategies, and e) general observation by the researcher/presenter of teachers conducting math lessons.

Additional Comments of Participants

Those participants who wrote that they did not experience math anxiety considered the math anxiety workshops to be a worthwhile project and gave their support to the accomplishment of the goals set forth in the study. Some of the benefits gained from the workshops were recorded. One participant stated: "My style hasn't changed, but maybe I am now a bit more open to new techniques. I'm not afraid to try them." Two participants responded to the question of feeling better prepared to teach problem-solving strategies in basically the same manner, which was: "I feel about the same. But, due to the data discussed within the workshop, it allows classroom teachers the chance to see how society views math anxiety."

In the initial workshop presentation on What Is Math Anxiety, a subtopic delved into the effects of math anxiety on teachers and minorities. Two of the participants wrote that: 1) "The workshops reminded me that women and minorities are thought of as having a fear of mathematics. I feel that if these groups allow themselves to think as society dictates, they cannot do their best in the classroom. By knowing what society thinks, women and minorities can work to prove society wrong;" and 2) "I feel that if women and minorities allow themselves to be told that they cannot teach mathematics successfully, then eventually they may start to believe it."

One year later suggestions that were given by the participants centered on one main theme. The suggestions were as follows: 1) more workshops dealing with problem-solving strategies, 2) more workshops facilitating the sharing of techniques among teachers, and 3) workshops reporting successful strategies used during the year with students.

Staff Development Processes

Based on the experiences and teacher assessments, certain conclusions were confirmed, and some principles of effective staff development reported in the literature were consistent with this study. Effective staff development procedures and processes are centered around individuals and the school as an organization. Working from the viewpoint of meeting individual needs, this study originated in a sense that most teachers shared some degree of math anxiety. Math anxiety reduction courses or counseling had not been included in their preservice or inservice training. Moreover, rapid changes in the mathematics curriculum and school-based need to improve student achievement and performance levels in mathematics was important to teachers personally and professionally.

Teacher input and suggestions served as an added impetus to teachers' attending the workshops and voicing their concerns and needs both personally and professionally. Some teachers were extremely vocal about their feelings to other participants. Others were borderline sharers, and because of many factors did not care to share their fear of mathematics with others, although their fears were apparent in various actions or comments noted during the workshop sessions and in feedback assessments.

Math anxiety is prevalent among some teachers of elementary students. The grade levels taught by those experienced teachers has no bearing on how effective the instructional level or means of delivery will be on the students. Computational expertise was not the problem in this study, but the delivery of problem-solving strategies as a means of enriching the mathematics curriculum. The implementation of problem-solving strategies in the workshop modules increased teacher subject-matter knowledge and professional and personal growth in problem-solving strategies and techniques.

Recommendations for Staff Development

Individuals wishing to implement math anxiety reduction workshop sessions for elementary teachers on a voluntary basis should consider several consensus building approaches. First, present an introductory workshop session on reducing math anxiety at a faculty meeting so that all school personnel will have an overview of the topic. A staff meeting provides an environment that is less threatening because it does not point a finger at any particular group of professionals. Second, solicit the aid of outside change agents whose organizations have dealt with the problem of math anxiety at all educational levels and can offer a broader view of how it affects members of society. State Education Departments that provide this type of service should be a major source of help in addressing certain needs of the teaching profession. Third, encourage the building principal to express support for workshop sessions on math anxiety and attendance at future workshop sessions. Fourth, share

results of some of the assessment feedback so that teachers verify the fact that their input was valuable and important in planning the sessions. And, fifth, elicit from interviews and workshop sessions specific concerns, identified needs, suggestions for format organization, potential resource personnel or guest speakers and scheduling needs.

Suggested ways of maintaining attendance as sessions progress include at least six steps. Provide ample coverage for teachers wishing to attend sessions. Notify teachers well in advance of planned workshop sessions so that they can prepare lesson plans for their students and the person(s) covering the classroom assignment. Use a variety of methods, activities and techniques at the sessions. Provide as much of a sharing and non-threatening climate as possible. Give all participants an equal voice in the participation process. Use feedback provided by participants and central office administrators in the planning of future sessions where they are feasible and helpful to the project.

