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"Math Anxiety: Its Causes, Effects, And A Program For Its Cure"

A Thesis Submitted to the

University Honors Program

In Partial Fulfillment of the

Requirements of the Baccalaureate Degree

With University Honors

Department of Educational Psychology

by

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ABSTRACI'_ (100-200 WORDS):

The aim of this project was to locate the major research dealing with math anxiety, and -based on the conclusions of this research, to develop a program dealing with math anxiety that can be implemented into a high school math curriculum. Too often, the research is not synthesized into a practical solution to the problem; therefore, I chose to take the research one step further and create a plan that can be implemented, by teachers in any math classroom, to help their math anxious students deal with their anxiety. The findings of this project are significant. The most important are: Math anxiety is a real problem that has debilitating effects on its victims, math anxiety is a curable disease, and math anxiety must be dealt with because it is very often transferred from teacher or parent to student or child. We must begin taking this problem seriously, otherwise our students will not be able to assimilate into the technological society that awaits them.

We live in a highly technological society, a society where an understanding of mathematics is necessary for success in virtually every occupational field from which one can choose. The days when one only needed to know how to add, subtract, multiply, and divide have vanished. Whereas, in 1984, only 6% of jobs required workers to possess skills such as an ability to use calculus, statistics, econometrics, advanced calculus, modern algebra, and statistics, 13% of the jobs created between 1984 and 2000 will require these skills. Furthermore, as time moves on and the movement toward the use of computers, robotics, and high powered mathematics such as linear algebra and calculus to solve increasingly complex problems continues, these skills will be even more essential for individuals to find jobs. Unfortunately, we also live in a society where the common person is frightened or repulsed by mathematics. The typical response today is, "I have never been any good at math" or "I hate math" or "I do not understand math". This attitude that far too many individuals have, must be addressed and dealt with if we are to adequately prepare our students for the jobs they will be seeking in the year 2000 and beyond. In the following pages, the issue of mathematics anxiety will be addressed, including definitions, causes, effects, and finally a possible plan for curing this debilitating condition.

Before we go any further, a working definition of mathematics anxiety is necessary. Tobias describes mathematics anxiety as the "I can't syndrome!" (p. 56). The term has also been defined as "the panic, helplessness, paralysis, and mental disorganization that arises among some people when they are required to solve a mathematical problem"

(Tobias &Weissbrod . p. 63). Several other researchers, Richardson and Suinn have proposed that "Mathematics anxiety involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (p. 551). Lazarus, a leading expert in the field of stress, describes "Mathphobia" as, "an irrational and impeditive dread of mathematics" (p. 16). While no QM.. definition is accepted by all the individuals researching the topic, the typical definition, and the one which shall be inferred throughout this paper is Tobias' "I can't syndrome!"

The above definitions define what mathematics anxiety is; however, it is also important to not only know what mathematics anxiety is, but how to determine who suffers from this condition. Fortunately, a multitude of measurement scales and tests exist to help locate or determine an individual who has this condition. Several of these measuring devices are: the Mathematics Anxiety Scale ~MAS), the Worry-Emotionality Questionnaire, and the Mathematics Anxiety Rating Scale (MARS). These tests each have unique aspects; however, their main objective is to measure the level of anxiety an individual experiences as a result of mathematics and mathematics tests. While it may be a good idea to have students complete one of the above tests, it is not absolutely necessary. A teacher may directly observe students as they perform and diagnose an individual with math anxiety. The actions or responses to watch include: nervousness, fidgeting, conveyed feeling of helplessness when approaching an unfamiliar problem, inability to perform elementary operations, lack of interest in subject, and other similar characteristics. A student who exhibits most or all of these characteristics could very

well have mathematics anxiety. Several informal questions, taken from Wigfield and Meece, may also be asked as a confirmation of math anxiety, including:

1) When the teacher says he/she is going to ask you some questions to find out how much you know about math, how much do you worry that you will do poorly?
2) How do you feel when you are in math class?
3) Do you dread having to do math?
4) Compared to other subjects, how much do you worry about how well you are doing in math? (: p. 212)

Mathematics anxiety is a topic which has attracted the attention of researchers for the better part of thirty years, and in that time a variety of possible causes have been identified. Several of these causes are: poor teaching of mathematics, students' negative perceptions of mathematics, and socialization to avoid mathematics. It has been suggested by Lazarus that the current educational practices do not successfully detect when a student does not adequately understand math concepts and or procedures. Consequently, further down the line the student experiences failure and frustration, then inevitably becomes math anxious. "One obstacle to the prevention of Mathphobia is the difficulty of early diagnosis ... the educational system inadvertently promotes Mathphobia (Lazarus p. 19).

