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ABSTRACT

This document provides details about the Teacher Education and Mathematics (TEAM) Project, which developed a model program and instructional materials that can be used to increase confidence and skills of students in undergraduate teacher education courses. TEAM materials and curriculum were specifically designed to: (1) reduce mathematics anxiety in teacher education students; (2) develop instructor skills in identifying sex bias in mathematics curriculum materials and teacher-pupil classroom interaction; and (3) increase teacher knowledge of mathematical concepts needed for elementary school instruction. The project concentrated on writing, field-testing, and evaluating instructional modules and assessment instruments to meet the goals stated above. Sections of this document cover: (1) Executive Summary; (2) Review of Year One Activities; (3) The TEAM curriculum; (4) Activities, Material Development and Revisions; (5) Evaluation; and (6) Implications for Future Research. The material notes that while several modules were identified as in some need of revision, the material overall was perceived as satisfactory by both faculty and students. (MP)

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FINAL REPORT

1979 - 1980

Teacher Education and Mathematics Project
Women's Educational Equity Grant No. #G,007801146

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I. EXECUTIVE SUMMARY

Mathematics is a key area of the curriculum since mathematics is used by citizens in all walks of life. Mathematics has also been identified as fulfilling a gatekeeping or filtering function because of its importance in many careers. There are sex differences in mathematical experiences both in and out of school, and math anxiety and sex role stereotyping of mathematics as a male domain have frequently been cited as factors in math avoidance for women. One important area of intervention is the schools and within them, teacher attitudes, class activities and materials. There is a need for teachers who are free of math anxiety, who understand basic mathematics concepts, and who perceive mathematics as equally important and useful for both girls and boys so that they can help their students enjoy mathematics and continue to study mathematics so that career options are not foreclosed.

The project on Teacher Education and Mathematics (TEAM) has developed a model program and instructional materials that can be used to increase confidence and skills in mathematics of students in undergraduate teacher education courses. More specifically, the program and materials are designed: to reduce mathematics anxiety in teacher education students; to develop their skills in identifying sex bias in mathematics curriculum materials and teacher-pupil interaction in the classroom; and to increase their knowledge of mathematical concepts needed for teaching mathematics in the elementary school.

In order to meet these goals, the project has concentrated on writing, field-testing, and evaluating a series of instructional modules and assessment instruments. There has been an emphasis on defining a learning environment that can serve as a model for the classroom experiences teacher education students will later provide for children. The inductive approach was used

for mathematical instruction, and each module begins with problems designed to teach the principles through easy to more difficult examples. Units within the modules conclude with a statement of the principles and the objectives of the unit.

Instructional modules have been developed in the areas of Patterns, Approximation and Estimation, Metric Measurement, and Choice and Chance.

Each mathematics module includes: 1. an instructor's text; 2. student materials and exercises; 3. solutions and guide to student exercises; and 4. a student summary and review. The instructor's handbook describes the math anxiety reduction activities used with groups of students. These activities ranged from group discussions, designed to focus on students' feelings about mathematics and awareness of their increased knowledge and skill, to special sessions on test anxiety in the mathematics class. The attitudinal modules developed were: Demystifying Math; Sex role Stereotyping in Mathematics Education; Women, Mathematics, and Careers; and Women as Mathematicians. These modules are designed: to develop an understanding that math anxiety is a shared problem; to increase teachers' skills in locating sex bias in curriculum materials and to counteract such bias when it is identified; and to foster positive attitudes through an increase in knowledge of womens' contribution in mathematics and a recognition of the importance of mathematics in a wide variety of careers.

In addition to the instructional modules and cassettes, TEAM products include a bibliography of references relative to math anxiety and women, dissemination (information) papers presented at professional meetings, and a final report.

EVALUATION

TEAM course materials were modified on the basis of use of the materials

by faculty and students in three field trials. During year one of the project, the materials were used by a mathematics educator and a psychologist. During year two, the materials were used in two colleges in the fall, with a math educator and psychologist in one setting and a mathematics instructor and psychologist in the second setting; in the spring the materials were used by a mathematics teacher educator, with only consultation by a psychologist.

There were specific suggestions for revision from each field trial and revisions are in the final materials. Overall, the materials in their field test form were perceived as satisfactory by both faculty and students. To assist potential users of the TEAM materials to understand student feelings as they progress through the TEAM course, evaluation case material was developed. Issues that occurred in student logs were identified. These issues focused on the classroom atmosphere and the substantive approaches to math content and anxiety. For the classroom atmosphere, the two key themes were first, the students' feelings of not being "alone," "left behind," and their growing comradeship and second, the patience and understanding of the faculty using the TEAM materials. Substantive issues dealt with the inductive approach and the numerous examples used in presenting the mathematics content. Students varied in their reaction to this instructional technique, yet the overall evaluations in attitudes and math anxiety are positive. The test preparations designed to reduce anxiety and particularly math anxiety were very positively viewed. Two student logs provide further understanding of the changes occurring in attitudes and student perceptions of the changes.

The pre-course measures of anxiety indicate that the students volunteering for the TEAM course had higher scores on a measure of math anxiety (MARS) and lower scores on the perceived usefulness of mathematics and confidence in their ability to use mathematics. Post-course measures of attitudes, mathematics anxiety and mathematical concepts indicated significant gains in each area, as well as performance equal to or better than comparison students who were less math anxious and who tended to have more positive attitudes toward mathematics. For mathematics content, as measured by a 36-item test of mathematics concepts, there were reliable student gains where pre and posttests were given to TEAM groups.

As a result of the attitude modules, TEAM students could name more famous women mathematicians when given that question pre-and post course, and all TEAM I and III students had noticed the treatment of women in elementary school math texts and considered it unfair, when compared to non-TEAM students. Another question tapped student feelings about teaching mathematics in the elementary school. More TEAM students felt very or somewhat comfortable about teaching mathematics than did a group of comparison students.

An overall student evaluation question asked students whether they would recommend offering the course on a regular basis to all teacher education students. A large majority, 83%, would either highly recommend the course or recommend it for some students. A follow-up of TEAM I participants had a very positive result in response to questions to college faculty supervisors of student teachers: more TEAM student teachers chose to teach math voluntarily (80% compared to 58% on non-TEAM student teachers).

Overall the TEAM evaluation data are highly positive and indicate that the materials should be useful to other teacher education programs that wish

to prepare elementary school teachers who are less math anxious, more competent and more aware of the need for sex equity in mathematics instruction.

II. Review of Year I Activities

During the 1978-1979 year the Teacher Education and Mathematics Project (TEAM) planned and developed a series of instructional modules designed to increase mathematics knowledge and reduce anxiety about mathematics. The instructional modules are for use by teacher education faculty with undergraduate elementary teacher education students. Four mathematics units were written and piloted with 44 students during 14 three-hour class sessions. The mathematical content of the units is: Patterns, Approximation and Estimation, Metric Measurement, and Choice and Chance.

The inductive approach was used for the mathematical instruction. In this approach, each module begins with problems designed to teach the principles through easy to more difficult examples, and the unit concludes with a statement of the principles and the objectives of the unit. Numerous examples were presented to students, who were then asked to find an appropriate generalization for the material. Although considerable class time is spent in this approach while students grope to find the appropriate methodology, the approach offers distinct advantages: students understand the bases for generalizations and can reconstruct the solution process; students practice a strategy for solving mathematical problems which is useful in out-of-classroom situations; and students who are prospective teachers are provided with a model method of teaching mathematics in an interesting and stimulating manner.

The mathematical units are accompanied by instructional interventions designed to reduce anxiety about mathematics. This psychological component focuses on students' feelings about mathematics in relation to problem solving, awareness of increased knowledge and skill, and test anxiety. The topics and activities for the attitudinal component include a plan for the orientation session, and initial or "intake" interview schedule and a final interview schedule. Sessions on demystifying math (developed by Dr. Stanley Kogelman) and material on how to conduct small group sessions were also prepared. The materials for a sex role stereotyping module include how to review text books for sexism and the implications of sex role stereotyping in the classroom. Materials to increase perception of math as a female domain include brief biographies of famous women mathematicians, a student interview form for women who use math or science in their work, a discussion of careers in which people use math, and suggestions for activities to be carried out by children.

Evaluation data were collected so that the materials could be improved on the basis of student and consultant reviews and classroom observations by project staff. Three groups of students were assessed for different purposes during the first year of the project. First, during the fall of 1978 groups of students were administered several of the attitude measures to determine the suitability (ease/difficulty, acceptability) of these measures for use with undergraduate elementary teacher education students. Second, the TEAM students who enrolled for the spring semester TEAM course in mathematics and anxiety reduction were assessed both before and after the courses. And third, a comparison group of students was assessed to provide evidence of the effectiveness of the TEAM courses.

The overall picture that emerged of the TEAM undergraduate elementary teacher education student was that of a person who had not taken mathematics since high school, who reported negative experiences and feelings about mathematics, and who wanted to increase her achievement and confidence in working with mathematics. TEAM participants in the first year of the program were generally typical of the type of student the project intended to recruit and serve.

The comparison group was formed from students who were one semester ahead of the TEAM I participants, already in the education sequence of courses, and who were beginning the mathematics methods course. They were at the point the TEAM participants would be after the TEAM experience and therefore, were selected as a comparison group.

Three attitude measures were administered to both groups: Mathematics Anxiety Rating Scale (MARS), Fennema-Sherman Mathematics Attitudes Confidence, and Usefulness Scales. (These instruments are described in Section V.A). The data indicated that TEAM students reported significantly more mathematics anxiety and less confidence than the comparison group of teacher education students.

Pretest-posttest comparisons on TEAM I indicated significant differences in the desired direction on all three measures. At the conclusion of the semester, TEAM students showed math attitudes similar to the comparison group.

Three types of dissemination activities were conducted during 1978-1979. A press release was written and distributed which resulted in three news articles. Papers on various aspects of TEAM were presented at the Institute on Multiethnic Studies for Teacher Education of AACTE

(American Association of Colleges for Teacher Education), and at APA (American Psychological Association). A workshop was presented at Queens College for faculty, students and community members; another was conducted for mathematics teachers in the Los Angeles City School District.

The Year I Final Report includes specific information on the conceptualization and selection of the topics, on developing an institutional structure for the course, on recruiting participants, on the selection, development and piloting of evaluation instruments, and on the literature review. It also includes a summary of each session, data collection procedures used by observers and student and faculty reactions to the modules. Evaluation recommendation and information on Year II planning are also included.

III. The TEAM Curriculum

A. The Structure of the Modules.

To present an overview of TEAM an Instructor's Handbook has been prepared.

In addition, each mathematics module has at least four separate components:

Instructor's Text

Student Materials and Exercises

Solutions and Guide to Student Exercises

Student Summary and Review

The attitudinal modules include an Instructor's Text and Student Materials. A special component of the attitude modules is an Audio Cassette. Each of these module parts will be described in this section.

1. The Instructor's Handbook

The Handbook sets the tone for the TEAM courses and outlines the structure and purposes of the instructional material. It includes: User's Guide, Introduction (to the problem of mathematics attitudes), Purposes and Strategies, Learning Environment, Attitudinal Interventions and a Bibliography. An Appendix on the evidence basic to the TEAM instructional strategies is provided along with a bibliography.

2. The Instructor's Text

The Instructor's Texts are the heart of the TEAM curriculum. Each one provides the content for the module, presented in a natural sequence for instruction. The text includes objectives of the lesson, explanation of concepts presented, definitions where necessary and approaches to be used to promote students' understanding of the material. The math Instructor's Text also indicates which exercises are appropriate for specific topics. Sample items developed to assess each objective are included for evaluation purposes.

The unique part of the Instructor's Text is the section entitled Commentary presented alongside the Instructional Content which incorporates teaching and counseling suggestions. The counseling notes include descriptions of what to expect from students on an attitudinal level for different topics and suggestions on how to use class sessions to build confidence and relieve anxiety. Instructional notes also include classroom organization suggestions and additional activities.

3. Student Materials and Exercises

These sets of materials have been developed for students' use and provide the hand-outs for class sessions. The materials include items such as representations of spirals found in nature (Patterns), a Pascal Triangle (Choice and Chance), relevant journal articles (Sex role stereotyping in Math Education), and "Metric Me," (Metric Measurement) an assessment of one's metric measures such as height and weight.

The exercises are problems which relate to the material presented by the instructor. These exercises can be performed by individuals, or by groups of students during class sessions in a group problem solving paradigm, or can be assigned as homework.

4. Solutions and Guide to Student Exercises

In this section the solutions to the student exercises are presented, and the instructor is provided with questions, suggestions and ideas for using the exercises.

5. Student Summary and Review

The Student Summary and Review Section was developed for presentation to the student upon completion of the module. At that point the content should be internalized and a concise outline of the modules' major points can be a helpful learning tool. The Student Summary and Review is helpful too, in quiz preparation.

6. Audio Cassettes

For three of the attitude modules audio cassettes have been

developed to aid in classroom presentation of material. The cassette and a script are included with these modules.

III. B. Instructional Modules: Math

Four mathematical modules which can be presented in any sequence are included in the TEAM curriculum:

Approximation and Estimation

Choice and Chance

Metric Measurement

Patterns

1. APPROXIMATION AND ESTIMATION

The purposes of this module are to:

- Have students understand when estimating and approximating are properly used;
- Enable students to become skillful in using approximate numbers when exact numbers are not needed;
- Enable students to assess the reasonableness of results;
- Have students develop references for various numbers;
- Familiarize students with calculators;
- Decrease anxiety and increase confidence in the area of approximation and estimation.

The objectives of the module for students to be able to:

- Select those that express approximate numbers in a given set of numbers;
- Place parentheses in a given mathematic expression to indicate a specified order of operations;

. Cite references for various measurements and other numbers;

. Round a given number to a specified degree of accuracy;

. Compute using the square brackets;

. Determine appropriateness of rounding up or rounding down in a given situation;

. Translate written words into decimal numerals and conversely;

. Express a given number in scientific notation and convert scientific notation to standard numerals;

. Analyze a calculation for reasonableness of results;

. Demonstrate the use of various computation shortcuts.

Approximately 8 hours of instructional material are included.

2. CHOICE AND CHANCE

The purposes of this module are to:

. Familiarize students with the vocabulary and concepts of probability;

. Enable students to compute simple probability measures;

. Develop problem solving skills;

. Demonstrate the extent to which probability is used in daily life;

. Reduce anxiety and develop confidence in the area of probability.