Administrative personnel can enhance your project and provide support from the top level downward. Some suggestions for implementing staff development workshops follow. Request the approval of the district administrative heads in carrying out your program. Meet with your school principal or other principals to discuss with him/her your program outline. Arrange to present to all the staff at a scheduled faculty meeting. Involve prospective participants in hands-on activities that generate discussion and interest in your project. Show the involvement of others in your program such as district coordinators, central office

administrators, and principals. Offer to present a workshop at another school site or for the district.

Individuals concerned with participants' believing that sessions provided them with utilitarian information and activities should consider the following. Utilize the input and feedback that participants provide both orally and in written form when planning sessions. Emphasize practical and specific suggestions rather than philosophical and general suggestions. Provide opportunities to participants so that they may share their own professional and personal experiences in workshop sessions.

Individuals concerned with the reduction of math anxiety among elementary teachers should consider the following. Involve the participants in activities and projects that are designed to meet the individual needs of the participants. Develop problem-solving strategies that will build and enhance the math curriculum used by the participants. Develop problem-solving strategies that will meet the needs of the student population. Invite participants to share their own subject-matter knowledge of various problem-solving strategies or techniques.

Topics on teacher attitude toward mathematics should be included in staff development workshops on math anxiety reduction. The topics provide an opportunity to heighten teacher awareness of how negative attitudes of the teacher can influence and impact upon a student's performance and achievement levels in mathematics. Staff development workshops should be held to enhance the participants' personal and professional skills in various parts of the curriculum. New mathematics

techniques should be addressed by teachers and those responsible for carrying out the mathematics curriculum.

Problem-solving strategies should be incorporated into math anxiety reduction workshops for teachers. Teachers need relevant information and activities that help them to carry out their professional duties in an effective manner and that empower and enhance their subject-matter knowledge of mathematics. On-going programs should be provided by experts or mathematics teachers who have background knowledge in counseling individuals with math anxiety. One-on-one assistance should be provided for individuals in an effort to reduce math anxiety. Small-group interaction provided for individuals seeking help for this phobia helps to alleviate some of the feelings of isolation or helplessness. The mathematics curriculum should be reviewed to ascertain where the pressure lies for those individual teachers who are finding difficulty implementing the mathematics curriculum in their classrooms. A non-threatening atmosphere should be provided for participants by those who are responsible administratively for the curriculum, for teachers, and for students.

Staff development in the area of math anxiety reduction can be effective if certain criteria are taken into consideration. The staff development project must meet the needs of the participants. The participants must view the project as a need that they can support and buy into. It must try to meet the needs of the staff on an individual basis, as well as in cooperative group learning situations. The timing of the project is also pertinent to the study. The support of the administration should be made known to the participants. The setting

should be easily accessible to participants. Resources and activities that provide for individual and group professional growth serve to enhance the program. Teachers will feel that they have not wasted their time and effort in attending the workshop sessions. When teachers feel that they share equal power with each other, an atmosphere of dominance among the participants is alleviated. Documentation of successful programs provides for more respect and support for the staff development project.

Those who are advocates for research programs that help in the reduction of math anxiety among individuals should share with others their data concerning the effects of math anxiety on individuals in general, and specifically among teachers. Presentations at staff development workshops serve to disseminate data among a wider audience; writing for journals read by one's peers helps in understanding this fear.

A sharing of ideas, needs, and concerns serves as a beginning foundation of unity among a staff. Teachers need to help themselves create a strong emotional and caring community of individuals in a changing world that will reflect directly on the positives and negatives of society. Support should be given to those individual teachers who wish to reduce math avoidance/math anxiety. Math anxiety should not be viewed as a problem chiefly among women or minorities. Unless one also recognizes the particular affects on women and minorities, math anxiety will not easily be eliminated, because men will dominate

discussions concerning the relatively poor performance of females and minorities in mathematics. Math anxiety should be viewed chiefly as a human problem. It is a condition that has developed out of what we have been taught by society and what society itself has helped to perpetuate among individuals in all settings.

After Effects

Several projects and activities were outgrowths of the math anxiety workshop sessions held at Theodore Roosevelt School. For some members of the auxiliary staff, namely the physical education teacher and reading coordinator, the workshops stimulated them to implement more problem-solving strategies in the disciplines that are their domains. Three of the classroom teachers continued developing their problem-solving strategies/techniques in a course held at a local college. The course was especially designed to develop problem-solving strategies for the elementary teacher. The program was sponsored by the New York State Education Department and implemented at the College of Old Westbury.