The teaching of mathematics can also lead to mathematics anxiety in that this is a "communicable disease". Tobias has found that mathematics anxiety also can result from an unfortunate experience with a mathematics teacher. Attitudes play a very important role in mathematics anxiety and it has been found that attitudes towards

mathematics are transmittable (Williams p. 98). The findings of a 200 subject study of students majoring in elementary education conducted by Bulmahn and Young (1982) supports their hypothesis that students who seek to become elementary education majors are not typically students who have an appreciation for mathematics "... in the broad sense+from its logical beauty to its real-world applications" (p. 55). Consequently, students in these teachers' classrooms end up acquiring this condition simply through, association. Bulmahn and Young suggest that a math specialist be provided in all elementary schools to help math anxious teachers deal effectively with their anxiety. A third cause of mathematics anxiety, attributed to teaching, is a mismatch of students' learning styles with traditional teaching styles' of mathematics. Traditionally, mathematics has been taught in a lecture, modeling, guided practice approach with very little "hands on" opportunity. The problem with this approach is that many of the students in the class are being excluded and inadequately served because they are kinesthetic learners, or sensory learners. These individuals need the games, the visual models to touch and take apart, the hands on instruction that most conventional mathematics classrooms do not offer. A fourth cause of mathematics anxiety that is directly related to the teaching of math was found by William Bush at the University of Kentucky. Bush examined 31 fourth, fifth, and sixth grade teachers and their students and concluded that the math anxious teachers, "devoted more time to seatwork and whole-class instruction, devoted less time to checking homework, playing games, problem solving, small group instruction, and individualized instruction,

and taught more skills and fewer concepts." (p. 508) These teaching practices have been addressed by the National Council of Teachers of Mathematics as outdated, unsuccessful, and detrimental to the individual. In the NCTM's "Standards", the teacher of mathematics is to focus and teach math conceptually, problematically, practically, and make wide use of group and individualized instruction, which is exactly what the math anxious teacher does not do.

In addition to teacher induced mathematics anxiety, students may also cause their own anxiety. The students' perceptions are key, and lead to increased anxiety. Studies have found that curricular areas where clear evaluative demands are placed on the student, i.e, the knowledge of specific ,rules and the requirement of precise answers, evoke the highest levels of anxiety (Everson, et al pp. 2-3). Math is just this type of subject. Furthermore, Bandura's theory of self-efficacy applies directly to students' levels of mathematics anxiety. This theory posits that "behavior change is a product of increased client expectations of self-efficacy, that is, a person's perceptions of his or her effectiveness, in the problematic areas of their lives.'" (Cooper p. 4) In other words, if students believe that they can not do mathematics they will not be able to do mathematics, but if students believe that they can do mathematics, a wonderful thing happens - they can! Therefore, these negative beliefs, which are prevalent in so many students today, must be addressed if we are to help students overcome their math anxiety.

A third, independent, cause of mathematics anxiety is socialization to avoid mathematics. Until recently, female students were not encouraged to take mathematics courses beyond those required to

graduate. Furthermore, many students are socialized to believe that the hard sciences, of which mathematics is one, are only for the "nerds" or those intending to enter careers in science, mathematics, or technology. Therefore, they have avoided such subjects. This avoidance of mathematics has bred in these individuals a fear, hatred, dislike and suspicion of mathematics which manifest themselves through increased levels of anxiety.