The objectives of this module are for students to be able to:

. List the outcomes for an experiment using a Tree Diagram;

. Calculate the number of outcomes of an experiment using the Multiplication Principle;

- Calculate the number of permutations for a set of things using all of the objects;
- Calculate the number of permutations for a set of objects using any number of them;
- Perform computations with factorials;
- Determine the total number of subsets that can be formed from a given set of elements using the formula 2^n;
- Use the Pascal Triangle to determine the number of subsets of a specific number of elements that can be formed from a given set;
- Pose questions for which the numbers of the Pascal Triangle are the correct answers;
- Determine the probability of an event, given the total number of outcomes and the number of favorable outcomes;
- Determine the probability that an event will not occur, given the probability that it will;
- Predict the number of times an event can be expected to occur in a given number of trials, given the probability of the event.

Approximately 8 hours of instructional material are presented.

3. METRIC MEASUREMENT

The purposes of the module are to:

- Familiarize students with the vocabulary and concepts of measurement, particularly metric measurement;

. Develop an understanding of which measurement units are appropriate to specific measuring tasks;

. Develop reference measures for various measurement units;

. Enable students to convert units within the metric system;

. Increase problem-solving skills;

. Decrease anxiety and increase confidence in the area of measurement.

The objectives of the module are for students to be able to:

. Select appropriate metric units to measure length, capacity, mass, and temperature;

. Estimate using metric units;

. Make comparisons between commonly used metric units and parts of the body or familiar objects in the environment;

. Convert and compute within the metric system;

. Demonstrate knowledge of concepts of measurement;

. Use accepted standards for recording metric measurements;

. Demonstrate knowledge of the structure of the metric system: i.e. the decimeter - cubic decimeter (liter) - kilogram relationship that relates the linear, capacity and mass system.

Approximately 8 hours of instructional material are provided.

4. PATTERNS

The purposes of the Patterns module are to:

- Show the importance of patterns in the discernment of number relationships;
- Demonstrate that math exists in nature;
- Demonstrate there are various ways to approach the solutions of mathematical problems;
- Upgrade problem solving strategies, particularly through the systematic recording of data;
- Reduce anxiety and increase confidence with number relationships.

The objectives of the Patterns module are for students to be able to:

- Identify and write triangular numbers;
- Apply the formula n^2 to calculate the sum of the first n odd numbers;
- Show through diagram, that $1+3+5...+(2n-1) = n^2$
- Apply the formula $\frac{1}{2} n (n+1)$ to calculate the sum of the first n natural numbers;
- Apply the formula $n (n+1)$ to calculate the sum of the first n even numbers;
- Demonstrate knowledge of the sums of even and odd numbers;
- Identify and write a specified term of the binary sequence;

. Express the sum of any number of terms, n, of the binary sequence in the form $2^n - 1$;

. Write a specified number of terms of a Fibonacci-type sequence;

. Follow and extend a given number sequence.

Approximately 8 hours of instructional material are included.

III. C. Instructional Modules: Attitudes

Four attitude modules, which can be presented in any sequence, are included in the TEAM curriculum:

Demystifying Math

Sex Role Stereotyping in Mathematics Education

Women, Mathematics and Careers

Women as Mathematicians

1. DEMYSTIFYING MATH

The purposes of this module are to:

. Develop an understanding that math anxiety is a shared problem;

. Provide an atmosphere where the therapeutic discussion of anxieties is apt to take place;

. Suggest behavioral approaches to help the individual better cope with mathematics.

The activities of this module include:

. Group discussions about math autobiographical information;

. Considering common math myths and how they influence our behavior;

. Considering the role of math in participants' daily lives;

. Identifying ways to counteract the debilitating effects of math anxiety;

. Considering ways to help children demystify math.

Approximately 4-6 hours of class discussion and activities are included.

2. SEX ROLE STEREOTYPING IN MATHEMATICS EDUCATION

The purposes of this module are to:

. Increase students' awareness of the existence of sex bias in curriculum materials and in classroom practices;

. Increase students' skill in identifying sex role stereotypes in materials and practices;

. Increase students' skill in counteracting sex bias in instructional materials, and practices;

. Provide a model for developing criteria than can be used to compare textbooks;

. Suggest methods of counteracting sex role stereotyping in the classroom;

. Encourage students to analyze their own math education as a possible factor in their math anxiety;

. Increase confidence in mathematics and decrease math anxiety.

The activities in this module include:

. Content analysis of math textbooks;

. Viewing and discussing the slide show Images of Males and Females in Elementary School Textbooks by L. S. Weitzman and D. M. Rizzo;

. Discussions of students' math experiences;

. Discussion of how to handle sex stereotyping in the classroom;

. Listening and discussing an audiocassette Teachers are Important.

Approximately 2-4 hours of instructional material are provided.

3. WOMEN, MATHEMATICS, AND CAREERS

The purposes of this module are to:

. Expand the knowledge base about math-related careers;

. Develop an understanding of the importance of mathematics to many careers;

. Suggest ways of transmitting this knowledge and understanding to children in the classroom.

The activities of this module include:

. Interviewing a career woman who uses math;

. Discussing the role of mathematics in careers;

. Listening and discussing the audio cassette: Getting from Here to There;

. Planning a lesson for children that relates math to careers.

Approximately 4-6 hours of instructional material are provided in this module.

4. WOMEN AS MATHEMATICIANS

The purposes of this module are to:

. Develop an awareness that some famous mathematicians have been women;

. Suggest ways to present material about famous women to children;

. Increase confidence and decrease anxiety about mathematics.

The activities in this module include:

. Taking pretest (non-graded) on female mathematicians;

. Listening and discussing the audio cassette: Interviews with the Past, a fictionalized discussion with two famous women mathematicians;

. Reading about women mathematicians - mathematics educators of note;

. Discussing personal environmental features that contributed to the mathematical development of famous women.

Approximately 1-2 hours worth of instructional material is presented.

IV. Activities, Material Development and Revisions

A. Overview of Year Two Activities

The primary activity of Year II was the field trial and revision of the modules which had been developed and piloted during Year 1. These included the modules on: Patterns, Approximation and Estimation, Choice and Chance, Demystifying Math, Sex Role Stereotyping

in Mathematics Education, Women, Mathematics, and Careers, and Women as Mathematicians.

The modules were field tested during Year II in five settings:

City College (Fall 1979)

Queens College (Fall 1979)

Curry College (Fall 1979 - Spring 1980)

Queens College (Spring 1980)

Brooklyn College (Spring 1980)

These field testing situations differed in many respects, including the amount of time devoted to TEAM materials, the instructional arrangement, the type of student. Descriptions of each situation are presented on the following pages.

As a result of the field trials and the feedback received from faculty and students, the modules were revised, and prepared for final distribution. In addition, new materials were developed. The module on metric measurement was prepared and a set of audio-tapes to complement the attitude modules were developed. The bibliography of references compiled in Year I was entered into a computer so that additions could be made more readily. Considerable effort was made to disseminate the findings, as was true in Year I, and these are presented in sub-Section E that follows.

Major effort was again placed on evaluation. The City College class and the Queens College class of the Fall 1979 field testing, considered TEAM II, received a complete battery of pre and post testing of achievement and attitude measures. Classes were ob-

served, faculty reactions were assessed, and the students were asked to rate the materials. These results are presented in the next section (V. Evaluation). Also included are the results of TEAM III, the Queens College (Spring 1980) field site.

A follow-up on TEAM I students (Queens College, Spring 1979) was conducted. These students were participating in a student teaching experience and were observed by Queens College faculty. During the first semester (Fall 1979), students were expected to teach a math lesson as one assignment in their methods of teaching mathematics course. Professors observed these lessons and discussed these with students. During the second semester (Spring 1980), the faculty were interviewed about all their student teachers to assess the use of mathematics in the classroom and attitudes of student teachers. The results of this investigation are presented in Section V.

B. Tryout of Modules at Field Sites

1. College A (Fall 1979) - TEAM II

A mathematics educator and a psychologist conducted the TEAM course work at College A in the Fall of 1979. The Team material was integrated into an existing course scheduled on mathematics instruction. Sixteen students participated in this course, which met for three hours on Thursdays at 6 p.m. Many of the students who attended this evening course were working in schools during the days as paraprofessionals and were returning to obtain a college degree. The following modules were used in instructing the class: Patterns, Demystifying Math, and Sex Role Stereotyping in Mathematics Education. The evaluation data

for these students are presented in Section V.

2. College B (Fall 1979) - TEAM II

A mathematician and psychologist conducted the TEAM course at College B in the Fall of 1979. Students who intended to teach, particularly in the early childhood and elementary grades were recruited to participate in the course. The course enrollment was 18. This course met for three hours on Thursdays at 1 p.m. Most of the students were enrolled full-time as undergraduates in the Education Department. The following modules were presented to this class: Patterns, Approximation and Estimation, Choice and Chance, Metric Measurement, Demystifying Math, Sex Role Stereotyping in Mathematics Education, Women, Mathematics and Careers, and Women as Mathematicians. The evaluation data for these students are presented in Section V.

3. College C (Fall 1979 - Spring 1980)

A mathematics education instructor at College C, expressed a desire to field test the attitudinal components of the TEAM materials within an established course of mathematics education. Twenty-one students participated in this course and were exposed to the modules on sex role stereotyping. She was able to select components of the module and incorporate them satisfactorily into the existing course.

4. College D (Spring 1980), TEAM III

A mathematics educator, conducted the TEAM III class. Students were recruited from the Education Department, and 30 enrolled in the course. The students were full-time undergraduates working toward certification, for the most part, in elementary and early childhood grades.

The following modules were presented:

Patterns; Approximation and Estimation; Choice and Chance; Metric Measurement; Demystifying Math; Sex Role Stereotyping in Mathematics Education; Women, Mathematics and Careers; Women as Mathematicians. Full evaluation data on this group are presented in Section V.

5. College E (Spring 1980)

A mathematics educator assigned the Approximation and Estimation module to her class of students, all of whom were prospective teachers, generally at the elementary school level. In this case, the Student Materials and Exercises, and Summary and Review of the module were used for self-instructional purposes: questions regarding content were discussed during the full class sessions in this course on teaching mathematics. Student ratings of the module were collected: no other evaluation data were collected from the students. The faculty member also completed the rating scales for the module.

C. Development and Revision of Modules

On the basis of the initial pilot testing, and reactions to the modules from the field test groups, all of the modules were revised to some extent. For the most part, this took the form of making the mathematics modules shorter, more cohesive, and developing exercises for the students which not only involved the new concepts, but allowed students to practice basic concepts as well.

An additional module was completed. The Metric Measurement module (described in detail in Section III) develops concepts of measurement in general (area, length, width, volume) within a context which is apt

to be unfamiliar to many of the students - metrics. The interrelationships between metric measures (meter, liter, and gram; centimeter, kilometer, etc.) are stressed.

D. Completion of Audiotapes

Audiotapes were recorded to supplement the attitude modules and to allow the instructor one more medium through which to present the TEAM concepts. To accompany the module Sex Role Stereotyping in Mathematics Education, the audiotape, "Teachers are Important," was developed. The script concerns a series of conversations between two teachers, one of whom is competent and comfortable with mathematics, and a friend of hers who is frightened and feels incompetent with mathmatics. Through the course of the tape we hear how teachers can assist one another, and specifically how teachers can influence the way their students perceive mathematics.

In the module Women, Mathematics, and Careers, the purpose is not only to expand the knowledge that future teachers have about the career uses of math, but also to provide prospective teachers with tools when they have their own classrooms. The audiotape "Getting From Here to There," developed to accompany this module, serves both purposes. The script revolves around a classroom assignment in an elementary school class where a group of children decide to present a panel to their classmates. The panel is composed of women who use math professionally. The vehicle of the audiotape allows the TEAM instructor to provide knowledge of the actual careers (a computer programmer, a public health statistician, and a home economics teacher) and simultaneously

to suggest an effective method of having children pursue similar topics (a panel of experts visiting the class).

The third audiotape "Interviews with the Past" is part of the Women as Mathematicians module. Two female mathematicians (Sophie Germain and Sonya Kovalevski) are interviewed in radio-style conversations to delve into the life histories and life purposes of these two famous women.

E. Completion of Bibliography

The bibliography of references compiled in Year I was updated. Categories were developed and citations grouped into these: Attitudes toward mathematics for students and teachers, Mathematics careers and sex bias, Sex role stereotyping, Math anxiety, Sex differences, Math anxiety reduction programs, Mathematics content, Teachers' perceptions and skills, Women mathematicians and Math anxiety assessment. The citations were entered into a computer to facilitate future updating.

F. Dissemination Activities (September 1979 - August 1980)

- Math Anxiety Correlates: A Study of Prospective Elementary School Teachers (Elaine Chapline, Elenor Denker, Claire Newman) was presented at the Annual Meeting of the American Psychological Association (APA in New York City in September 1979, sponsored by Division 35, the Psychology of Women.
- A description of the TEAM Project was presented by Drs. Chapline and Newman at the annual meeting of the Association of Mathematics Teachers of New York State (AMTNYS)

in November 1979 in Rochester, New York. Approaches to mathematics and anxiety reduction were presented and sample instructional materials were available.

. A description of the TEAM Project was presented at the annual meeting of the American Association of Colleges of Teacher Education in Dallas, Texas in February 1980 by Drs. Chapline and Newman.

. At the annual meeting of the National Council of Teachers of Mathematics (April 1980, Seattle) titled "The Curriculum of the 80's," Dr. Newman presented Teacher Education and Mathematics: the Team Project.

. Teacher Education and Mathematics: Program development and evaluation (Elaine Chapline) was presented at the annual meeting of the American Educational Research Association in Boston, April, 1980. The paper was entered in the ERIC system (ED 186 272).

. Math Anxiety Reductions and College Classroom Interventions (Elaine Chapline) was presented at the Annual Meeting of the American Psychological Association in Montreal in September 1980.

. Articles have been published in local newspapers based on a news release by Queens College.