The author of this study later conducted a workshop for teachers of students in grades three through five as a part of the district's on-going staff development program. The researcher also conducted two workshops on math anxiety among minorities and the development of problem-solving strategies for higher student achievement and performance. The workshops involved parents and students at the elementary and junior high levels.

This project aimed at improving teachers' attitudes toward mathematics instruction in an elementary school with the expectation that indirectly teacher behaviors would lead to improved achievement scores. Although changes in achievement scores in mathematics have varied for many reasons and were not solely influenced by these workshops, it would be disappointing if test scores dropped significantly in the year following the workshops. In fact, test results indicated that student performance and achievement levels surpassed that of the national average. The after effects of the workshops on teacher behavior indicated positive gain in student achievement levels, but that cannot be taken as conclusive one way or the other.

Conclusion

The goal of the study was to assist an experienced staff in the reduction of math anxiety through staff development workshops. The study has focused on participants who serve minority students and whose setting is less than ideal. There are many problems that need to be addressed. Some have been addressed, in one fashion or another. A common, yet silent thread of hope has run through this study, linking better schools, better teachers, better students, better curriculum designs, and evaluation. Along with that common thread, teachers have shown that they willingly act to enhance their professional and personal growth. They have shown that teaching is not only something that they do as part of the educational community, but they have shown too that they continue to grow professionally.

Staff development workshops that focused on the reduction of math anxiety among elementary teachers at the Theodore Roosevelt School worked because of support from administrators, the building principal, auxiliary staff, and the participants for whom the project goals were designed. Good staff development processes allowed 1) individual teachers who feared math to attend the workshops, 2) a school-based project to be implemented by staff members who volunteered, 3) peer-group interaction and a sharing of ideas among colleaques/administrators/ experts, 4) problem-solving strategies that entailed cooperative efforts, 5) activities that addressed the school's instructional curriculum, 6) increased morale among teachers, administrators and students, 7) development of new techniques in presenting concepts, and 8) professional growth of teachers.

The benefits of staff development for teachers resulted in 1) improving teacher attitudes toward mathematics, 2) increasing sensitivity to the needs of those individuals who are disabled by this fear, especially females, minority groups and some elementary school teachers, 3) addressing individual concerns and needs regarding mathematics or math anxiety, 4) developing problem-solving strategies as a means of assisting teachers in the reduction of math anxiety, 5) implementing problem-solving strategies, 6) enhancing problem-solving strategies in the improvement of teaching techniques/ styles, and 7) increasing teachers' computer literacy.

The long range benefits of staff development for students included 1) improved mathematics instruction, 2) improved mathematics

competency/achievement level, 3) improved student attitued toward mathematics and a broadened awareness of the importance of mathematics, 4) increased peer group interaction and a sharing of ideas and skills, and 5) improved performance in the mathematics-related fields of science and computers.

Teachers are concerned about their overall effectiveness as instructors of students. Teachers know when they are well prepared to impart knowledge to students, and they know how effective their impact can be on students. Technological changes are rapidly making their presence known in the educational field. These technological changes require competent and well-trained students who are proficient in mathematics and science. Teachers help facilitate learning for students when they have demonstrated the confidence and subject-matter expertise required to become well-prepared mathematics instructors.

APPENDIX A
MATH ANXIETY SURVEY ONE
ROOSEVELT PUBLIC SCHOOLS
Roosevelt, New York 11575

I would like to solicit your opinions regarding teacher attitudes toward arithmetic. Whenever feedback is used in my professional writings, anonymity will be protected. Using the scales below, please rate the following statements on a scale of 1 to 5 to represent the degree to which you accept the statement as true for elementary teachers in Roosevelt.