Mathematics anxiety thus has a variety of causes; it also has a number of effects on an individual who suffers from it. Naturally, a math anxious student would be expected to have lower scores in math. This is exactly what happens; however, something, maybe not as obvious, also occurs in a math anxious' student's performance and that is that scores decrease across the curriculum. In other words, the math anxious student not only does poorly in math, but in English class, history class, and other subjects as well. Hembree (1988} conducted a very extensive analysis of 562 students and found that highly anxious students exhibit inefficient study habits and difficulty organizing instructional material (Everson, et al p. 4). These deficits decrease the student's performance in all subject areas. Furthermore, because mathematics anxiety is transmitted from individual to individual, this disease is promoted and spread by math anxious individuals. This is a serious effect of math anxiety, because it is highly unlikely that math anxiety will just disappear, but it will continue to grow stronger and affect greater numbers of individuals, unless something is done to stop it. The most serious effect of mathematics anxiety is that, if untreated, it will keep thousands, and quite possibly millions of individuals from ever becoming working members of the

middle and upper middle class. Society has changed and so have the requirements to get jobs. Today, and increasingly so in the future, individuals must possess the confidence and ability to use mathematics or they will be unemployable. Therefore, this anxiety so many individuals experience will keep them from getting a job. This problem alone has numerous consequences, a discussion of which is outside the scope of this paper; however, unless these individuals become confident in using math, we will have a national problem on our hands.

Although math anxiety is a very serious problem, curing this dreaded disease is a possible and necessary task; however, it entails a great deal of hard work and a willingness to change. One possible change that teachers can make is to provide students with feedback. Green (1990) conducted a very complex study observing the effects of free comments, specified comments, and no comments on individuals' performance and determined that the "free comments treatment was superior to the specified comments and no comments treatments in facilitating student performance" (p. 332). Green does not specifically mention that free comments decrease or reduce anxiety; however, one way to decrease anxiety, is to get individuals to believe that they can do math. Teacher feedback which is contingent on the nature, response, and relevance of the feedback stimuli is an effective method for increasing performance. Another method of decreasing math anxiety is to create programs that address attitudes, beliefs, and perceptions toward mathematics. Individuals' perceptions play a very key role in the levels or amount of anxiety they experience. Trained counselors can play a dominant role in such interventions, as these counselors attempt to get individuals to

effectively deal with the anxiety itself. Math dominated interventions have also been suggested. The primary purpose of these programs is to provide individuals with more information and knowledge of mathematics because the more they know and understand, the less they have to fear (Williams p.99). A combination of the above approaches is also a possibility and is used extensively.

Finally, the educational practices which are promoting, or at least sustaining, mathematics anxiety must be addressed. The various learning styles of individuals must be considered and accommodated. Learning groups, visual aids, and applications of the material to students' lives and experiences can be incorporated into the classroom to meet the multitude of learning styles that exist. Mathematics also needs to be made more relevant according to the National Council of Teachers of Mathematics, *An Agenda for Action,* stated, "Mathematics programs for the 1980's should involve students in problem solving by presenting applications at all grade levels" (p. 4). Teachers also must provide the opportunity for positive math experiences. Assigning weaker students somewhat easier problems for starters often boosts their confidence and reduces their anxiety. The use of games is also a successful strategy to encourage original thinking, creativity, intuition; these games also build confidence.

Finally, too many teachers are afraid to let their students see them make a mistake. According to Driscoll (1981) "effective mathematics teachers not only offer many examples, but also model problem solving and logical thinking in their instruction" (Williams p.l00). These ideas are where today's mathematics teachers need to begin if we are going to cure our children and this nation of its mathematics anxiety.

Findings of the extensive research devoted to math anxiety suggest that it is imperative for future educators, especially math educators to be aware of the causes of math anxiety. Being aware of the causes; however, is only half of the battle. The other, and possibly more important half, is the solutions that must be implemented to cure this disease. Whether approaches be math content based, anxiety management based, or a combination of the two, solutions must be implemented to fight this condition which affects so many individuals in the country. Unfortunately, this is not a problem that we can ignore and hope it will take care of itself. This is a problem that must be dealt with, otherwise it will persist and affect millions more in the future. The technological society we live in demands a working understanding of mathematics, and this understanding is likely to get even more complex. Mathematics anxiety must be dealt with more effectively if we have any hope of staying competitive globally and progressing forward as a nation.