G. Staff Responsibilities

The TEAM staff was carefully selected and has proven to be a multi-skilled group. Most were able to function in several capacities. The

three primary staff members were Dr. Elaine B. Chapline, Psychologist and Project Director, Dr. Claire M. Newman, Mathematics Specialist and Dr. Carol Kehr Tittle, Psychologist-Evaluator. These three individuals conceptualized the program, submitted the original grant proposal, translated the broad goals into activities, developed the instructional materials and evaluation design, and supervised the other staff members. In addition to these three senior staff members, the project staff in Year II also included an Evaluation Associate (Elenor Rubin Denker), a Mathematics Associate (Francine Sicklick) and two Graduate Assistants (Annette Berson and Dorothy Watkins).

The other member of the TEAM staff Year II was a Secretary-Administrative Assistant, (Katherine Flanagan). Other individuals were consulted regularly. These consultants were Dr. Stanley Kogelman, a specialist in mathematics and mathematics anxiety; Dr. Anne Peskin, and Dr. James Bruni, professors of mathematics education; and Mitchell Lazarus, mathematics educator, and Fredrick Paul, Chief of the Bureau of Mathematics of the New York State Education Department, provided evaluative comments about modules.

V. EVALUATION

A. Evaluation Approach and Design

The evaluation of the TEAM project has three major goals:

1. To provide judgment and process feedback to the TEAM developers for the improvement of TEAM course materials;
2. To provide summative data on changes in attitudes, mathematics anxiety and mathematics concepts; and

3. To compare the effect on student attitudes, mathematics anxiety and mathematics concepts of participation in a TEAM course with effects for non-TEAM students.

The first evaluation goal was primarily for TEAM developers, although descriptions of process are also valuable to potential users. Goals two and three are particularly of value to future users of TEAM materials.

In the first year of the project the responses of a sample of teacher education students were used to determine the appropriateness of several instruments. The Mathematics Anxiety Reduction Scale, (MARS), (Suinn, 1972) and several of the Fennema-Sherman Attitudes Toward Mathematics Scales, (F-S Scales) Fennema and Sherman, 1976) were selected. In the second year the Attitude Towards Women Scale (AWS) (Spence and Helmrich, 1973) was used for TEAM II. Other instruments were developed for the project and included interviews and questionnaires, student and faculty rating forms for the TEAM modules, as well as observer schedules. (See Table 1).

Both the instruments and method of using the TEAM materials varied in the three semesters of field trials. Therefore, with few exceptions, the data are described separately for each group--TEAM I, TEAM II, and TEAM III--as well as for the corresponding comparison groups. The specific evaluation objectives and data collected for students are summarized in Table 1. The characteristics of the student groups are described in Section B, and the findings are presented in Sections C to E. Section D provides case descriptions which are intended to give a more complete understanding of the process students experience as part of their participation in a course using the TEAM materials. A summary is provided in Section F.

TABLE I EVALUATION FOR 1978 - 1980 FIELD TRIAL SITES

Project Goal	Measurable Objectives	Evaluation Data	TEAM I Spring 1979	TEAM II Fall 1979	TEAM III Spring 1980
1) Develop materials that decrease math anxiety.	1) a) MARS scores will significantly decrease over course of semester.	1) a) MARS pre and post	X	X	X
	b) Fennema/Sherman Confidence and Usefulness scores will significantly increase over course of semester.	b) F/S Confidence and Usefulness scales pre and post.	X	X	X
	c) Students will report significantly less math anxiety at end of semester	c) Self-rating pre and post. (student attitude questionnaire).	X	X	X
		Most measures also given to comparison groups.	Posttest only		Pretest and Posttest
2) Develop materials that increase math Competence.	2) Strategies for approaching math problems will improve over course of semester.	2) Math concepts test (project test) given pre-posttest	Posttest only	X	X
		Math concepts test given to Comparison group I as Posttest	Posttest only		
3) Develop materials that reduce sexrole stereotyping in prospective teachers.	3) The ability to identify sexrole stereotypic material in texts will increase.	3) a) Pre-post question on student attitude questionnaire.	Posttest only	X	X
		Pre-post question given to comparison group	Posttest only		X

TABLE 1 (continued)

Project Goal	Measurable Objectives	Evaluation Data	TEAM I Spring 1979	TEAM II Fall 1979	TEAM III Spring 1979
4) Develop materials that increase knowledge of women and math.	4) a) Knowledge of famous women mathematicians will increase.	4) a) Pre-post questionnaire item		X	X
	b) Realization of the usefulness of math will increase	b) F/S Usefulness Scale pre and post; (comparison group I also)	X	X	X
5) Develop materials that increase student confidence in teaching mathematics	5) a) The number of students stating they have positive feelings about teaching math will increase.	5) a) Student attitude questionnaire.	X	X	X
Greater than for non-TEAM student teachers	b) The number of TEAM student teachers voluntarily teaching math will be greater than for non-TEAM student teachers	b) College supervisor ratings	X		
6) Develop materials that are usable by instructors of prospective teachers.	Instructors and/or consultant will rate the materials on degree of helpfulness (usefulness), clarity, interest, appropriateness of content level, and relevance for elementary school teachers.	6) Field trial instructors will rate each TEAM module upon completion		X	
		TEAM observers will interview field trial staff after each class. Key topics include remedial techniques, sequence, organization of session etc.	X	X	X

Table 1 (continued)

Project Goal	Measurable Objectives	Evaluation Data	TEAM I Spring 1979	TEAM II Fall 1979	TEAM III Spring 1979
7) Develop materials that are judged beneficial by teacher education students.	7) a) Undergraduate teacher education students will rate the materials on degree of usefulness; b) clarity c) interest value, d) appropriateness at level, e) relevance.	7) TEAM modules will be rated upon completion.	X	X	X

B. Characteristics of Student Groups

Team I and Comparison Group I: Student Characteristics

There were 46 students interviewed upon admission and prior to the beginning of the TEAM courses. These Team students reported a wide range of background courses in mathematics. A majority of students had taken high school courses in elementary algebra (87%), geometry (85%), and trigonometry (63%). It was a rare student who had gone on to solid geometry (7%) or to calculus (4 or 5%). In college, less than 25% of the students reported taking mathematics courses such as calculus (22%) or statistics (22%).

Since the math anxiety reduction or attitudinal component of the course was concerned with student perceptions of mathematics, several interview questions (as well as the attitude measures described below) were concerned with this area. Students were asked how they felt about their math courses in high school and/or college. Over half the students responded that there was at least one high school mathematics course that they did not enjoy (63%). The main reasons why they enjoyed a course were given as it was easy (35%), it was fun (24%), the teacher was good (15%) and the course was relevant (13%) and logical (13%). The antithesis of these statements were the main reasons given for not enjoying a course.

When asked how they "feel" about math, students gave a variety of responses, predominantly negative: I don't understand it (13%); I don't like it (15%); it is hard (9%); I'm afraid (15%); and I avoid it (9%). Only 22% said they enjoyed it or it depended on the teacher how they felt about it. In response to a question on whether students recalled

any particularly traumatic experiences in learning mathematics, 80% of the students said "yes". The predominant reason for the traumatic experience was given as a teacher (68% of the students who had experienced trauma). A further question concerned with feelings asked students how they would feel walking into a mathematics classroom right then. Only 4 students (9%) said they would feel positively; 76% of the students said they would feel either hesitant or fearful. These feelings were also reflected in students' anticipation of what they would like to get from TEAM. Eighty-two percent said they would like to attain more confidence and increased achievement in mathematics.

The overall picture that emerges of the TEAM I undergraduate elementary teacher education student is that of a person who has not taken mathematics since high school, who reports negative experiences and feelings about mathematics, and who would like to increase her achievement and confidence in working with mathematics. TEAM participants in the first year of the program are generally typical of the type of student the project intended to recruit and serve.

The distribution of age and ethnic group for these students shows that they are predominantly white and under 20 years of age (that is, the standard age for college students). Six students are "re-entry" women, paraprofessionals who are completing a college education, and the majority of them are over 30. Forty of the students are white, four are black and two hispanic. Of these 46 students, all but one is female. Forty-four students completed the course, all were female, and they were primarily college juniors entering the education sequence.

The comparison group was formed using 51 students who were one semester ahead of the TEAM participants, already in the education sequence of courses, and who were beginning the course in mathematics methods. They were at the point the TEAM participants would be after the TEAM experience. Since most of the eligible students registered for TEAM, therefore a control group of non-enrollees at the same point in their educational sequence was not possible.

Team II; Student Characteristics

The TEAM II group consists of students from two CUNY colleges, Queens and City. As described earlier, these two colleges varied in their use of TEAM materials, but both followed the approach of using a math educator and a psychologist to improve math knowledge and lessen math anxiety. TEAM II students completed pre and post tests in math concepts (a shortened version at one college), the MARS, F-S Scales, AWS and an attitude/demographic questionnaire. This latter questionnaire was developed from analysis of the open-ended questions and interviews of the TEAM I students. The pre-post questionnaires are reproduced in Appendix 2.

Thirty-three students completed the pre-course questionnaire; 30 were females and 3 were males. There were 7 who were sophomores, 21 juniors and 4 seniors. Ethnic group representation was: 10 black, 6 Hispanic, and 15 white students. Their ages ranged from 18 to 44, with an average age of 25 (median of 23 years) A majority of students reported having had elementary algebra (83%), in high school, about two-thirds had taken intermediate algebra (64%), and only 30% reported advanced algebra. Sixty percent said they had taken a course in geometry, and 24% a course

in solid geometry. One person reported a calculus course completed, 30% a trigonometry course, 25% general math, and 10% business math. About half had completed a general math course in college and 10% calculus, 21% statistics course and 3% (1 student) a college computer math course.

Students reported their general attitude towards math on a scale from 1 - highly positive to 5 - highly negative. Nine percent (3 students) reported a highly positive attitude, 24% (8) each reported somewhat positive, neutral, and somewhat negative attitudes, and 18% (6) reported a highly negative attitude toward math. These percentages were similar for the questions, "How do you react to mathematical situations?" Six students (18%) reported they enjoy them, 9 (27%) said they were neutral, 2 (6%) said they don't understand them, and the remaining 15 (46%) said, "I feel afraid or nervous." Student self-ratings on anxiety about mathematics (Question 7 appendix 2) showed that almost 90% rated themselves as having some degree of anxiety, 33% said highly anxious, 27% said moderately anxious, 30% said a little anxious, and 6% (2 students) reported themselves as not anxious.

Students reported that they used math in their daily experience frequently (42%), occasionally (48%), and rarely (3%). Interestingly, when students answered the question "Who helped you the most when you had difficulty with math at school?" 24% indicated their mothers, 9% their fathers, and another 24% friends. (The remainder cited a sibling, another relative, a tutor and no one (9%).)

Students also rated their fathers' and mothers' attitudes toward their studying math in school--from highly positive to highly negative.

About thirty percent rated both parents' attitudes as highly positive (father 33%, mother 27%), somewhat positive ratings were 27% for fathers and 36% for mothers, neutral attitudes were 21% for fathers and 24% for mothers, and somewhat negative attitudes were reported only by one student for each parent (3%).

Other questions asked about the expectations students had for the TEAM course and whether students could name any famous women mathematicians. None of the students could name a woman mathematician, and their expectations for the TEAM course were similar to those of TEAM I students: anxiety reduction (20%); increased math achievement (5%); and both of these goals (18%). Other students expected to increase their confidence or have a more positive outlook on mathematics (27%), and 15% expected the course would assist them to become better math teachers.

The TEAM II students were similar to TEAM I students in many of the characteristics described above. They were, however, older students and more heterogeneous in ethnic group membership. The counselor at College A indicated that the high percentage of bilingual Hispanics probably influenced the pace of the course and that some of the articles distributed in TEAM materials were difficult for some students. Family responsibilities of older students resulted in limited time spent on assignments and study time.

TEAM III and Comparison Group III: Student Characteristics

The TEAM III group consisted of students from Queens College taught by a mathematics educator, with out-of-classroom consultation and oc-

casional participation by a psychologist. With the exception of the material on Sex Role Stereotyping in Mathematics, Women, Mathematics and Careers and Women as Mathematicians, all classroom instruction was by the math educator. These students had a complete set of data instruments administered pre and post-course, and a Comparison group (III) was also tested with MARS and the student questionnaire.

The TEAM III group had 27 female and 3 male students. Twenty-two were juniors and 8 were sophomores. The majority of students were white (25), two were Hispanic and one was black. Their ages ranged from 19 to 43, but 96% were 19-23 years old.

As with TEAM II, a majority of students reported completing elementary algebra in high school (83%), 63% had taken intermediate algebra, and 37% had completed advanced algebra. Eighty percent had taken a course in geometry, 47% trigonometry but only 10% reported a solid geometry course and 7% a calculus course. Six percent reported a business math course, and 13% one in general math. At the college level, 33% reported a general college math course, 20% a calculus course, 3% a statistics course and no one reported a computer math course.

The majority of students reported their general attitudes toward math as somewhat or highly negative (74%). For mathematic situations, 50% reported being afraid or nervous, 10% said, "I don't understand them" and 20% said they were neutral. When questioned about math anxiety, 70% reported they were highly or moderately anxious, and 27% said they were a little anxious. (Only one student reported feeling no math anxiety.)

A majority of students reported that they used math occasionally in their daily lives (63%). Most students also received help in math within their family (40%) or from a relative (7%) or friend (30%). They reported somewhat less positive attitudes toward math on the part of mothers (highly positive, ratings of 27% of fathers and 13% of mothers). As with the earlier TEAM groups, none of the students named a famous woman mathematician. Expectations for the TEAM course centered in anxiety reduction and increased math achievement (40%), increasing confidence (33%) and becoming a better math teacher (23%). Students were not confident about teaching mathematics (57% said they would be somewhat or very uncomfortable teaching math; 10% felt neutral; and 17% felt somewhat or very confident.)

Comparison group III students were typically at the beginning of the teacher education sequence, enrolled in courses in educational psychology. There were 41 students; all were female. Thirty-three percent were college sophomores, 61% were juniors and 6% were seniors. For ethnic group 81% reported white, 16% Hispanic and 3% Black or Oriental. Age ranged from 18 to 49, with the mean age 25, the mode 19, and the median 20 years. Their past experience with mathematics (types of courses taken) was fairly similar to that of the TEAM III group, with the exception that fewer comparison group students reported courses in elementary algebra (83% in TEAM III vs. 52% in the comparison group).