1 Never true
2 Seldom true
3 Sometimes true
4 Often true
5 Always true

Generally teachers. . .	Degree of Acceptance
1. often choose a career in elementary education because teacher training programs usually require less coursework in the math content area.	1 2 3 4 5
2. usually rely on math textbooks to teach mathematics.	1 2 3 4 5
3. rely heavily on math answer keys to score student work.	1 2 3 4 5
4. worry about grade level assignment because they lack mathematical preparation.	1 2 3 4 5
5. use manipulatives in the instruction of mathematics.	1 2 3 4 5
6. who instruct in arithmetic experience some form of math anxiety.	1 2 3 4 5
7. fear mathematical topics beyond the computational level such as base theory, probability and spatial visualization.	1 2 3 4 5
8. who fear math have no developed their content knowledge of arithmetic.	1 2 3 4 5

9.	who fear math do not comprehend the differences that exist between teaching procedures and teaching critical thinking in arithmetic.	1	2	3	4	5
10.	who instruct minority students have different expectations for them in the math/science area than for their white counterparts.	1	2	3	4	5
11.	at the elementary level have more academic contact with males in the instruction of arithmetic than females.	1	2	3	4	5
12.	who experience math avoidance spend less time on task with students in this area.	1	2	3	4	5
13.	who experience math anxiety negatively influence the way that students perceive the subject.	1	2	3	4	5
14.	who experience math anxiety are women and/or minorities.	1	2	3	4	5
15.	who experience math anxiety may mask their knowledge of mathematic reasoning through computational expertise.	1	2	3	4	5
16.	gravitate toward other subject areas because they feel inadequate in mathematics.	1	2	3	4	5
17.	emphasize computational skills rather than problem-solving strategies.	1	2	3	4	5
18.	develop conceptual understanding and problem-solving skills with their students.	1	2	3	4	5

Date:_____

APPENDIX B

MATH ANXIETY WORKSHOP
SURVEY TWO

1. Have you received any preservice or inservice training on math anxiety reduction?

2. Would you like to participate in math anxiety reduction workshops?

3. Have you received any preservice or inservice training in problem solving strategies?

4. Would you like to be a participant in workshops on problem-solving strategies?

5. Have you received any preservice or inservice preparation on mathematical concepts?

6. Would you like to participate in workshops on mathematical concepts?

7. What topics would you like to see covered in the math anxiety reduction workshops?

8. Would you be interested in participating in a personal case study of teachers and math anxiety?

9. What day of the week would be convenient for you to attend the workshops?

10. Would you like to have grade level meetings instead of whole group?

Name Date

APPENDIX C

Theodore Roosevelt School

MATH ANXIETY WORKSHOP

STARTLING STATEMENTS

1. How many women are among the 1,338 living members of the National Academy of Sciences?

2. Women are 52 percent of the U.S. population; what percent are they of the U.S. engineering force?

3. What is the average yearly salary offer to a student with a 1981 bachelor's degree in petroleum engineering?

4. What is the average yearly salary offer to a student with a 1981 bachelor's degree in the humanities?

5. For a woman to make more than the median income of a man with 8 years of elementary school, how much education must she have?

6. What percent of people working in apprenticeships in California are women?

7. What percent of female high school students are enrolled in electrical and mechanical vocational educational courses?

8. What percent of secretarial jobs are held by women?

9. What percent of employed lawyers are women?

10. What percent of employed doctors are women?

11. What percent of employed electricians are women?

12. Women are 98 percent of employed dental assistants; what percent of practicing dentists are women?

13. What percent of middle management jobs are held by women?

14. Women are 94% of math teachers in grades K-3; what percent are they of math teachers grades 9-12?

15. In 1928, women were 55% of elementary school principals; what percent were they in 1980?

16. What percent of high school principals are women?

17. What percent of school superintendents are women?

18. What percent of college or university presidents are women?

19. The average salary for a classroom teacher in the U.S. in 1980-81 was $17,678. What was the average for California?

APPENDIX D

SOME SYMPTOMS OF MATH ANXIETY

Theodore Roosevelt School

Math Anxiety Workshop

A. Physical Symptoms

Some of the physical symptoms associated with math anxiety were found to be common and severe. Some of them are:

1. Queasy stomach
2. Headaches
3. Shortness of breath
4. Stiff necks
5. Numbness of body parts such as arms
6. Diarrhea
7. Inability to focus on written material
8. Backaches
9. Sweaty palms