Having taken a look at what math anxiety is, what several of the causes of this disease are, what effects this disease has on its sufferers, and some possible solutions, I want to propose a program, which is based on the research, that will enable math educators to help math anxious students overcome their anxiety about mathematics. The structure of my program is taken from a research program done by Roberta Daniels and Julie Lamb; however, the content of the program is original and is based on the synthesis of the research findings.

Overcoming Your Mathematics Anxiety

A Propaa to Deal with M.tIl Anioty iu the Hip Sclaool

by

Steven Christopher Urosevich

Course Outline

I. **Uait I** Math Anxiety Bill of Rights (1 class sessions)

II. **Uait II** Developing Positive Self-Esteem (4 class sessions)

III. **Uait III** Developing Positive Mathematical Attitudes (3 class sessions)

IV. **Uait IV** Problem Solving Skills (3 class sessions)

V. **Uait V** Math Project (3-4 class sessions)

VI. **Uait VI** Review and Evaluation (1 class session and interview)

Expected Number of Class Sessions: 15-16 Class Sessions

Not e: Before beginning this program, the teacher must conduct a Math Anxiety interview with each student using the anxiety questionnaire which can be found at the end of the program and administer the MARS test to each participant. After these have been completed, a file for each participant should be created so that, at the end of the program, an overall evaluation of the effectiveness of the program can be carried out.

Unit I: Math Anxiety Bill of Rights

Each and every person involved in this course has certain rights. Read these rights and understand that, while in this program and after, these are l.Q.lU.ri&h15 and never let anyone discourage you in your mathematical endeavors or take any of these rights away!

Direetions: Read these rights in the group and then discuss why these rights are necessary. Ask if the students have any rights that are not included that should be? If so, include them and post these rights in the classroom.

The Math Anxiety "Bill of Rights"

-I have the right to learn at my own pace and not feel put down or stupid if I'm slower than someone else.

-I have the right to ask whatever questions 1 have.

-I have the right to need extra help.

-I have the right to ask a teacher for help.

-I have the right to say 1 don't understand.

-1 have the right to feel good about myself regardless of my abilities in Math.

-1 have the right not to base my self-worth on my math skills.

-1 have the right to view myself as capable of learning math.

-1 have the right to evaluate my math instructors and how they teach.

-I have the right to relax.

-I have the right to be treated as a competent adult.

-I have the right to dislike math.

-1 have the right to define success in my own terms.

*By Sandra Davis--Found in Tobias "Math Mental Health" (p. 93)

Unit II: Developing Positive Self-Esteem

Session One

Things I Do Well and Things I Do Not Do Well

Directions: Take out two sheets of paper and on one sheet write all of the things that you do well. These do not necessarily have to be school related. Anything that you do well should be included. On the second sheet, write down all the things that you do not do well. Additionally, write down how you might improve the things you do not do well.

When everyone appears to have finished, have the students break off with a partner and discuss' what they have written on their sheets. Then explain that they now have the responsibility of helping each other out in their weaknesses and acknowledging others' strengths whenever possible.

Assignment; For the next session, I want you to come with a paper about things that you like about yourself. There is no limit on number of pages, but spend some time thinking about who you are and things that you like about yourself. Come prepared to discuss these papers!

Unit II: Developing Positive Self-Esteem

Session Two

Begin this session with a class discussion of the students papers about things they like about themselves.

Next, discuss as a group, the terms optimistic and pessimistic. Come up with as many examples, synonyms, antonyms, and causes as possible. After the discussion, get a glass of water and fill it half way. Ask the students to write down on a piece of paper a description of the glass of water. Collect these descriptions and read aloud to the class. Discuss any differences that may arise. See whether students see a connection between certain descriptions and attitudes of optimism or pessimism.

Finally, in a large group, discuss how pessimistic attitudes are formed, how optimistic attitudes are formed, whether they can be changed, and how?

Assignment: Have students identify their own pessimistic ideas and come up with a plan to deal with these ideas.