The general attitude toward mathematics was reported as somewhat or highly negative by 51% of the students (compared to 74% for TEAM III students). Their general reaction to mathematical situations indicated that 39% said they were afraid of them (50% in TEAM III) and 5% said

they didn't understand them (compared to 10% in TEAM III). Thirty-one percent said they were neutral (20% said the same in TEAM III). Fifty-one percent reported this general level of math anxiety as moderately or highly anxious, 26% a little anxious and 24% as not anxious.

Almost half of the comparison group students reported feeling somewhat or very confident about teaching math (46%), 15% felt neutral and 18% felt somewhat or very uncomfortable (compared to 57% of the TEAM I students).

These data on the comparison group students, as with comparison group I, indicate that TEAM students differ in self-reported anxiety and attitudes toward mathematics, although they were fairly similar to other students in their past courses taken in math, for example. The comparison group of students for TEAM III also are somewhat older than TEAM III students.

Pretest Status of Math Attitudes:

Status of the TEAM and Comparison groups for pretest measures are summarized here. (Posttest data are given in Section E.) Table 2 permits an examination of the initial status of two of the experimental groups, and a contrast with the two comparison groups. Three measures were administered across all groups: The MARS with a possible range of scores from 98-490, (98 items, from 1 to 5 points each), and two Fennema-Sherman scales, Math's Usefulness and Confidence, (of 12 items, scored from 1-5 points each), with a possible range of 12 to 60.

Table 2 Means and Standard Deviations of Attitude Measures for the Experimental and Comparison Groups (pretest scores)

Attitude Measure	TEAM I (n=44) M	SD	Comparison Group I (n=51) M	SD	t	p
MARS	345.3	64.7	209.1	65.0	2.71	.008
F-S Math Usefulness	34.8	6.3	38.8	5.0	3.39	.001
F-S Math Confidence	20.5	9.6	29.3	10.0	4.33	.001
	TEAM III (n=30)		Comparison Group III (n=41)			
MARS	260.5	69.1	231.1	63.6	6.5	.001
F-S Math Usefulness	44.3	7.1				
F-S Math Confidence	30.1	11.8				

The data for TEAM II (n=34) showed a mean on the MARS of 249.8 and a SD of 82.1 The mean scores on the Fennema-Sherman Usefulness and Confidence scales were 48.1 (SD 5.3) and 35.9 (SD 11.3), respectively. The data on the attitude scales show that TEAM I students reported more math anxiety and less confidence than Comparison Group I of teacher education students, as did the TEAM III students compared to their control group.

A mathematics concept test (see appendix 4) developed for the project was administered as a pretest to College B of the TEAM II group, and all of the TEAM III students. The pretest mean of the 36-item measure was 21.5 (SD = 7.1) for 17 students in TEAM II, and 24.3 (SD = 5.4) for TEAM III students.

C. Process Evaluation

Several data collection strategies were used to document the implementation of the TEAM modules and to describe student and faculty judgments of sessions and materials. For TEAM I, observational data were collected at every session by at least two observers. The frequency of student participation was tabulated and apparent anxiety-produced reactions were classified and rated as to intensity. Running logs on math and psychological content, as well as instructional activities were kept and used in meetings with project staff in planning for revision of materials.

For TEAM II and III one observer was present at each session. However, the recording log was changed to the form shown in Appendix 4. The focus was on describing the class structure (individual, small or large groups, or entire class) and activity (faculty lecture, student discussion, etc. In this format observers noted class events at 10 or 20 minute intervals and interviewed the instructor for ratings on TEAM modules after the class session. These logs were summarized and given to the TEAM curriculum developers along with any student ratings (Appendix 5). Periodically, students were asked to rate the session they had just completed. In the second year, these ratings were completed only at the end of the modules. The major purpose of all of these activities was the improvement of the materials after the field trials. Sample data from these evaluation activities are presented on the following pages.

Student ratings of selected class sessions: TEAM I

Session 3 - TEAM I. Students responded to a rating form (See Appendix 4) which had items on session interest, usefulness, difficulty and so on. For example, session 3 was a continuation of the Patterns module (the second class on this module) and the ratings are summarized in Table 3. The math class was rated as moderately interesting and useful. The math content was perceived as quite new, but also as quite understandable. It was not rated as frightening by a majority of students. Some students found it too easy; fewer found it too hard. Most students did not find it too long. The group (attitudinal component) session was rated as moderately helpful and enjoyable, and quite reassuring. The session was rated as neither too long nor too short. The math assignment, which was perceived as quite new, was moderately interesting, useful and understandable. It was not rated as particularly frightening, nor too easy, nor too long. For some, it was considered somewhat difficult (mean = 2.7). Students also wrote in comments on the rating form. The comments were:

> I feel I am finally understanding something that has to be done in math.
>
> The math is beginning to become more involved and I feel I'm beginning to get very nervous about it.
>
> I felt the material was explained very clearly.
>
> I felt very relaxed and therefore, not afraid.

TABLE 3, TEAM I Mean Student Ratings of Session 3. (n = 39)

Was this math class:	AM	PM
1. Interesting?	3.6	3.9
2. Useful?	3.3	3.7
3. New to you?	4.0	3.5
4. Understandable?	3.7	3.9
5. Frightening?	2.2	2.2
6. Easy?	3.0	2.8
7. Hard?	2.1	3.0
8. Too long?	2.5	2.6
Was this group session:		
9. Helpful?	3.3	3.9
10. Reassuring?	3.6	3.4
11. Enjoyable?	3.3	3.5
12. Too short?	1.5	2.8
13. Too long	1.8	2.6
Was the math assignment:		
14. Interesting?	3.3	4.3
15. Useful?	3.3	3.9
16. New for you?	4.0	3.2
17. Understandable?	3.?	3.8
18. Frightening?	2.5	2.6
19. Too easy?	2.0	3.9
20. Too hard?	2.7	2.7
21. Too long?	1.9	2.2

	Not at all		So-so		Very much
Rating Scale:	1	2	3	4	5

Session 6 - TEAM I. Session 6 was the second session on the Approximation and Estimation module; mean ratings are given in Table 4 for sessions 6 and 12. The math content was rated as not particularly new, frightening or hard. The afternoon students rated the content as more interesting than did the morning students. The atmosphere was reported as moderately helpful, reassuring and enjoyable by the morning students, and more positively by the afternoon students.

Student comments included:

I thought the class was a little boring, too many examples were given to illustrate an easy to understand concept.

I thought the material was fairly interesting and fun but I was bored because I am confident and know this material very well.

I really had trouble understanding some of the problems and don't know how well I will do on the homework but I'll try. It shouldn't be that bad.

I felt very confused today.

I found the lesson a little drawn out.

I feel confident in this math course no matter what the subject matter is. Even if I do not do well in it, I still feel confident.

I just know that I will have to study harder.

What Ellie said really hit about just because you are able to follow along to the end doesn't mean it was simple. I think most of us are programmed to expect the difficult stuff and anticipate problems. When they aren't there, we say to ourselves - well, if I got it then it must have been really simple.

Was a little too redundant.

Like doing a puzzle - figuring alternatives. Estimating is a daily happening with me. It does not intimidate me. Calculations may be a different story.

I find the math is getting a little bit harder. I'm not as nervous as I was before if I find I do not understand something. I know eventually, I'll understand it by either getting additional help from the teacher or from classmates.

Straightened out some wrong theories I held on number placement and decimal placement.

Table 4 Mean Student Ratings of Sessions 6 and 12: TEAM I

	Session 6		Session 12	
Was the math content:	AM (n = 21)	PM (n = 16)	AM (n = 22)	PM (n = 18)
1. Interesting?	2.3	3.8	3.3	4.2
2. Useful?	3.2	4.1	2.7	3.8
3. New to you?	2.3	1.8	3.7	3.9
4. Understandable?	3.6	4.3	3.4	3.9
5. Frightening?	1.6	1.5	2.0	1.7
6. Hard?	2.2	2.4	3.0	2.9
Was the general atmosphere:				
7. Helpful?	3.1	4.6	3.5	3.7
8. Reassuring?	3.1	4.5	3.2	3.7
9. Enjoyable?	2.8	3.7	3.1	4.0

	Not at all		So-so		Very much
*Rating Scale:	1	2	3	4	5

Session 12 - TEAM I. Session 12 was the second session of the Choice and Chance module. The math content was judged to be "moderately" interesting, new, understandable and difficult by the morning

group and "quite" interesting, useful, new, understandable and difficult by the afternoon group (see Table 4). Neither group found the session frightening. The atmosphere was rated from "moderately" to "quite helpful," reassuring and enjoyable for both groups, although the afternoon group tended to have more positive ratings than the morning group.

Student comments included:

This unit is much more difficult than the past one has been.

It's hard to go back to doing the math after the break.

I thought I was going to learn the basic math to some degree. e.g.: 7 x 7 or 1/2 + 1/4.

It's a pleasure to be able to come into a math class and understand what's going on, but at times I was bored. Mayber there should be some kind of division of the class.

Student comments provided useful information for revision. Several of the modules were extensively revised, based on student, faculty, and consultant ratings. The revised materials were used by the TEAM II and III groups.

Module Ratings -- TEAM II

Data for the Patterns, Choice and Chance, and Approximation and Estimation modules are presented in Table 5.

Table 5 Mean Student Ratings* for Selected Modules: TEAM II

Was the math content:	College A Patterns (n = 12)	College B Patterns (n = 17)	College B Choice & Chance (n = 14)	College B Approximation and Estimation (n = 18)
1. Interesting?	4.3	4.1	3.9	4.0
2. Useful?	4.2	3.5	4.4	4.4
3. New to you?	3.3	4.2	3.2	2.8
4. Understandable?	3.7	4.1	3.6	4.1
5. Frightening?	2.3	2.6	2.9	2.3
6. Hard?	2.5	2.7	3.4	2.7
Was the general atmosphere:				
7. Helpful?	4.0	4.6	4.1	4.5
8. Reassuring?	3.8	4.5	3.7	4.6
9. Enjoyable?	4.3	3.9	3.6	3.9

	Not at all		So-so		Very much
*Rating Scale	1	2	3	4	5

For College A, the Patterns module ratings indicate that in general the math content was judged to be quite interesting and useful, somewhat new and understandable, and not particularly frightening or hard. The atmosphere was perceived as quite helpful and enjoyable, and somewhat reassuring. At College B, the same module was also judged to be quite interesting, new and understandable. It was also not perceived as frightening or difficult content. The usefulness was rated so-so, and the

atmosphere as quite reassuring, helpful and somewhat enjoyable.

The Approximation and Estimation module was perceived as quite interesting, useful and understandable. It was not particularly new, frightening or hard. The atmosphere was again perceived as quite helpful, reassuring and enjoyable. The content of the Choice and Chance module was considered also to be quite useful and interesting, but newer in content and somewhat more frightening and hard. The general atmosphere was, however, perceived as helpful, and somewhat reassuring and enjoyable.

Module Ratings: TEAM III

Student ratings were collected for one of the math modules--Approximation and Estimation--and for the module on Sex Role Stereotyping in Mathematics Education. These ratings indicated that the Approximation and Estimation content was judged to be only somewhat interesting, useful, new and understandable, and so-so in difficulty. The general atmosphere was also about average in judgments of helpfulness, reassurance, and enjoyability. Student comments on the math module included:

> I found some sessions to be better than others. Basically I found metrics to be the most confusing.
>
> I don't feel I'm prepared for the quiz - several unanswered questions and assignments.
>
> I found the math content useful only at certain times -
> 1. the metric system,
> 2. using a calculator (how to feed an equation into it),
> 3. average and approximation
>
> Learning about the memory was helpful - very much.

Two students commented on the sex role stereotyping module:

> The class sessions were an enlightening experience. I thoroughly enjoyed the sessions.

> This topic is an extremely interesting and useful part of the course. I hope there is more that deals with attitudes used in teaching. Our own analysis of texts was a fun way of learning.

Overall, the student ratings indicate that for the TEAM II and III students the math content of the modules rated was generally interesting, useful, understandable, and new to at least some students. The focus on dealing with math anxiety also seem to have resulted in a classroom atmosphere that was perceived as helpful and reassuring.

4. Faculty Ratings and Comments on Modules: TEAM II

At College A the instructor had seven class sessions using TEAM materials: session one included an orientation to the project and testing, session 2 through 6 included materials from the units on demystifying math and on patterns; and session 7 was devoted to patterns. At College B, session one was similar; session two included Demystifying Math and Patterns, and sessions three through six were on Patterns. Sessions 7 to 10 used the material on Approximation and Estimation, and session eleven the material on Metric Measurement. Session 12 was concerned with Women as Mathematicians and sessions 13 through 15 involved the material on Choice and Chance.

College faculty evaluations were obtained by asking, "What parts went well today? And what parts didn't go well?" The math educator at College A, using the Patterns material, indicated that the story of Gauss, development of a sum and identifying patterns went well; averaging numbers did not go as well. At College B the math educator indicated a highly positive response to the Approximation and Estimation material. She also indicated that the geometric interpretation of patterns did not go well, that there were too many ways given to sum an integer, and

that the Metric Measurement materials needed more than one session.

No preferable sequence was found within the Patterns module at College A; at College B the math educator indicated that: unnecessary material was in the Patterns module; the Approximation and Estimation module should precede the Patterns module; that Metrics should have two sessions; and that she preferred teaching combinations after permutations (putting probability in the middle).

At College B, with respect to the math anxiety reduction materials, the discussion of anxiety and logs went well, as did the chance to express feelings, logs, the slide show, stereotypes discussion and the model of interviewing. However, the math educator felt the stereotypes discussion took too long.

The psychologist at College A was concerned that the materials distributed for reading were too demanding (the class included a high percentage of bilingual Hispanic and black students who were working full time, had families and were attending college). Main activities directed toward the psychological aspects of learning mathematics centered on student confidence and competence. One discussion related to the TEAM philosophy involved the group verbalizing how their students felt when facing difficulties in arithmetic. Students realized that their style of working with the children actually reinforced the same anxieties and fears and feelings of inadequacy that they felt in their elementary classes years before.