B. Emotional Symptoms

1. Self-distrust
2. Frustration
3. Paranoia
4. Inhibition--Freezing or quitting

APPENDIX E

LEARNING TO REDUCE MATH ANXIETY

OVERCOMING

1. Developing an understanding of how math anxiety affects you and then working through the various ways in which it determines your approach to math.
2. There must be a thorough grasp of the many facets of the interactions between your feelings and your attempt to do math.
3. Calls for experiencing and looking at your emotional responses to math over and over again.
4. There are many things about math and your experiences with math that can cause you to get angry. When this anger is unexpressed and stays inside you, it has no place to go and turns into anxiety. This makes it impossible to work.
5. As you become more aware of your anger toward math, it becomes easier to express it. That helps decrease anxiety and also enables you to channel your anger constructively into increased assertiveness.
6. Face the anxiety--accept that you are anxious. Allow yourself to feel the symptoms and fears.
7. Start at any point--writing, talking, working a problem.
8. Stay with it--Stay with what you can do.
9. Come to grips with your feelings and reaction when confronted with it as you gain awareness of what math does to you and of what you do to yourself. You will find it is not just math that sets off certain negative responses in you.

10. Math anxiety is like a phobia; the panic you experience is based on fears that have been with you for a long time.

LEARNING MATH

1. There is a difference between not having the ability to do something and not knowing how to learn it. Usually the things you excell at are things you know how to learn.

2. Being yourself--learning style--visual, oral, independent, groups--awareness of your own learning style.

3. Trust your attitude toward intuition; this seems to be a factor also in the distinction between math anxious and people who do well in math.

4. Emphasis or right answer may inhibit the learning potential of good and poor students alike. Right answer emphasis breeds hostility as well as anxiety.

5. Inability to handle frustrations contributes to math anxiety.

APPENDIX F

WHAT IS PROBLEM SOLVING?

Definitions by Professionals/Professional Organizations

Portia Elliott--states that, "A situation is a problem for a person if he or she is aware of its existence, recognizes that it requires action, wants or needs to see and does so, and is not immediately able to resolve the situation.

Equals Project--says that, "Taken in its most global sense, problem solving is the process of applying previously acquired knowledge to new and unfamiliar situations. It is a set of strategies that can be useful in any decision-making position or situation. As such, it is essential to the user to participate intelligently in society.

George Lencher--views problem solving as: any mathematical task that can be classified as either an exercise or a problem. An exercise is a task for which a procedure for solving is already known; frequently an exercise can be solved by the direct application of one or more computational algorithms. A problem is more complex because the strategy for solving is not immediately apparent; solving a problem requires some degree of creativity or originality on the part of the problem solver.

APPENDIX G

SUMMARY OF THE NATIONAL COUNCIL OF SUPERVISORS OF MATHEMATICS POSITION PAPER ON BASIC MATHEMATICAL SKILLS

Mathematics supervisors are concerned that, as a result of the "back-to-basics" movement, today in many schools there is too much emphasis on computation and not enough stress on other important mathematical skills. To respond to this trend, the National Council of Supervisors of Mathematics (NCSM) set up a twelve-member task force to write a position paper on basic mathematical skills. The position paper was first written in July, 1976, and later revised on the basis of ideas from supervisors throughout the country.

This position paper urges that we move forward, not "back" to the basics. The skills of yesterday are not the ones that today's students will need when they are adults. They will face a world of change in which they must be able to solve many different kinds of problems. The NCSM position paper lists ten important skill areas that students will need.

Problem Solving: Students should be able to solve problems in situations which are new to them.

Applying Mathematics to Everyday Situations: Students should be able to use mathematics to deal with situations they face daily in an ever-changing world.

Alertness to Reasonableness of Results: Students should learn to check to see that their answers to problems are "in the ballpark."

Estimation and Approximation: Students should learn to estimate quantity, length, distance, weight, etc.

Appropriate Computational Skills: Students should be able to use the four basic operations with whole numbers and decimals and they should be able to do computations with simple fractions and percents.

Geometry: Students should know basic properties of simple geometric figures.

Measurements: Students should be able to measure in both the metric and customary systems.

Tables, Charts and Graphs: Students should be able to read and make simple tables, charts and graphs.

Using Mathematics to Predict: Students should know how mathematics is used to find the likelihood of future events.

Computer Literacy: Students should know about the many uses of computers in society and they should be aware of what computers can do and what they cannot do.