Unit II: Developing Positive Self-Esteem

Session Three

For this session, a role playing exercise is going to take place. The demonstration is going to involve two individuals, one an optimist or positive thinker, the other a pessimist or negative thinker. The problem that each will face will be the same, but the outcome will be quite different. Each will face a problem that is quite unfamiliar to them, and they will have to come up with a solution. It would be a good idea not to use a mathematical problem here, simply because we are dealing with attitudes and not content. Whatever problem you, the teacher, come up with make sure the optimistic individual has a plan he can follow for the solution, and that the pessimist does not. The pessimist should berate his or her actions, get frustrated, and eventually give up.

The discussion that follows the role playing exercise should focus on the attitudes controlling the outcome. Be sure to make the point that neither individual had prior experience with the problem to be solved (even if you have to make it), but that it was the attitudes that determined the outcomes. Discuss how our attitudes may help or hinder our performance in various areas of our lives, including mathematics.

Unit II: Developing Positive Self-Esteem

Session Four

In this session, the focus is going to be on what is traditionally "guy stuff" and what is traditionally "girl stuff". The discussion groups should be broken into guy groups and girl groups. Fascilitate the discussion but do not lead it. Begin the discussion with the question "What kinds of things to guys do'?" After each side has come up _with a list ask the same question except for the girls, i.e., "What kinds of things do girls do'?" Hopefully, you will get lots of gender specific answers like girls are moms, they are secretaries, teachers, and many other traditionally female occupations. Likewise, the guys should come up with car mechanic, scientist, businessman, and many other traditionally male dominated occupations. Then you can pose the question, "Why are men the scientists and women the secretaries?" Asking questions like these will hopefully bring an awareness that women can be scientists as well, but because of the gender inequalities that exist more men are in that particular profession. Get them to discuss how things might change and how they could specifically take part in this change. This will hopefully challenge some of the original girls notions of "1 can't do math because I'm a girl".

Ass ig n men t: Have the students go home and locate in the paper, magazine, or news cast a woman who is involved with mathematics. Have them read the article and ask them, "What makes that woman any different from you'?"

Unit III: Developing Positive Mathematical Attitudes

Session One

This first session focuses on the usefulness of mathematics by viewing the program "Math...Who Needs It'?" However, before the program is viewed, give the students fifteen minutes to come up with all of the occupations that they think utilize mathematics on a regular basis. Then watch the movie and compare the occupations they listed with those presented in the movie.

Assignment: The homework for the next session is to go to some business in the community and interview someone associated with that company. The interview should focus on issues such as: what types of mathematics are used on a day to day basis, what training was available, what type of continuing education is required of employees, and other related questions. Either tape record the session or take very detailed notes. After the interview, write a paper, at least 2 pages in length, on what you learned about that company and its use of mathematics. Come prepared to discuss your findings at the next session.

Unit III: Developing Positive Mathematical Attitudes

Session Two

In a large group, discuss the findings of the students on the interviews. They will most likely be surprised at the number of jobs, even in their community, that use mathematics every day.

Give the students the following information, from A Core Curriculum pp. 5, and use it as a discussion piece.

Math Skill Level

Level 6: Advanced calculus, modern algebra, and statistics.

Level 5: Knows calculus and statistics; econometrics.

Level 4: Is able to deal with fairly complex algebra and geometry, including linear and quadratic equations, logarithmic functions and deductive axiomatic geometry.

Level 3: Understands basic geometry and algebra. Calculates discount, interest, profit and loss, marksmen and commissions.

Level 2: Adds, subtracts, multiplies and divides all units of measure. Computes ratio, rate and percent. Draws and interprets bar graphs.

Levell: Adds and subtracts two-digit numbers. Does simple calculations with money and with basic units of volume, length and weight.

Discuss what types of jobs might need what skill level, what skill level was called for in the jobs they researched, what skill level they. felt they would need for the job they wanted, what skill level they now believe they need, etc.. Announce a field trip for next session.

Unit III: Developing Positive Mathematical Attitudes

Session Three

For this session plan a field trip to a corporation that utilizes mathematics, example an engineering firm, architectural firm, etc. and have a female employee give a tour of the corporation explaining what types of mathematics are used every day on the job. Also have the tour guide address what skills will be most important in the future. The main purpose is to inform the students as to the importance of mathematics, where it is used, and that females, as well as males are able to participate in mathematical occupations.