Three math modules were rated on Need for Revision by College B faculty. (See Appendix 6 for form). The Approximation and Estimation module received the maximum rating (Is highly satisfactory) as shown in Table 6. The Choice and Chance module received moderately satisfactory

Table 6 College B Ratings* of Modules by Mathematician: TEAM II

IS THIS MODULE FOR TEACHER EDUCATION STUDENTS:	Module: Approximation & Estimation	Choice & Chance	Patterns
1. At an appropriate level of difficulty?	5	4	2
2. Likely to be interesting to these students?	5	4	2
3. Based on material that is important for the prospective teacher of elementary mathematics?	5	4	3
4. Likely to increase their mathematics confidence?	5	3	5
5. Sufficiently clear to be used by other teacher education instructors?	5	4	4
6. Suitable for students with varying math backgrounds?	5	4	4
7a. Likely to increase their mathematics knowledge?	5	4	5
7b. Likely to increase their knowledge about sex-role stereotyping.	NA	NA	NA
7c. Likely to increase their knowledge of women in mathematics?	NA	NA	NA
7d. Likely to increase perception of mathematics as an important subject for women	5	NA	NA

*Scale 1 needs major revision; 2 needs some revision; 3 is adequate; 4 is moderately satisfactory; 5 is highly satisfactory

ratings, with one exception. The Patterns module received ratings indicating a need for some revision on difficulty and interest level, but a highly satisfactory rating on likely to increase mathematics confidence. Comments suggested specific revisions on several word problems.

The observer records of classroom structure and activities are not reported here in detail. The predominant finding is that the TEAM II and III faculty taught the math content using a highly structured, full class approach. This may be partly the result of having small classes (the n's for the three classes varied from 12 to 19), and also of the nature of the materials. Further understanding of the process of TEAM classes is indicated by case material taken from student logs primarily from the TEAM II classes. (See also the questionnaire responses in Section E.)

5. Ratings of Audio Cassettes

The three audio tapes designed to provide alternatives in instructional materials, were planned during the first year of the project. Scripts were written by consultants and staff, revised and then role-played by TEAM I students in the second year of the project. Subsequently, the tapes were produced using the revised scripts, with the assistance of technical consultants.

Ratings of the completed tapes took place at the end of the projects' second year. Students at several points in the teacher education sequence at Queens College, from an introductory course to a graduate curriculum course, served as raters.

The ratings, (presented in Tables 7, 8 and 9) were made using a five point scale (1 = not at all, 3 = so-so and 5 = very much) to rate six qualities of the tape and three qualities of the general class atmosphere. The ratings of Getting From Here to There were carried out in a graduate class in Social Studies methods and materials, (n=19) two undergraduate classes in mathematics education (n=25 and 28) and an introductory education course (n=32). The ratings of Teachers Are Important were carried out in a graduate Social Studies methods and materials class (n=18), and two undergraduate mathematics methods classes (n=24 and 28), an open-education class (n=21) and an introductory education course (n=31). The ratings of Interviews With the Past were carried out in a graduate mathematics and science education (n=23) and science education (n=15) course, and an undergraduate mathematics and science education (n=10) class.

The ratings indicate that the tapes were at least satisfactory in the qualities "interesting," "useful," "thought provoking." The ratings on "understandable" and "clearly audible" were rated positive for Getting From Here to There and Teachers Are Important. Audibility and understandability were less satisfactory for Interviews with the Post. The ratings on "new to you" suggests that students had limited information about the importance of sex role stereotyping in education. The general atmosphere was rated positive in 11 of the 12 classes involved in the rating process.

Table 7 Mean Ratings of Getting From Here to There by Four Groups of Students

	I (n=19)	II (n=25)	III (n=28)	IV (n=32)
Was the tape:				
1. Interesting?	3.8	3.9	4.4	3.5
2. Useful?	3.5	4.6	3.9	3.5
3. New to you?	2.7	3.6	3.8	2.8
4. Understandable?	4.4	4.5	4.9	4.5
5. Clearly audible?	4.3	4.6	4.8	4.5
6. Thought provoking?	3.8	3.8	4.1	3.6
Was the general atmosphere:				
7. Stimulating?	3.4	3.4	3.9	3.4
8. Relaxed?	3.9	4.1	4.5	3.9
9. Enjoyable?	3.7	3.9	4.3	3.6

Table 8 Mean Ratings of Teachers are Important by Five Groups of Students

	I (n=18)	II (n=24)	III (n=28)	IV (n=21)	V (n=31)
Was the tape:					
1. Interesting?	4.1	3.6	3.9	2.6	3.5
2. Useful?	4.2	3.7	4.0	2.5	3.9
3. New to you?	2.4	2.6	3.3	1.9	2.1
4. Understandable?	4.9	4.6	4.8	3.5	4.4
5. Clearly audible?	4.9	4.6	4.4	3.2	4.3
6. Thought provoking?	4.5	4.0	3.8	2.7	3.7
Was the general atmosphere:					
7. Stimulating?	4.1	3.1	3.2	1.9	3.4
8. Relaxed?	4.8	4.0	4.3	2.8	3.6
9. Enjoyable?	4.2	3.8	3.9	2.4	3.7

Table 9 Mean Ratings of Interviews with the Past by Three Groups of Students

	I (n=23)	II (n=15)	III (n=10)
Was the tape:			
1. Interesting?	4.1	3.1	3.7
2. Useful?	3.0	2.1	2.9
3. New to you?	4.4	4.7	4.8
4. Understandable?	3.5	3.9	3.6
5. Clearly audible?	3.0	3.1	3.6
6. Thought provoking?	3.7	3.4	4.2
Was the general atmosphere:			
7. Stimulating?	3.6	2.9	3.5
8. Relaxed?	4.5	3.7	3.7
9. Enjoyable?	4.1	3.2	3.6

D. Case Material

The case material is presented here in two parts. The first part identifies the themes or issues that occurred in the student logs and that focused on the classroom atmosphere and substantive approaches to math content and anxiety. The second part follows three students for the semester, using their log entries to show attitude change.

As part of the development of positive attitudes toward mathematics, 19 students of TEAM II were asked to write a weekly log in which they would reflect on their feelings, progress, and the course in general. Logs were submitted regularly by 12 of the students whose responses ranged from one or two sentences to three and four pages in length.

There were several themes that could be identified in the logs. Two themes related to the classroom atmosphere that developed. One of these themes concerned the students' feelings of not being "alone," or "left behind," and a "growing comradeship" which evolved out of their anxieties about mathematics:

> It seems as though there is a growing comradeship for most people in the class. I know everyone's problems in math and they know mine.
>
> When I realized I was not the only one confused it made me feel better.
>
> Now I know I will not be left behind while the rest of the parade marches on to the mystical land of learning without me.

Another theme focused on the patience and understanding of the faculty teaching the TEAM course:

> I wasn't afraid of asking dumb questions or being laughed at . . .

> (. . . there's hope) I really like the time and patience the professors of TEAM math offer and give to their students from math skills to mental stabilization about anxiety attacks.
>
> I keep waiting for her (the math instructor) to give up on me.
>
> I'm glad to see that when I ask her (the math instructor) she is patient and goes back over the material slowly. She doesn't put anyone down, or make you feel stupid. She is willing to stop and go back over things. That makes me feel more relaxed.
>
> Her patience seems to be the key: "If you don't understand it, we will do it again."

Two other themes or issues concerned the pedagogical approach in mathematics and the focus on test anxiety in the psychological component of the course. The mathematician presented the math material in great detail with multiple solutions. The students were divided in their reactions to how helpful this method was. Many students expressed negative feelings toward over-explanation, but the positive view of this approach is expressed in the last two quotations below:

> I think it was explained too much, thus making the lesson harder to understand.
>
> The more approaches to solving each problem, the more stress build-up in me.
>
> I become slightly anxious when we take so long on one problem.
>
> I felt, as soon as I understood, I wanted to leave well-enough alone. I didn't want to learn new ways to do it because I was afraid I'd get confused.
>
> The material was presented and explained in such detail that it wasn't necessary to be at all anxious.
>
> The teacher was trying to convey . . . try another way to do a problem, you may find the method easier--I was on a high.

The students expressed very positive reactions to the test preparations which were designed as one part of the effort to reduce anxiety connected with the mathematics content of the course.

> I feel secure in knowing that the material on the test was covered completely in class.
>
> Talking about the material before the test was handed out helped (relieve anxiety or pressure) and so did the promise of retest if I didn't do well enough.
>
> I want you to know that this was the first time I took a math exam and wasn't scared to death when looking at the questions.

The students in TEAM III reflected the approach to evaluating student progress by their log entries:

> We finished up our topics on approximation and estimation. We reviewed on Thursday for our test Monday. I feel there is more involved in this module than there was on the first module on patterns. We seem to have spent more time on patterns and rather rushed through this. We should have spent more time on the metric system. I'm still not familiar with it.
>
> The review was quite helpful though anticipating questions on the test seems to be a good idea. I feel confident about taking this test although I'm not sure how I'll do.
>
> I think the test was fair, but some of the things caught me off guard, like the part where we're asked to choose what measurement unit was correct. This is where my only mistake was. For some reason, I was more nervous for this test than the first one. But, for this test I got the 19 because I studied and not because the test was easy. I realize now that there is a difference between straightforward and fair--and easy.

So that we might gain a broad picture of actual change of attitude toward mathematics learning as a result of the TEAM course (experience), three students were studied in depth. The changes in attitudes that some students experienced are evident from the log entries of Helena, Diane and Kathy (fictious names).

Helena - A poor math student who has admittedly "blocked" math.

Helena had a MARS pretest score of 417 and posttest score of 322. The pre-post scores on the Fennema-Sherman Confidence Scale were 25 and 31 and for the Usefulness Scales were 48 and 45. The math concepts pretest score was 14 and the posttest score was 24 (of 36).

> Knowing that too many students seemed smarter than me made me feel so inadequate for such a long time.
>
> One teacher told me I had better work harder when actually, I was burning the midnight oil studying. (This I never forgot.)
>
> I liked your TEAM psychologist proclamation about advising us to leave the past behind, to forget about the 'yesterdays,' and to deal in the 'now.' Maybe you have given me the incentive which I need, so that I will sit down and approach these problems from another perspective--one that is positive, challenging, and full of hope.
>
> I am put at ease with (the mathematician's) relaxed manner of teaching. Even the girls in the class are relatively nice to one another.
>
> When I tried to do that problem from the board I felt so frustrated, as if all concepts I had understood in class had suddenly vanished.
>
> I thought (the teacher) was very patient and compassionate. Her intonations verified that she wasn't going to put pressure on us and suddenly I felt very reassured and was able to deal with the problems in a relaxed fashion.
>
> Today, while taking the test, my mind went blank . . . When I was told that I could take the test again, my inner fears abated because I saw that I would be given another chance to show improvement. I don't find this class very easy . . . I hope the work will come more easily.
>
> . . . with more self-discipline and extra help, I feel that I'll have a good chance to keep the doors to my mind open.
>
> . . . I didn't understand completely. During class, I kept trying but (the teacher) took the time out and personally tried to make me comprehend the material. I have always had a closed mind about rounding-off numbers.
>
> I didn't understand the metric units at all. I found that only by doing the exercises and by using the metric units did I understand it.

Something significant happened two weeks ago. I was pretty upset about this week's math test. When I went to study for it I felt the tension and feelings that I was going to fail it, but when I looked at my study guide I said to myself, 'this is what I learned in class and what (the teacher) went over with me when I came for extra help.' Soon I experienced a recall. I could finally understand it. This rarely happened in class--usually I have great difficulty with the problem solving. To me this was a breakthrough.

Today I was nervous about the test. When I saw an improvement on my test score I was overjoyed. This gave me quite a bit of confidence.

I think that I was so proud because I had gone over the work myself and taught myself the areas that I did not previously understand. I'm pleased at this accomplishment.

Diane -

Diane had a MARS pretest score of 297 and posttest score of 141. The F-S Confidence scores were 28 and 38 (posttest) and the Usefulness scores were 41 and 49. Her Math Concepts pretest score was 10 and posttest score was 25.

It took me quite a while to decide if I should take this course. It sounded like a good idea because I need something to help me get over my math anxiety but I thought nothing could really help and that it was just another math course to dread going to all the time. I finally decided to sign up because it made me realize that if there is a course like this one, I can't be the only one with this attitude. I don't expect to be a scholar in math but I do hope to acquire a positive attitude toward math.

I really do not know why I have such a dislike toward math. Some of the worst experiences I can remember are during grammar school, when I had to go to the board, especially if I had the wrong answer.

When (the teacher) called on someone for an answer I began to get nervous and forgot everything. When I realized that I was not the only one confused, it made me feel better.

I felt today's lesson went well for me . . . I realized there is more than one way to solve a problem. When there is no one pressuring me to solve a problem a certain way, I don't feel nervous and I can choose a procedure that I feel comfortable with.

When I was called on to give an answer, I became a little anxious, but I knew that I had the right answer. I don't know why I got that feeling, but as soon as I gave my answer the anxious feeling went away.

I found the math a little difficult; however, when (the teacher) helped me out it became clear to me.

It was such a good feeling to understand the concept of rounding numbers. I want to do more of them because I can't believe I finally got it.

One of the questions I thought I didn't know the answer to, I did. I wrote it down, but then I crossed it out. I don't know why. I think that perhaps it seemed too easy.

It (metrics) really doesn't seem all that bad. I'm sure it will take time to learn it completely, but I'm not at all dreading it as I had been quite a while ago.

I really enjoyed today's class. I've always wanted to know about the metric system but I've never really looked into it. I used to think I'd never be able to learn a whole new system, but I do not feel that way anymore.

When I started the test I did not feel at all nervous, which is a good feeling. It really makes it much easier to concentrate.

I find I am really interested in learning something new. It's a much better feeling not having to worry about it. I never thought I would enjoy coming to a math class.

(after the final) I feel pretty good. I feel I learned quite a bit from this course.

Kathy -

Kathy had a MARS pretest score of 303 and a posttest score of 206.

The F-S Confidence score was 25 pre and 40 post TEAM. The Usefulness Scores were 52 and 59. Her Math Concepts pretest score was 16 and the posttest was 31 (of 36 possible).

There are numerous reasons why I have a bad way of looking at math. Since grade school I haven't liked math and was usually scared to go to class. I would be very nervous before, during, and after class. I remember having the problem of not catching on the first time something was explained. I usually needed things to go a little more slowly to understand. There probably were others in

the class who did too, but when someone would ask the teacher to go over it once more, the teacher would get exasperated or sarcastic or even shout. This happened to me a lot. It was very embarrassing and frightening, so soon I just didn't even bother to ask. I sat there and tried to fake it. If I was called on, I usually guessed an answer.