APPENDIX H

Math Anxiety Workshop Four

POINTS ON MOTIVATING STUDENTS

1. We must teach students "How to Think."
2. Motivation should come from within the person.
3. We must enhance our students' ability to act independently, make decisions, develop positive self-esteem, master a variety of skills, and to perform well in the academic arena.
4. Teachers should utilize teaching methods that will help students to learn more easily--such as peer tutoring and collaborative learning groups.
5. Develop a plan that is practical in helping your students to assume more responsibility for their own learning.
6. Understand the many variables that are influential in the quality of students learning in the classroom setting and the variation in student learning styles.
7. Make the most of extrinsic reward and praise systems by laying a foundation for greater intrinsic motivation in your students.
8. Review the impact of your own attitudes, expectations, and pressures on student motivation--try to understand how your behavior affects the learning environment in your classroom.

APPENDIX I

MOTIVATION

How good a motivator are you?

Check your motivational practices by rating yourself on the questions below. Add your totals in each column. Score yourself as follows: 90-100, excellent; 80-90, good; 70-80, fair; below 70, poor.

	Usually (4 points)	Sometimes (2 points)	Never (0 points)
1. I believe my students are competent and trustworthy.			
2. I avoid labeling students.			
3. I avoid sarcasm, put-downs, and ridicule of students.			
4. I send explicit invitations to succeed.			
5. I listen to what my students really say.			
6. I let students know they are missed.			
7. I make good use of student experts in the class.			
8. I use heterogeneous groups to build interdependence.			
9. I teach leadership and communication skills.			
10. I avoid overemphasis on competition, rewards and winning.			
11. I help groups evaluate their effectiveness in group process.			
12. I give equal time, attention and support to low-ability students.			

13. I communicate high expectations to my students. _____

14. I focus on future success rather than past failures. _____

15. I look for what is positive in student work and behavior. _____

16. I set and communicate clear goals for instruction. _____

17. I use well-designed, thought-provoking questions to stimulate readiness. _____

18. I use objects as "focusing events" to stimulate interest. _____

19. I use brainstorming to stimulate interest before beginning a lesson. _____

20. I use set induction activities that connect a present experience to a lesson concept. _____

21. I ask low-risk, open-ended questions. _____

22. I wait three to five seconds after asking a divergent question. _____

23. I suspend judgment and redirect a question to get multiple responses. _____

24. I paraphrase and clarify responses instead of judging and praising. _____

25. I personalize learning. _____

APPENDIX J

MATH ANXIETY SURVEY ONE YEAR LATER

Ulysses Byas School
February 11, 1988

Directions: Please answer the following questions below. Complete all questions. You may use additional space to answer each question.

1. Have you implemented more problem solving strategie. in your mathematics instruction?

2. Have you shown an improvement in your teaching techniques/style in the area of problem solving strategies?

3. Do you feel better prepared to teach problem solving strategies after attending the workshops?

4. Has your attitude toward mathematics improved?

5. In your own judgment, have you become more sensitive to the needs of students/women/minorities who experience math anxiety.

APPENDIX K

INTERVIEWS OF AN EXPERIENCED STAFF IN REDUCTION OF MATH ANXIETY

Introduction

Prior to developing the case study questionnaire format, the researcher had to contemplate certain criterion upon which to base this portion of the project. Previous observation of teachers, the conversations pertaining to grade level subject-matter such as mathematics, and an intuitive sense of teacher need in becoming better instructors of mathematics guided this researcher in formulating the questionnaire concerning math anxiety. This questionnaire was developed only for those who volunteered to be a subject in the individualized case study.

Those self-same criteria also aided the researcher in conducting a follow-up session once the participants had a general knowledge of what the project itself would be about, and it provided instant feedback to the researcher concerning the interest that the participants would have in the project. The initial question on survey number two which asked: Would you be interested in participating in a personal case study of teachers and math anxiety? and drew some volunteer participants who said "yes" immediately. They were eight in number. However, two wrote on their survey "maybe." Out of the two, one wanted a more detailed analysis of what would be involved in the case study. To allay the misqivings, the researcher followed-up by conducting a one-on-one session with the volunteer participants to inform them of the purpose of the case study and to give them further opportunity to buy in to the case study project. The follow-up session proved to be helpful, and the total number of volunteer participants increased to ten.