Assignment: Write a 2 page paper explaining what you saw, heard, learned on the field trip. Include a description of your attitude toward math vefore the visit and after the visit. If your attitude changed, discuss the reason(s) for that change. If your attitude remained the same but your certainty increased, explain why your attitude is even stronger.

Unit IV: Problem Solving

Session One

These three sessions are designed to introduce these students to the art of problem solving and provide an opportunity for them to practice their new approaches. Here, for the first time in this program, the students will be dealing with mathematics; however, all of the mathematics will be familiar to them so their anxiety level should not be all that bothersome.

To begin, discuss the importance of good problem solving skills. Let students know that there is no one right approach, and that many times a given "strategy" may not necessarily lead you down the path to the solution, but that this is O.K., they just need to examine what went wrong and try a different strategy. Several general strategies exist, two of which will be introduced in this first session.

Polya's Problem Solvin& Heuristic

1. Understand the Problem
2. Devise a Plan
3. Carry out the Plan
4. Look Back

The Puzzle Approach

This approach, taken from Tobias, relates problem solving to putting a jig saw puzzle together. It starts by devising an initial strategy, then the strategies may shift, then comes searching, sorting, guessing, refining of guesses, assesment of how the problem is going, then continuing the search. Discuss these strategies as a class and talk about alternative strategies that they may come up with.

Unit IV: Problem Solving

Session Two

The purpose of this session is to familiarize the students with these two hueristics by letting them apply them to the following word problem:

> *One hundred bushels of corn are to be divided among 100 persons. Men get 3 bushels each. Women get 2 bushels each. Children get 1/2 a bushel each. How will the bushels be distributed?*

Students should be divided into groups of three or four and given only a copy of the word problem. At this point some of the students may complain of not knowing what to do next or what the answer is. Encourage them to talk amongst themselves and to follow one of the two "plans" developed last session.

Note: For groups that are really stuck, help them get started on the right track, but only after noticeable frustration has set in. Allow students half of the session to work on the problem and more time if necessary, but do allow for enough time for the whole class to get together and discuss at least one of the groups work.

Unit IV: Problem Solving

Session Three

This session is a continuation of last session's work. Talk about alternative solutions to the proposed problem, whether all of the solutions have been identified, why more than one solution may have been found, the feasibility of the solutions (ex. what if a group decided that there would be .4 children, or other unfeasable possibilities), different problem solving strategies used, feelings experienced during the problem solving experience, possible extensions of the problem, and any other observations or questions students may have.

The goal of this discussion is to have the students analyze the problem at an even deeper level and to think about determining parameters to problems and why they exist. This is a crucial part of problem solving and will be utilized extensively on the project they will be working on in the next unit. After the discussion, give them three more problems that they are to work on during class, and if not finished outside of class. Stress that it is not so much the right answer that I am looking for, but rather the process they took to arrive at the answer they got. Remind them to use the problem solving hueristics that we came up with and to be sure to write down how they applied each part of the "plan".

Unit V: Math Project

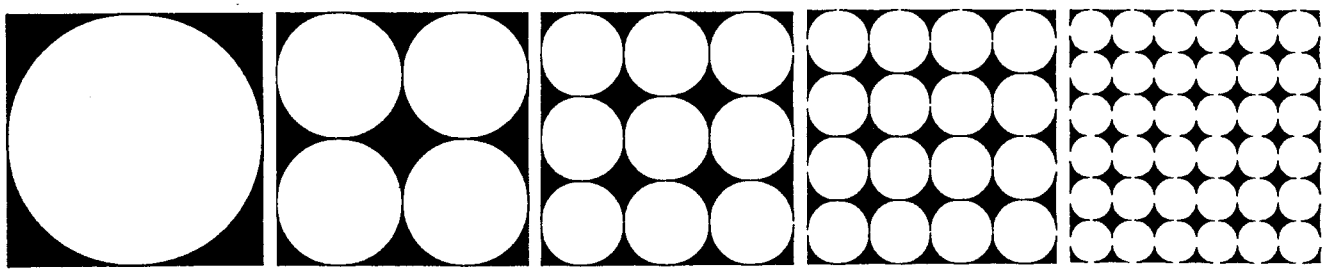
There are several reasons for an extended group math project, specifically the dart project which you will find included. The primary reason for this project is to give students more practice with solving problems. Another, equally important reason, is that it gives them an opportunity to do math the way it is done in the real world, which is in groups. It also gives them an opportunity to test their hypothesis, by actually doing the project (i.e. throwing the darts and determining the outcomes), and' it gives them an opportunity to communicate their results, both in writing and verbally.