Another thing about math is that I'm afraid of it. I feel that maybe I have a mental block against it. Before I even look at a problem I tell myself I can't do it. By the time I see it, I've already convinced myself that I'll never be able to figure it out.

. . . so the reason I took this class is to try to overcome this block or fear I have of math. Also, I want to prove to myself that if I'm not afraid to do it, to learn it, that I most likely will learn it. The other reason for taking the class is that I want to teach elementary school, and I want to feel comfortable, or at least more confident, with math.

When I understood the lesson I felt pretty good, until I started to worry about whether I would understand the other lessons to come.

Another thing is that not only has my conditioning been to have negative experiences with math--but my mother even picked it up. When I came home, she didn't really have anything for me to eat because I usually can't eat after a math class. She merely assumed that because I had a math class I would not be hungry. But I was hungry. I guess that's a good sign.

After class I felt pretty proud of myself. I felt good because I understood everything and was able to figure out the problems without too much of a struggle. It even felt like fun when I got the problems.

But I still feel a little suspicious about the work yet to come. Will I be able to grasp it or at least understand it? I feel a little bit more optimistic in comparison to how I felt after last week's class, though.

Though I felt frustrated a few times during class because I was getting a little confused at times. Also, when checking the homework I found that I worked out the problems correctly, but made mistakes in the multiplication. This disappointed me because in the past, if by some rare chance I would understand the math, I would make silly multiplication or addition or subtraction errors--but the problems would be marked wrong anyway. So, when this happened again, I got the same old frustrating, discouraging feelings back again.

I got help after class, and that helped a little, but I still felt disappointment in myself for those homework problems. I didn't feel as good and as confident as I did after the last class, but I did understand the material once (the teacher) helped me.

I felt very proud of myself. I was getting every problem correct and even beginning to enjoy it! I was beginning to feel more confident in myself.

I'm getting a better feeling about math already. I'm actually beginning to enjoy it. It's getting to be fun.

Today we had our test. I really wasn't too nervous; or so I thought, but I must have been inside because I knew the material and understood everything we had learned, but I couldn't remember the formulas on the test. I was about to freak out but I just told myself not to quit. Some of the problems I had to do the long way and some formulas I derived. I find, in math, when I'm studying I know it, but on the test, even though I know the material something inside tells me, 'no, that's wrong. I'm not confident in what I write down. I begin to doubt myself. I don't trust my answers, but I wasn't really upset.

I knew I could take the test over, I was basically disappointed in myself for forgetting some of the formulas. I was tense while waiting for the results of the test, which I was glad were returned right away.

When I got it back, I was relieved. Also--I did well! Much better than I had expected.

I guess I can't expect everything to happen overnight. At least I wasn't a nervous wreck as I usually am, and I didn't get a stiff pain in the back of my neck as I usually do. So I did forget some things because of nerves. It's still an improvement. Maybe the next time I won't forget anything and I'll be even less nervous.

I was disappointed though, as I said in class, that you said, "Only two more minutes." Because doing math <u>fast</u> is one of the fears of math, extra time helps for some, especially during a test.

After class last session I felt very 'smart.' I'm really getting the hang of things. I'm beginning to believe that if I had had understanding teachers, as I do now, honestly, then I would have no trouble with math as I do now. I am beginning to believe that I have the ability to learn and understand math, <u>if</u> it is taught to me with understanding and with skill. I'm not saying that I can learn very advanced math overnight, but I think that I wouldn't be as frightened to try.

After class I felt okay because I understood everything. At one point I didn't, but she went over it and then I got it.

. . . I felt so proud of myself. It's good to know something but better if you can apply it.

I wasn't even nervous before the test--just a little but not as bad as the last one--but I really wanted to get 100%. I really studied, and I just wanted to prove to myself that I could get them all right. I didn't, and so I was a little disappointed, but I'm going to take a retest and try to get them all right.

After class I felt pretty good. I understood what we learned and there weren't any problems. I think that the interview will be an interesting assignment, at least.

I found that I was very tired for class because the night before I was up till three a.m. This affected my concentration. It was hard for me to really concentrate as much as I would have liked to, but I managed and I covered all of the material.

After class I felt a bit confused. Not confused in a bad sense, but in a good sense. I felt I learned so much that I was a little confused. I felt I wanted to sort it all out. When we went over fractions, and I understood, I felt great. I felt I had learned something I should know and was embarrassed that I hadn't. Then I realized that I said I didn't understand at the time when I didn't. Maybe I can learn it because I want to.

--after the final exam!

Relieved! I feel I could have done better on the final, but I learned so much in the class on the whole, that I'm very satisfied. Very glad I took this excellent class.

These three students represent the higher end (more anxious) of the range of scores on the MARS pretest, and their student logs reflect their attitudes toward mathematics also. Their progress is shown in lower MARS and higher Math Concepts posttest scores.

Issues of faculty attitudes and the use of student assessments identied in part 1 are also repeated here. The extent to which these cases are "typical" or are the result of the TEAM materials are examined in the summative evaluation section below.

E. Summative Evaluation and Comparison

Summative data were collected through interviews and through paper and pencil measures of attitudes and achievement for each TEAM group of students. These data, along with comparison group data for TEAMs I and III, permit the reader to reach conclusions about the degree of improvement and effectiveness of the TEAM approach for reducing math anxiety and increasing student competencies in mathematics.

Student Attitude Change

Student attitudes were assessed through prepost interviews, logs, questionnaires, and administrations of the MARS and Fennema-Sherman scales. These data all point to a similar conclusion, that the various settings in which the TEAM approach was used resulted in a more positive and less anxious attitude toward learning mathematics.

Student responses to prepost questions directed at whether attitudes had changed over the semester, as well as their current attitudes, are shown in Table 10.

The majority of TEAM students reported that there had been a positive change in their attitudes toward mathematics. Overall, less than 20% reported no change and only 2% (two students) reported attitudes a little more negative. Another form of this question asked them to compare their present and pre-course status. As shown in Table 10, over two-thirds reported they felt less anxious and 27% reported the same status in anxiety. Samples of the open-ended responses TEAM I students gave for their positive changes are given in Table 11. Students in TEAM III had few responses to this question, perhaps because the majority had expressed most of these feelings in their logs.

Table 10 Change and Post Course Status of TEAM Groups Attitudes Toward Mathematics: TEAM I, II, and III.

Do you think your attitudes toward math have changed any this semester?

Response Categories	Group TEAM I n %	TEAM II n %	TEAM III n %	TOTAL n %
Yes, a lot more positive	13 (29%)	13 (38%)	7 (24%)	33 (31%)
Yes, a little more positive	21 (48%)	15 (44%)	15 (52%)	51 (48%)
No change	10 (23%)	4 (12%)	6 (21%)	20 (18%)
Yes, a little more negative	0 (0%)	1 (3%)	1 (3%)	2 (2%)
Yes, a lot more negative	0 (0%)	0 (0%)	0 (0%)	0 (0%)
No answer	0 (0%)	1 (3%)	0 (0%)	1 (1%)
Total:	44 (100%)	34 (100%)	29 (100%)	107 (100%)

Compared to the beginning of the semester would you say you are:

Less Anxious	27 (61%)	24 (70%)	22 (76%)	73 (68%)
The same	15 (34%)	7 (21%)	7 (24%)	29 (27%)
More Anxious	2 (5%)	1 (3%)		3 (3%)
No answer	0 (0%)	2 (6%)	_	2 (2%)
Total:	44 (100%)	34 (100%)	29 (100%)	107 (100%)

Table 11 Samples of student statements on positive change in their attitudes toward math: TEAM I

Question: Do you think your attitudes toward math have changed any this semester? How?

1. Oh Yes! In the beginning I didn't realize that I had certain abilities. Now I realize I have the potential.

2. Yes. I don't find it as hard now. Upped my confidence. I was very scared in the beginning because the last math class (in high school) was awful.

3. I do. I am more patient. Before if I didn't understand it, I'd skip it; now I don't give up too easily.

4. I felt very relaxed in the class. I see that you can experiment with math more. It's interesting.

5. Yes. I don't feel as incompetent as I used to. I feel I have a better understanding of math and don't feel as helpless.

6. Yes, definitely. I previously saw numbers in any form and I blocked them out. Now when I see numbers I take time, I concentrate.

7. Yes. I feel I can cope with some concepts. I feel that I can learn it and it is possible to cope with it.

8. I'm a little more comfortable with it. With enough help and work I can do better. I just got a job where math is involved.

9. Yes, I think they did a lot. I was so unsure. I can ask questions; I feel confident because I know what I am doing. Because I don't fail as much, I have more successes when I do the problems. I feel more relaxed and no tension. If you had a problem they would help you figure it out.

10. Yes, I think they did. Became more open with subject. I find in my field work, girls should be encouraged in math; they need it just as much as guys. Girls often have negative attitudes about math. The grade advisors don't always stress the importance of academics to girls.

11. Definitely. In one of my courses, Accounting, I got my first A. I used to go crazy with formulas; now I was able to memorize them. I enjoyed doing it in both classes; I would work problems out on my own.

Another question permitted the TEAM groups to be compared to Comparison Group III on their post-course attitudes toward mathematics. These data are in Table 12. TEAM students overall report a more positive attitude than do the Comparison Group students. Seventy-one percent of the TEAM students report somewhat or highly positive attitudes toward math, whereas only 28% of the comparison group reported these attitudes ($\chi^2 = 11.35$, $p = .02$).

Table 12 TEAM and Comparison Group attitudes toward mathematics.

Question: Would you say that your attitude towards math now is generally:

	TEAM I		TEAM II		TEAM III		TOTAL		COMPARISON III	
	n	%	n	%	n	%	n	%	n	%
Highly positive	7	(16%)	9	(27%)	6	(21%)	22	(21%)	3	(6%)
Somewhat positive	29	(66%)	12	(25%)	13	(45%)	54	(50%)	10	(22%)
Neutral	5	(11%)	8	(24%)	7	(24%)	20	(19%)	17	(37%)
Somewhat negative	3	(7%)	4	(12%)	2	(7%)	9	(8%)	13	(28%)
Highly negative	0	(0%)	0	(0%)	1	(3%)	1	(1%)	2	(6%)
No answer	0	(0%)	1	(3%)	0	(0%)	1	(1%)	0	(0%)
Total:	44	(100%)	34	(100%)	29	(100%)	107	(100%)	45	(99%)

The self-reported rating on level of anxiety pre and posttest can be compared for TEAM II and III students. These data are shown in Table 13. More students report their state of anxiety as moderate, a little or not anxious, after the course than before it. This changed from 66% before the course to 91% after the course.

Table 13 Pretest-posttest self-reported level of math anxiety TEAM II and III.

Question: How would you rate your anxiety about mathematics? Do you feel:

	Pretest						Posttest					
	TEAM II		TEAM III		TOTAL		TEAM II		TEAM III		TOTAL	
	n	%	n	%	n	%	n	%	n	%	n	%
Not anxious	2	(6%)	1	(3%)	3	(5%)	7	(21%)	1	(3%)	8	(13%)
A little anxious	10	(30%)	8	(27%)	18	(29%)	15	(44%)	10	(35%)	25	(40%)
Moderately anxious	9	(27%)	11	(37%)	20	(32%)	9	(26%)	15	(52%)	24	(38%)
Highly anxious	11	(33%)	10	(33%)	21	(33%)	2	(6%)	3	(10%)	5	(8%)
No answer	1	(3%)	--	--	1	(1%)	1	(3%)	--	--	1	(1%)
Total:	33	(99%)	30	(100%)	63	(100%)	34	(100%)	29	(100%)	63	(100%)

Another series of questions examined whether students would identify famous women mathematicians, the way females are treated in math textbooks, and how students thought they would feel about teaching math in elementary school. None of the students could name a famous woman mathematician before the TEAM course. None of the Comparison III group students, when posttested at the same time as the TEAM III students,

could name a famous woman mathematician. However, in both TEAM II and III almost half the students could name three famous women mathematicians (45%), another 23% named two, and 11% named one correctly. There were, however, still 21% of the students who did not name from 1 to 3 women correctly, although they knew that there were such women.

Table 14 presents data for a question on how women are treated in math textbooks. Both TEAM I and III data show all students have noticed the treatment of women in math texts. A few of the TEAM II students indicated that they had not noticed. (Observer logs at College A show that only one session involved this topic and it consisted of a slide-tape presentation and discussion, not student analysis of current elementary school math texts.) Comparison III data show a high percentage of students who have not noticed the treatment of females (60%) and a small percent who considered the treatment unfair (11%), compared to TEAM students (overall, 79%). Thus, where the TEAM materials are used there is a change in students perception of how women are treated in math textbooks, primarily to recognize the lack of fairness and stereotyping in texts.

Examples of the types of comments students make in open-ended responses to this question were available from TEAM I students. Responses to the manner in which females are treated in math texts were coded into four categories, three of which indicated dissatisfaction with the treatment of females. Only three students (7%) stated the treatment of females was not so bad. Samples of the the types of statement in the other three categories were:

"I think it is disgusting. Now I can see why women feel the way they do about math. It starts at such a young age, the sex-bias, that it is easy to see the women's attitude toward math."

"I think it is horrendous. It has a long-term effect on their attitudes toward themselves as people and on their potential in the world of mathematics."

"Unfairly shown as nurses, teachers. Wasn't aware of it until we examined math texts--really a revelation. Young years are very impressionable and important. Teachers have a great deal of influence at that time."

"I can't believe it. They make the woman feel that men can do it and women cannot. I see it in magazines, TV, and so on."

"Never noticed it before . . . new books seem to be free of sex-bias."

"I felt females are treated in a subordinate manner. Makes me feel sad. I have to be twice on guard. Examples in books were not blatant but rather subtle."

"That surprised me a lot: I was never aware before and I didn't notice it in elementary school. It is demeaning to girls; it is a shame. I wonder if young kids notice it."

"Stereotyped! Boys always seem to go fishing and they catch 5 fish. Peggy Sue goes to a party and she breaks three balloons. The boys are named Bobby and the girls Peggy Sue. If I don't get a job teaching, I am going to rewrite the textbooks."