CASE STUDY OF AN EXPERIENCED STAFF IN THE REDUCTION OF MATH ANXIETY

In survey two of this study, the teachers were asked if they would like to participate in a personal individualized case study on math anxiety. The questionnaire was adapted from Mind Over Math by Stanley Kogelman and Joseph Warren. Ten of the participants volunteered for the case study project. Due to time and scheduling problems the researcher was only able to interview seven of the volunteer participants. Only four of the interview sessions are recorded in this study. The results and findings are reported here.

1. Question one asked if the participants experienced math anxiety. In response to that question, 85 percent of the respondents stated in the affirmative that they had experienced math anxiety.

2. Question four inquired, "When did you perform poorly in math?" Fifty-seven percent of the participants commented that their math performance at the elementary level was poor. The participants also reported that throughout their secondary and college level math courses they experienced math anxiety with some exceptions depending on the teacher's approach and attitude.

3. Question five asked if they remembered any particular traumatic experience in math. A participant remembered the feeling of being neglected during instructional time for arithmetic and doubly knowing that there was also no help at home if she ran into difficulty with the arithmetic program. Some stated that they had never felt comfortable

with mathematics and suffered with it throughout their formal educational life.

4. Question six asked participants if there was ever a time when they liked mathematics. Forty-three percent of the participants responded that they liked mathematics at certain stages of their secondary and college level mathematics classes.

5. Question seven wanted to know what factor brought about the change in their viewing mathematics in a more positive light. Fourteen percent of the respondents recalled that it was a mathematics instructor that helped them to like mathematics more and to feel more at ease than they had previously felt before taking his/her mathematics class.

Group Findings

1. All participants felt that due to inadequate preparation at the secondary level and some extending from the elementary level that they were not mathematically mature as they entered into college level mathematics classes.

2. Most suffered with mathematics at all levels.

3. Some felt that the support given them had an underlying negative attitude emanating from the supporter and this made them feel even worse.

4. Some of the parents could not understand their resistance to mathematics.

5. Some altered their choice of careers at first because of the poor preparation and performance level in mathematics.

comfortable with mathematics. The best experience in any mathematics area occurred in an algebra class due to the fact that the instructor posed a positive image. She was a good motivator and when the teacher was positive, interviewee performed well. When the teacher was negative, the interviewee did not perform well.

There was no instructional help from home. Help either came from teachers or peers. She also followed no sequential mathematics courses and opted to take general math classes. Problems with math anxiety started from the early stages of this interviewee's educational background, as far back as elementary school.

CASE STUDY OF PARTICIPANT "B"

Interviewee B stated that in elementary school she did not receive the basic arithmetic background from the very start of her formal schooling. Part of the problem was that the teacher made her feel insecure because of her race. It was felt by this interviewee that the teacher did not give her the instructional time or attention needed to grasp the basics. However, the instructional attention was only denied to her in that subject area and not others. Due to this poor foundation, she felt handicapped and generally stayed with the non-regents math classes.

Insecurities demonstrated themselves throughout the secondary and collegiate life of this interviewee. In the seventh-ninth grade she performed poorly in mathematics but did not fail. She knew that she had to take the mathematics classes, but the understanding or mathematical

maturity did not develop in her case. Friends were there to help in the completion of homework assignments, but making the connection was still elusive--getting passing grades was the most important factor to her. parents were supportive emotionally but could not provide any academic help in any of the math areas. Due to a lack of proper mathematics preparation, she opted for a career that would be less taxing in the mathematics area and would require very little math calculations. She originally was a stenographer. She felt that the limitations had been set in place and held her back most of her adult life until she decided to return to school and get a college degree. When she decided to return, a traumatizing experience occurred in a class in logic. However, when she transferred to another college and met a Professor Barrett, he changed her outlook on mathematics. Mathematics became enjoyable; she was able to respond in class, to do her homework assignments by herself and could retain the understanding of the mathematics concepts taught in that class.

CASE STUDY OF PARTICIPANT "C"

Interviewee C stated that she had a semi-difficult time in mathematics at the elementary level due to the fact that she had to use her fingers to do her addition and subtraction facts at all times. She could not make the transfer from the concrete to the abstract in this area. Often her classwork and homework assignments were partially completed because of the time consumed by the use of the fingers. But what was computationally completed was correct and this did not shatter her confidence too much. Overall, the feeling of being inadequate in

mathematics took hold of the interviewee as she progressed through junior and senior high school and directly into college. As she encountered more of the higher order mathematics courses, she still did not understand the abstract concepts behind the skills and felt that she never would no matter how many times a concept or skill was explained to her.