The project is to take 3 to 4 weeks to complete. You will find a copy of the project to follow. The only directions to the teacher is that he or she should divide the students into groups of 4-5 students and upon doing so go over the project with the students to see whether everyone understands. The rest of the project is fairly self explanatory and should be carried out by the students with the teacher acting only as the facilitator. The teacher should observe the interactions among the students within their groups attitudes, emotions. For the final session, each group should take 15 minutes to describe their findings. Allow the students the opportunity to discuss relevant discoveries, frustrations, and observations. By the end of this project, their math anxiety should be noticeably different. Ask them about their feelings if that issue is not brought up in their presentations.

DART THRDVVING

SHEET 1

Figures A through E represent targets for dart throwing.



A B C D E

Suppose that you can earn points by throwing darts according to these rules:

You score 1 point. if your dart lands inside a circle.

You score 0 points if your dart lands inside a square but outside a circle.

Darts thrown outside a square do not count [you can throw them again.]

Which target would you choose to throw at? _____

Why?

How can you support your answer mathematically?

Hint 1: Think about the combined areas of circles within a square and the area of that square.

Hint 2: What is a "nice" number to choose for the side length of the squares in order to perform the calculations easily?

Describe your plan in words.

Leave all results below in terms of π.

Information for All Targets

Side length of square: _____ units

Area of square: _____ square units

Target A

Radius of one circle: _____ units

Area of one circle: _____ square units

Ratio: _____ = _____
[state in words] [value]

Target B

Radius of one circle: _____ units

Area of one circle: _____ square units

Area of _____ circles: _____ square units

Ratio: _____ = _____
[state in words] [value]

Target C

Target D

Target E

What do you conclude?

Press the area ratio[s] for all targets as a decimal. What fraction or percentage of the time would you expect a dart to land inside a circle if you knew that it hit inside the square?

DART THROINING (CONTINUED)

Experinrentsl Results

Part I Your teacher will supply target A and another target.

Choose a member of your group to be the dart thrower. Measure a distance eight feet from the target and place a piece of tape on the floor. Standing behind this tape, the dart thrower throws some number of times (your choice) at target A. Keep a tally of darts (a) inside the circles and (b) in the square but outside any circle. Darts outside the square do not count.

CAUTION: All members of the group must stay behind the thrower, and only the thrower retrieves the darts.

Repeat this activity with another target supplied by your teacher.

For each target, calculate as a decimal the ratio of the darts inside the circles to the total darts hitting the target.

Target A	Target _____
$\frac{\text{darts inside circles}}{\text{darts hitting target}} =$	$\frac{\text{darts inside circles}}{\text{darts hitting target}} =$
ratio:	ratio:

Are these ratios the same? Are they about the same as your "mathematical" results on sheet 2? What do you conclude?

What decision(s) did you have to make as you did the activity? Might they have influenced your ratios? Why or why not?

Experinrentsl Results

Part II You will use the same two targets for this activity that you used for part I.

Choose another member of your group to be the dart thrower. Measure a distance six feet from the target and place a piece of tape on the floor. Standing behind this tape, the dart thrower *with eyes closed* throws some number of times [your choice) at target A. Counting only darts that hit the target, keep a tally of darts [a) inside the circles and [b) outside the circles.

CAUTION: All members of the group must stay behind the thrower, and only the thrower retrieves the darts.

Repeat this activity with another target supplied by your teacher.

For each target, calculate as a decimal the ratio of the darts inside the circles to the total darts hitting the target.

Target A	Target _____
$\frac{\text{darts inside circles}}{\text{darts hitting target}} =$	$\frac{\text{darts inside circles}}{\text{darts hitting target}} =$
ratio:	ratio:

Are these ratios the same? Are they about the same as those computed in part I? Are they about the same as your "mathematical" results on sheet 2? What do you conclude?