Table 14 Posttest responses to treatment of women in math texts: TEAM and Comparison III groups

	TEAM I		TEAM II		TEAM III		TOTAL		COMPARISON III	
	n	%	n	%	n	%	n	%	n	%
I have not noticed	0	(0%)	5	(15%)	0	(0%)	5	(5%)	28	(60%)
Treatment seems okay	3	(7%)	4	(12%)	1	(3%)	8	(7%)	4	(8%)
I think it's unfair	36	(82%)	24	(70%)	24	(83%)	84	(79%)	10	(11%)
No answer/other	5	(11%)	1	(3%)	4	(14%)	10	(9%)	5	(21%)
Total	44	(100%)	34	(100%)	29	(100%)	107	(100%)	47	(100%)

Since the TEAM project has long-term objectives of influencing how prospective teachers practice in the classroom, another question asked students how they expected they would feel about teaching math in elementary school. Table 15 presents post-course data for each TEAM group, Comparison group III, and the pretest responses for TEAM III. A comparison of the positive responses, very and somewhat confident and comfortable, shows that significantly more of the TEAM students (76%) gave these responses, compared to the comparison group (51%). Chi square comparing the TEAM III and Comparison III groups is not significant. While the TEAM III posttest ratings are not different from those of the Comparison group, they showed improvement from pretest data which show that before the course only 16% of the students gave these responses while posttest data show 78% describing themselves as confident. The TEAM course appears to have increased the status of math anxious students to the point where they report being more comfortable with teaching math than comparison students. (See also the data below on the follow-up of TEAM I as student teachers, where more TEAM I students voluntarily taught math lessons than did non-TEAM student teachers.)

Table 15 Posttest Responses to feelings about teaching math in elementary school: TEAM and COMPARISON III Groups

Question: How do you think you'll feel about teaching math in elementary school?

	TEAM I		TEAM II		TEAM III		TEAM TOTAL		COMPARISON III	
	n	%	n	%	n	%	n	%	n	%
Very confident and comfortable	3	(7%)	9	(31%)	7	(25%)	19	(20%)	13	(30%)
Somewhat confident and comfortable	29	(71%)	11	(38%)	15	(53%)	55	(56%)	11	(26%)
Neutral	0	(11%)	5	(17%)	1	(4%)	6	(6%)	7	(16%)
Somewhat uncomfortable and insecure	9	(22%)	2	(7%)	4	(14%)	15	(15%)	11	(26%)
Very uncomfortable and insecure	0	(0%)	2	(7%)	1	(4%)	3	(3%)	1	(2%)
Total:	41	(100%)	29	(100%)	28	(100%)	98	(100%)	43	(100%)

A final overall evaluation question used in the second and third semesters of the project asked whether students would recommend that the course be offered on a regular basis for teacher education students. Responses for TEAM II and III students are given in Table 16. About 40% of the students highly recommend the course, and another 43% recommended it for some students. Overall, 84% of the students would recommend the course; none of the students considered it an irrelevant course, and another 5% suggested that the course needed change.

Table 16 Student responses to TEAM overall evaluation question: TEAM II and III.

Question: Would you recommend that this course be offered on a regular basis for teacher education students?

	TEAM II		TEAM III		TOTAL	
	n	%	n	%	n	%
Yes, highly recommended	15	(44%)	11	(38%)	26	(41%)
Yes, for some students	15	(44%)	12	(41%)	27	(43%)
Neutral	2	(6%)	3	(10%)	5	(8%)
No, needs changes	1	(3%)	2	(7%)	3	(5%)
No, irrelevant course	0	(0%)	0	(0%)	0	(0%)
No answer	1	(3%)	1	(4%)	2	(3%)
Total:	34	(100%)	29	(100%)	63	(100%)

The critical incident technique was used to gather evaluation data for TEAM I and the responses suggest why the TEAM course is recommended by students for part of the regular teacher education program. Students were asked, "What was the best thing about the course for you?" and, "What was the worst thing about the course for you?" Responses were coded for each question and examples of each code category are provided here. The most frequently cited "best" course experiences were in the area of self-confidence and awareness. A sample response was: "The whole course in general, was very good for me. I'm not as nervous about taking a math course as I was before. This course gave me confidence in approaching math." Another response was, "It changed my perception of math and myself in relation to it. I've always hated math and felt that I was just no good at it. I think the course made me see that given enough time, and when taught with patience, I can do o.k." Twelve students (39%) were in this self-confidence category.

Nine students (21%) gave responses that were categorized as "relaxed atmosphere." Sample responses were: "The best thing about the couse was the feeling of a very relaxed atmosphere and not being afraid if I didn't understand the work"; and, "It was a positive experience in a very supportive atmosphere." Math achievement was the third most frequently cited best experience (7 or 16%) of the students. Sample responses were: "I learned new things about math. Also, instead of being told what the formula was, I was able to figure it out myself (with a little help)"; and, "I learned a lot of rote learning." The category of TEAM staff (14% of the students' responses) was typified by

the statement,..."The extra help and support made available by the staff. The atmosphere was also very helpful since it was relaxed and friendly, not your average math class." The remaining best experiences included enthusiasm about math ("It gave me more enthusiasm in wanting to learn math") and the lessening of anxiety about taking math tests ("I learned to relax when it came to taking math exams and I also learned a lot about the field itself and about the attitudes and feeling that others have about it"). Overall, the "best things" about the course cited by students were centered on the TEAM project goals of increasing confidence and achievement in the area of mathematics.

Student responses for the "worst thing" about the course also centered on a few areas--varying level of difficulty of the material for groups of students and the resulting problems of too slow a pace for some students and too fast a pace for others.

Another "worst" experience was given as, "The anticipation of tests." and "A feeling of anxiety when I didn't understand a new method." Statements about the math content included, "I felt that some of the math that we were taught was not relevant for us as future teachers" and, "A lot of the course material I felt was a waste of time, like the math formulas for adding different sums of numbers," and five comments (out of 44 respondents) were specifically on the difficulty of the Choice and Chance module (which was extensively revised after TEAM I).

Other examples of the positive responses some students have for the TEAM course are provided in the logs of TEAM III students, and are summarized in the last entry of a student who gave the course an enthusiastic recommendation:

> I can't believe this is the last log; I think I'm actually going to miss writing them! They've really been a help to me all along, and I think it would be good to go back and reread my earlier logs. I realize that I have learned a lot (i.e. the Metric System!!!) as far as both competence and confidence are concerned. However, it would still be very interesting to actually see any weekly changes in my attitude.
>
> Mastering the Metric System is perhaps my single most important accomplishment this semester academically. However, this is not the only thing I've learned from TEAM! I feel I've gained a great deal of academic confidence in math. Indeed, I still can't believe that I'm having a math final in college, and I'm not even worried. It's been a while since I looked at the formulas for adding the first 100 numbers, but I know that once I review it I'll remember it. The greatest thing is that when a friend said, "Too bad you have a final on your birthday, June 2, I said, "It doesn't matter--it's only math!" "Can you believe it?!!?' I never thought I'd say that about any final especially math.
>
> That statement, coupled with my knowledge of the metric system, would be enough to say that I have benefitted from TEAM. But I've been noticing that my confidence has transferred to areas to math other than those dealt with in class. Even though I probably started the course in better shape (academically and mentally as far as math is concerned) than most people in the class, I have definitely made a great deal of progress: indeed, I don't need to convince myself that TEAM has definitely helped me--I know it's true!

Other attitude change data examined below are the MARS and Fennema-Sherman Scales Scores.

Results of Attitude Instruments

Standard measures of attitudes were also administered to examine attitude change. The instruments were the Mathematics Anxiety Rating Scale (MARS) and the Confidence and Usefulness scales of Fennema-Sherman Attitudes Toward Mathematics Scales.

The data in Table 17 show generally very consistent and significant decreases in the MARS scores for all three TEAM groups. Thus, the TEAM approach in different settings used by different faculty appears to be

effective. Similar effects are shown for TEAM I and III on the F-S scales; TEAM II does not show significant increases in ratings of Confidence in Math and Usefulness of math, but the trends are in the same positive direction. Students' scores showed increases in the perceptions of mathematics as useful and increases in their confidence.

Table 17. Pretest-Posttest means, SD's and t for the MARS and F-S Scales: TEAM I, II and III.

MATHEMATICS ANXIETY RATING SCALE*

	Pretest Mean	Posttest mean	n	t	P
TEAM I	245.3 (SD=64.7)	211.6 (SD-64.6)	44	4.26	.001
TEAM II	249.8 (SD=82.1)	195.8 (SD=66.6)	34	3.13	.003
TEAM III	260.5 (SD=69.1)	198.1 (SD=57.5)	30	6.50	.000
COMPARISON III	231.1 (SD=63.6)	218.1 (SD=78.2)	41	1.74	.089

FENNEMA-SHERMAN MATH USEFULNESS**

TEAM I	34.8 (SD=6.3)	28.1 (SD=5.7)	44	3.69	.001
TEAM II	48.1 (SD-5.3)	49.3 (SD=6.3)	34	.88	ns
TEAM III	44.3 (SD=7.1)	48.7 (SD-5.9)	30	4.20	.000

FENNEMA-SHERMAN MATH CONFIDENCE**

TEAM I	20.5 (SD=9.6)	26.4 (SD=9.3)	44	5.86	.001
TEAM II	35.9 (SD=11.3)	41.0 (SD=11.5)	34	1.82	ns
TEAM III	30.1 (SD=11.8)	38.5 (SD=10.5)	30	7.60	.000

* Higher scores indicate more math anxiety: 98 items, 1 - 5 points each.

** Higher scores indicate more math usefulness or confidence:

12 items, 1 - 5 points each.

Comparison groups for TEAM I and III also received some of the same attitude measures. Table 18 presents the TEAM I comparison group posttest data and Table 19 the TEAM III comparison group data.

Table 18. Means, Standard Deviations, and t tests on Posttest attitude measures for TEAM I and Comparison Group I.

Measure	TEAM I group M	TEAM I group SD	Comparison group M	Comparison group SD	t	p
MARS	211.6	64.6	209.1	65.0	.19	N.S.
F-S Usefulness	21.9	5.7	21.2	5.0	.59	N.S
F-S Confidence	33.6	9.3	30.7	10.0	1.43	N.S.
	n = 44		n = 51			

The data for the attitude measures in Table 2 (given earlier in Section B) indicate that the TEAM I group had significantly higher initial scores (more math anxious, less confident about math, and lower values for the usefulness of mathematics) than the comparison group (posttested only). On the posttest in contrast to the comparison group as shown in Table 18, TEAM I showed no significant differences on any of the attitude measures. At the conclusion of the semester in the TEAM project, these students showed math attitudes similar to students at the same point in the teacher education sequence who were not as anxious about mathematics.

The data given earlier in Table 17 show that the mean pre-posttest socres on MARS differed significantly for TEAM III students. The comparison group pre-posttest means did not differ significantly. A t test of the difference in means for pretest-posttest scores for TEAM III

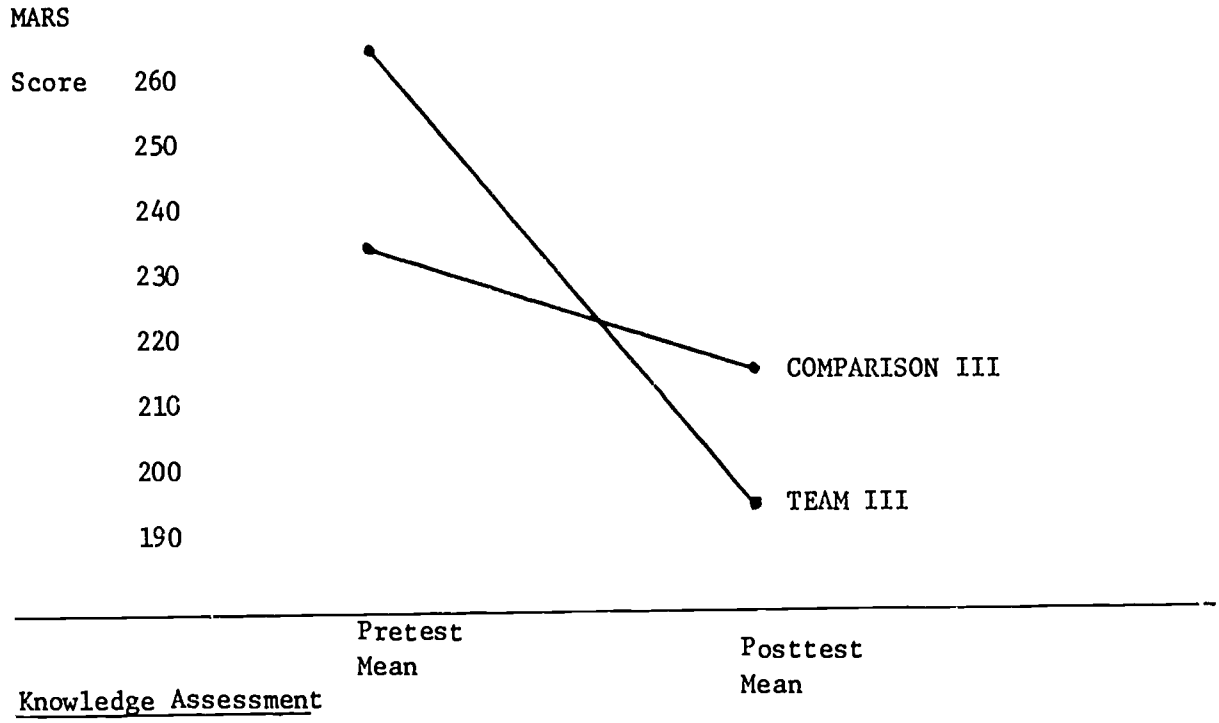
and Comparison group III are given in Table 19. MARS scores did not differ significantly between the two groups (t = 1.85, p = .068) for either the pretest or posttest scores.

Table 19. Means, Standard Deviations and t tests for pre and posttest data on attitude measures for TEAM III and Comparison Group III.

Measure		TEAM III (n = 30)		COMPARISON Group III (n = 42)			
		M	SD	M	SD	t	p
MARS	Pre	260.5	69.1	231.1	63.6	1.85	.068
	Post	198.1	57.5	218.1	78.2	1.17	.246

Although the posttest scores did not differ significantly for the experimental and comparison groups on the MARS, Figure 1 shows a plot of the scores, and indicates that the significant difference on posttest MARS scores for TEAM III are not due to a regression effect. The significant change from pretest to posttest for TEAM III appears to reflect more than an artifactual difference due to statistical regression and therefore, an analysis of covariance was computed, using the pretest scores in the MARS as the covariate. The F for the covariate was 62.8 (p = .0000). The main effect for groups was also significant (F = 13.86, p = .0004). When adjusted for initial status on the MARS scores, the posttest difference in MARS scores is significant, with the TEAM group showing a lower mean score in the measure of math anxiety for TEAM III.