She remembered one positive experience that lasted for two semesters when she took geometry and did very well at that time. However, even in high school she opted only to take the mandatory math classes, and she chose not to pursue any others after that requirement was fulfilled. A traumatizing experience persisted for quite a long time—it involved her father giving her mathematical support during her secondary and college level mathematics courses; however, the father's attitude was negative and this helped to work against any positive feelings about mathematics. The math anxiety was still being perpetuated and a feeling of inadequacy still persisted. The participant noted that she still does not like mathematics, and the only change has come about since she became a teacher. Since she has to teach this discipline, some topics, ideas, concepts, and skills have become clear to her as she goes through the mathematics curriculum and the teaching process. She also noted that there was a lack of mathematical maturity in her particular case.

CASE STUDY OF PARTICIPANT "D"

This interviewee felt that she was a very poor mathematics student at all educational levels—even though she did not suffer as much at the elementary level as she did at the secondary level and higher up. Interviewee D described it as a horrendous experience year after year.

Year after year included a full term of a mathematics class and then attendance at summer school to pass for the school year. She received help from her mother to what she says, "get over the hump." But with that added support, she did not perform well. The greatest anxiety occurred with higher order mathematics courses, and prior to her taking a mathematics class she would set up a mental road block to achieving any measure of success in any mathematics class. The interviewee also felt that none of her classe contributed to any kind of mathematical maturity in her life. She noted that she never liked mathematics and that her mother could not understand the resistance to it that she put forth.

Tape Interview Questionnaire

The ten questions listed were the ones set forth to the participants and recorded for this study. The questions were:

1. Do you consider yourself to be a person that experiences math anxiety?

2. How did you feel about mathematics in elementary, junior high, high school and college?

3. When did you perform well in mathematics?

4. When did you perform poorly in mathematics?

5. Do you remember any particular traumatizing experience in mathematics?

6. Was there ever a time when you liked mathematics?

7. What changed that?

8. Who helped you when you had difficulty with mathematics in school?

9. What did your parents think of mathematics?

10. What about your brothers and sisters?

As an added afterthought, the interviewer posed the following question to the interviewees: What grade level would you prefer to teach other than the grade level you are presently teaching? The reply from everyone was still a grade on the primary level. The interviewer asked "Why?" The reply was that the mathematics was easier to handle at the primary level, and that they felt comfortable with it. Some interviewees commented that, if they were to teach at the upper intermediate level, they would need more training in the mathematics curriculum or that they would do it only if they had to.

Conclusion

Seven of the ten volunteer participants were interviewed. Scheduling and the matter of time hindered the researcher from including the remainder of the participants.

During the taped interview, a majority of the participants were very open to the questions asked of them. However, one participant was reluctant at first to answer the question concerning a traumatizing experience in mathematics. She stated, "I don't know if I'm willing to do that." The researcher assured her that it was all right if she preferred not to do that. However, after a little thought she decided that she would like to share that traumatizing event with the interviewer.

Many of those interviewed found that they enjoyed the coaching session, that it was non-threatening, and that it gave them the opportunity to vent and to share some of the negative feelings that they had associated with mathematics.

The interviews were scheduled for a thirty minute time frame. However, the interviews usually ran over into a forty minute time time frame or an hour. This was contingent on the need of the individual teacher to share with the interviewer. Initially, the researcher had tried to conduct the interviews on Monday afternoons after the school-day. This was not workable for both the researcher and those to be interviewed. Some interviews were conducted on a Tuesday, but most of them were conducted on Fridays. This day provided for ample coverage by a teacher assistant so that a volunteer participant could partake of an active role in the interview session.

In general, the following data added to the researcher's knowledge pertaining to math anxiety and teachers: Teachers were glad to share their personal and professional background concerning the negative effects of math anxiety on their lives, the interviews provided individual teachers with a sharing and caring atmosphere in which to address their needs and concerns, teachers admitted that they had some fear of mathematics and the interviews provided the teachers with the opportunity to begin addressing this fear of mathematics on a personal and professional level.

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