Unit VI: Review and Evaluation

As a culmination of this program, a post-test and personal interview is to be given to determine the success of this program. Before giving the post-test; however, a review of the major topics should be conducted. Go over the main points in each Unit and touch topics or sessions that may have been covered less adequately before. Because of the differences in students and teachers, each review will be different; however, this is a very important step in the process of curing mathematics anxiety. After your review, give the students the MARS test again. After scoring the test, conduct a personal interview with each student using the Math Anxiety Questionnaire from Wigfield and Meece (included following the program). When the personal interview is over and the MARS tests have been graded the students are finished with this program. They now should be ready to tackle any mathematical situation without experiencing the handicapping anxiety they once faced which immobilized' them and kept them from doing the problem. However, if the student or teacher feels as though the student is not yet ready, more practice and work should be done. -

As with any program, the teachers' work is not quite over even though the students are finished. The teacher needs to evaluate the overall effectiveness of the program and determine which, if any, units need additions or deletions. Once the teacher has "looked back" and made the necessary adjustments, then and only then, is the program finished.

Note: The MARS test is published by Fort Collins, Co: RMBSI, Inc.

Math Anxiety Questionnaire

1. When the teacher says he/she is going to ask you some questions to find out how much you know about math, how much do you worry that you will do poorly?
2. When the teacher is showing the class how to do a problem, how much do you worry that other students might understand the problem better than you?
3. When I am in math, I usually feel _____.
4. When I am taking math tests, I usually feel _____.
5. Taking math tests scares me (not at all or very much so).
6. I dread having to do math (never feel this way or always feel this way).
7. It scares me to think that I will be taking advanced high school math. (not at all or very much so).
8. In general, how much to you worry about how well you are doing in school?
9. If you are absent from school and you miss a math assingment, how much do you worry that you will be behind the other students when you come back to school?
10. In general, how much do you worry about how well you are doing in math?
11. Compared to other subjects, how much do you worry about how well you are doing in math?

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SEP 8199?

HAY" 3 1993

REQUEST FOR UNIVERSITY HONORS INDEPENDENT STUDY

PLEASE TYPE

steven C. Urosevich
Student Name

[redacted]
Local Address

EPSY 457
Department and Course Number

0191
Computer Reference Number

Fall 1992
Semester of Registration

May 8, 1992
Date of Request"

Attach additional pages as needed.

1. Describe bero~, in detail, the goal(s) of the work you propose. What will you study? I am going to do extensive research on the topic of math ~nxiety as it relates to the high school student, write a paper synthesizing the researeh, and attempt to come up with a plan to avoid or cure math anxiety in the students in my classroom.

2. Please list major works dealing with this topic (published material relevant to your project): See Bibliography Included

3. Describe the methodology of your proposed study. For example, if you plan regular conferences with your advisor, how often? What written work will your study produce? If you will be working in a laboratory, what equipment will be needed and what procedures will you follow?My project will. include regular conferences with my advisor probably twice a month (on average). It will also result in a paper, as earlier discussed, and hopefully a~plan for dealing with math anxiety in my own students. Ultimately this "plan" would be a compilation of different ideas and excercises to decrease the anxiety high school students experience, because of "Math.

4. What tangible evidence of the project's completion will you submit? I will submit a photocopy of the final text.

5. How will the projec~ results be presented, and to whom?
I plan to give a copy of the final text to my advisor and to the necessary individuals at the honors house.

6. List the courses you have taken (Honors and non-Honors) which provide a background for this study.

PHED 399H
EPSY 313

7. Please indicate the proposed title of your project/thesis.

Math Anxiety: Its Causes* Effects, and possible Solutions.

S. Christopher Rosenfeld — [redacted]

Student Signature — student Social Security Number

Request approved:

Roberta W. Nauman — 8-31-92

Instructor — Date

I hereby certify that the above mentioned independent study does not duplicate in content and/or method similar material offered in a regular course in this, the semester of enrollment or the immediately preceding or immediately subsequent semesters.

Virginia Many — 9-4-92

Department Chairperson — Date

[signature] — 9/9/92

Director, University Honors Program — Date