Figure 1. Pre-post MARS Scores for the TEAM III and Comparison III groups.



Knowledge Assessment

Increases in mathematics knowledge were assessed in two forms. For TEAM I knowledge was assessed on four measures during the semester. One of the measures, a mathematics concepts test, was administered as a posttest only. This test was developed in the first year of the project since no existing mathematics achievement test was appropriate. The math concepts test was administered pre and posttest at College B to TEAM II and TEAM III. These assessments generally show some gains in math knowledge but there were limitations in the math concepts test which was developed for the assessment. Some students on their pretests had all but a few items correct, indicating a ceiling effect.

Four assessment instruments were prepared for TEAM I (See Appendix 9). Quizzes 1 and 2 had ten questions. The mean score for Quiz 1 was 8.6 ($n = 44$), the mode was 10, and the range was two to ten. On Quiz 2,

the mean score was 8.2, the mode was also 10, and scores ranged from three to ten. The final examination assessed information and knowledge from the three modules developed at the time of TEAM I. A considerable range of scores was evident, 26 to 100, but over half the students received scores of 85 or better. The comparison of TEAM I and Comparison Group I means on the Math Concepts test of 36 items indicated no difference. The TEAM I mean was 25.3 and the Comparison Group I mean was 24.7, t = .38, n.s. (SD's of 7.7 and 7.8 respectively). The Math Concepts test did not show superior achievement for the TEAM I group. Since no pretest had been administered and wasn't possible to analyze changes in score. (Analysis of covariance using the MARS score as the covariate showed that the main effect remained non-significant, F = 2.80, p = .098). Table 20 presents the data on the Math Concepts test for TEAM II and TEAM III.

Table 20. Pretest-posttest results for the Math Concept Test: TEAM II and TEAM III.

Group	Pretest		Posttest		n	t	p
	Mean	SD	Mean	SD			
TEAM II - A*	5.3	2.2	7.3	2.3	13	3.82	.002
B*	21.5	7.1	28.8	7.0	17	4.43	.000
TEAM III***	24.3	5.4	29.5	5.2	30	6.9	.000

* a ten-item test

** a thirty-six item test

The students at College A were administered a shortened form of the concepts test, since they completed only one of the TEAM modules (Patterns). The t test for pretest-posttest means showed a significant p value. For

College B and TEAM III students the 36 item test was used and both groups also showed a significant difference between the pretest and post-test means. College B gains ranged from zero (a student who had perfect pretest and posttest scores), to a gain of 15 points. For TEAM III the gains ranged from a minus one (one point lower on posttest) to a gain of 17 points.

Both the student comments and pretest-posttest comparisons for TEAMs II and III indicate increases in student knowledge. TEAM I and Comparison Group I data indicate these gains probably do not bring TEAM students to a math knowledge performance that is significantly better than that of unselected teacher education students. However, this interpretation must be made cautiously, because of limitations in both the content and psychometric properties of the concepts test. See Section VI, Implications for future research, for further comment.

TEAM I Follow-up: Student Teachers

TEAM I participants were in the field placement or student teaching semester of the teacher education program in the Spring of 1980. There were 126 student teachers in the Early Childhood and Elementary placements during the semester. Of these, 32 (25%) had participated in TEAM I. These 32 students were assigned to eight college faculty supervisors during the first half of the semester. All student teachers were assigned to faculty who had not participated in the TEAM project. During the second half of the semester, student teachers were reassigned to other schools and faculty. For the second half of the semester the students were assigned to ten professors. The assigned faculty also supervised 41 other student teachers. A questionnaire, Treatment of Mathematics by

Student Teachers During Placement (Appendix 10) was completed by the eight faculty for the February-March placement, and by 10 faculty for the April-May placement.

The college supervisors for the first placement indicated that 47 (64%) of the 73 students observed chose to teach a math lesson. The proportion of TEAM students choosing to teach math voluntarily was .80 (16 of 20 students); the non-TEAM proportion was .58 (31 of 53). The difference in the proportions is significant ($Z = 1.75$, $p = .040$, testing the directional hypothesis that more TEAM students would voluntarily choose to teach a math lesson). The difference for the second placement was not significant, as many supervisors had required student teachers to present a math lesson if they had not already done so. Since TEAM student teachers were not assigned to specific supervisors nor observed by the TEAM faculty, and the presentation of a math lesson had not been required by any supervisors at the time of the first observation, TEAM participants presented a math lesson in a public elementary school classroom voluntarily. This result is one of the desired long-term objectives of the TEAM program, to affect classroon behavior in the teaching of mathematics. Several large-scale evaluation studies have linked frequency of presentation of reading and mathematics (i.e. pupil time-on-task) with pupil achievement. A necessary first step is the type of behavior found here for TEAM student teachers, that is, a greater willingness to teach mathematics voluntarily.

A series of ratings on general attitude toward math, willingness to teach math, enthusiasm communicated, general math skills, and quality of math lesson (poor to excellent - 1 to 5 point scale) showed no

significant differences in mean ratings for the TEAM and non-TEAM student teachers (Mean ratings varied from 4.0 to 4.5 with little variability). These results were found for both the first and second observations/ratings.

College supervisors were asked to judge the difficulty level of questions that the student teacher directed to boys and girls, and the equity of positive reinforcement for boys and girls. The difficulty of questions to boys and girls was rated as equal for almost all of the student teachers (94%). Similarly, the frequency of positive reinforcement for boys and girls was rated as equal (94%).

It was originally hypothesized that TEAM students would teach mathematics more often and be more enthusiastic about mathematics in the classroon than non-TEAM student teachers. TEAM students who had initially expressed greater math anxiety than a comparison group of teacher education students, and who obtained higher MARS scores, chose to teach mathematics more frequently. There were no significant differences on the variables rated by supervisors. Students were rated as presenting lessons with the same attitude, willingness and enthusiasm, math skills and quality of the math lessons. It seems reasonable to infer that the TEAM I students' progress in overcoming their mathematics anxiety during the course in the spring of 1979 was maintained for at least one year. In the spring of 1980 no statistically significant difference in style or quality of math lessons were discerned between TEAM and NON-TEAM student teachers. Since during one observation period TEAM student teachers were reported to have voluntarily presented mathematics lessons more frequently than their non-TEAM peers, their tendency to avoid mathematics had been influenced positively.

F. Summary

The evaluation for the TEAM project focused on providing feedback to TEAM developers for the improvement of TEAM course materials and assessing changes in attitudes, mathematics anxiety and mathematical concepts. Course materials were modified on the basis of the responses and ratings by faculty and students in three field trials. During year 1 on the project the materials were used by a mathematics educator and an educational psychologist during year 2 the materials were used in two colleges in the fall, with a math educator psychologist in one setting and a mathematican and psychologist in the second settings, in the spring the materials were used by a mathematics educator, with only consultation by a psychologist.

While they offered specific suggestions for revisions, overall the materials perceived as satisfactory by both faculty and students. The Patterns module received the lowest rating (needs some revision), of the three modules rated by the mathematician teaching the course in the fall, 1979. These ratings were given in response to two questions--appropriate level of difficulty and whether the content was likely to be interesting to these students. Consistently high ratings were given the Approximation and Estimation module. The Patterns module was extensively revised for the final set of instructional materials.

To assist potential users of the TEAM materials to understand student feelings as they progress through the TEAM course, evaluation case material was developed. Issues that occurred in student logs were identified. These issues focussed on the classroom atmosphere and the substantive approaches to math content and anxiety. For the classroom atmosphere,

the two key themes were first, the students' feelings of not being "alone," "left behind," and their growing comradeship, and second, the patience and understanding of the faculty using the TEAM materials. While some students raised questions about the inductive approach and the numerous examples used in presenting the mathematics content, and varied in their reaction to this instructional technique, students' overall improvement in attitudes and reduction in math anxiety are evident. The test preparations designed to reduce anxiety, particularly math anxiety, were very positively viewed. The student logs provide further understanding of the changes students experienced in their attitudes and perceptions.

The pre-course measures of anxiety indicate that the students volunteering for the TEAM course had higher scores on a measure of math anxiety (MARS) and lower scores on the perceived usefulness of mathematics and confidence in their ability to use mathematics. Post-course measures of attitudes, mathematics anxiety and mathematical concepts indicated gains in each area as well as performance equal to or better than comparison students who were less math anxious and who tended to have more positive attitudes toward mathematics. These results are particularly clear for such attitude items as, "Would you say that your attitude towards math now is generally highly positive?... to generally highly negative," and, "How would you rate your anxiety about mathematics? Do you feel not anxious?...to highly anxious." For mathematical concepts, there were reliable student gains where pre-post tests were given to TEAM groups.

There were also modules designed to increase awareness of famous women in mathematics, sex stereotyping in mathematics classroom materials, and the importance of mathematics in careers. TEAM students could name

more famous women mathematicians when given that question pre-and-post course, and all TEAM I and TEAM III students had noticed the treatment of women in elementary school math texts and more considered it unfair, when compared to non-TEAM students. Another question tapped student feelings about teaching mathematics in the elementary school. More TEAM students felt very or somewhat comfortable about teaching than did a group of comparison students.

An overall student evaluation question asked students whether they would recommend offering the course on a regular basis to all teacher education students. A large majority, 83%, would either highly recommend the course or recommend it for some students. A follow up of TEAM I participants as student teachers revealed that more TEAM student teachers choose to teach math voluntarily than did non-TEAM student teachers (80% compared to 58%).

Overall, the TEAM evaluation data are highly positive and indicate that the materials should be useful to other teacher education programs concerned with the preparation of elementary school teachers who are less math anxious, more aware of the role in women in mathematics, prepared to identify sex role stereotyping in math textbooks, and aware of the importance of math to women in a wide variety of careers. The materials should also be readily adaptable for use in the inservice training of elementary school teachers and perhaps for high school teachers and teachers of college level courses in departments of mathematics.

Implications for future research and development are in the areas of the instructional (inductive) approach, the integration of testing

with teaching, the relationship between the development of confidence and competence in a subject, the measurement of problem solving skills, and the effect of varying treatment according to the initial characteristics of participants.

VI. IMPLICATIONS FOR FUTURE RESEARCH

There are several implications for future research that arise from the development and evaluation of the TEAM materials and course. These are in the areas of the instructional approach, the integration of testing with teaching, the relationship between the development of confidence and competence in a subject area, the measurement of problem solving skills, and the effect of varying treatment according to initial characteristics of participants.

The instructional approach

The philosophy underlying the teaching strategy used in the TEAM materials is that the confidence and knowledge of the learner are best enhanced by the use of an inductive approach. In this approach, learners are not given the problem solving rules immediately, but arrive at them through generalizing from the solutions to a number of carefully selected and sequenced problems. As indicated by the student logs and open ended responses, the approach was fruitful in terms of learners being able to reconstruct formulas and approaches in examinations and feeling confident in their ability to do so. For some students, however, this is a new approach and their past experience makes them feel that the approach is lengthy and drawn out. Research is needed to examine these attitudes in more detail, and in particular to determine if the approach is effective for different types of students. (This also relates to the measurement

problem discussed below.)

The integration of testing with teaching

One prominent mathematics educator (Begle, 1979) has suggested that a key variable in assisting learning in mathematics is the frequent use of short quizzes and the immediate feedback they provide. In the TEAM project, tests are used as an opportunity to explore math-related anxiety. While there is some research on the use of tests to increase learning, there is little or no research on the use of frequent tests within a program having the reduction of anxiety as one of the goals. There is a need for research to determine the optimum number of quizzes needed within programs in which the instructional goals include both competence and reduction of content-related anxiety.

Confidence and competence

The TEAM materials and course have as their goal increasing mathematics competency and simultaneously building confidence in one's ability to use mathematics, with an accompanying decrease in anxiety about mathematics. The interaction of competence and confidence is one of the as yet untested hypotheses of TEAM. To achieve this goal TEAM materials were designed to present primarily unfamiliar mathematical concepts, so students could perceive clearly their gains in knowledge of mathematics and so that prior negative experiences with particular content areas would not have a major effect. Research is needed to test this hypothesis that the use of unfamiliar mathematical concepts facilitates increases in confidence (as opposed to the use of familiar

mathematical concepts) in programs such as TEAM. This is, an imaginative and innovative approach to old skills, facilitates the reduction of math anxiety, as well as increasing mathematical problem solving competencies.

The TEAM project has effectively met the goals of reducing math anxiety and increasing confidence (in several class settings). Increases in mathematical problem solving skills and understanding of mathematical concepts have not been as thoroughly examined. This is partially due to the lack of a measuring instrument to assess changes in understanding and application of mathematical concepts (see below). It is also due to the fact that the primary purpose of TEAM was materials development; a research project is now necessary which would thoroughly investigate the effects of TEAM on mathematical competence. It would be desirable to test the competence-comfidence hypothesis with inservice teachers in relation to their mathematics teaching.

The measurement of problem solving skills

Since the inductive approach to teaching mathematic concepts is intended to give the learner a new approach to problem solving in mathematics, the measurement of problem solving skills is critical. Most measurement of problem solving examines problem outcomes or solutions, but does not assess the most important component of the skill, the process by which the student solves the problem. The TEAM project had anticipated working on the measurement problem, but did not have the resources to do so within the time constraints of the project. A serious need to be met is the development of a process measuring "instrument." Careful

examination of the effects of the instructional approach, as well as the interdependence of confidence and competence, is not possible without further development of the measurement instrument. Research is needed to define the problem solving "process" in more detail (for these adult learners). Clarification of initial status of skills in problem solving, how adult students approach math problems, definitions of the effective approaches and assessments of process and outcome are required for such research. This clarification can be undertaken in research on programs using the TEAM instructional approach. It will then be feasible to develop measuring instruments that have the possibility of objective scoring and reliability.

The interaction between aptitude and treatment

TEAM participants were recruited by informing students that the program existed and inviting them to enroll. This resulted in a self-selected sample of students who had enrolled for various reasons and who had significantly differing skills and anxieties. It is expected that students with low skill and high anxiety need different treatments from students with high skill and high anxiety or low skill and low anxiety. Systematic examination of these subgroups is recommended.