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ABSTRACT

This Teacher Education and Mathematics (TEAM) module focuses on women, mathematics, and careers. Module goals include (among others) increasing students' awarenesss of the role that mathematics plays in almost all careers and their ability to pinpoint mathematics behaviors used in specific careers. The module consists of an instructor's text and student materials. The instructor's text provides (1) specific directions for guiding the lessons and (2) commentary designed to help teachers build positive mathematics attitudes. The format is one of "facing pages" whereby the right-hand page provides step-by-step teaching directives and the left-hand page furnishes commentary that articulates a philosophy, provides explanations, and suggests psychological approaches. The "commentary and notes" page also allots space for the instructor's use and when no commentary applies, the entire page is alloted to "notes." A sample letter, bibliography, background readings, and script for a companion audiotape titled "Getting from Here to There" are also provided. Student materials include such items (for use during or after instructional sessions) as a list of careers with related mathematical behaviors, an activity on teaching mathematics in careers, and another activity focusing on mathematics involved in a physician prescribing medication. (JN)

Women, Mathematics, and Careers

A Course to Reduce Math Stereotyping in

TEAM

TEACHER EDUCATION A

Queens Cc
Women's Educational Equity Act

TEAM

TEACHER EDUCATION AND MATHEMATICS

A Course to Reduce
Math Anxiety and Sex-Role Stereotyping
in Elementary Education

WOMEN, MATHEMATICS, AND CAREERS

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U.S. Department of Education

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6

CONTENTS

TEAM

WOMEN, MATHEMATICS, AND CAREERS

I

INSTRUCTOR'S TEXT

INTRODUCTION

The Women, Mathematics, and Careers module was prepared for use in a course or workshop series on attitudes toward mathematics. It consists of an Instructor's Text and Student Materials. Both parts of the module can be kept in a loose-leaf notebook.

The Instructor's Text provides (1) specific directions for guiding lessons and (2) commentary on the math content and on math attitudes. This is accomplished by a special "facing pages" format. The right-hand page contains directive text that indicates how the instructor may proceed, step by step, in presenting the lesson. The left-hand page, "Commentary and Notes," usually, provides teaching insights, other options of instruction, and often psychological strategies. Space for the instructor to add her or his own notes about a particular point in the lesson or about teaching experiences with the class (for future reference and use) is also provided on the left-hand page. Sometimes there is no pertinent commentary for the lesson page on the right so, the left hand page is alloted to, "Notes" exclusively.

An additional feature of the Instructor's Text in this module is the inclusion of supplementary materials for the instructor--a sample letter, a bibliography, background readings, and the script for the companion audiotape, Getting from Here to There. (See Contents on page vii, Part C.)

Student Mate ials, Part II, includes the following items for use during or after instructional sessions: "Startling Statements," "Interviewing Tips," "Profile of a Career Woman," "Math and Medical Careers," "Teaching Mathematics in Careers," and, "Examples of Mathematical Behaviors in Careers."

NOTES

10

OVERVIEW

The purposes of this module are to increase students':

- Awareness of the role that mathematics plays in almost all careers today
- Awareness that the study of mathematics serves as a "critical filter" in access to careers
- Awareness of current data on women's career status
- Ability to plan learning experiences for pupils that will increase their awareness of the role of mathematics in careers
- Ability to pinpoint the mathematics behavior used in specific careers
- Ability to carry out planned learning experiences with pupils
- Awareness of the need for women to succeed in mathematics in order to ensure women's equity in career opportunities

Part A: Math as It Relates to Careers emphasizes the role and importance of mathematics in many varied careers.

Part B: Career-Related Math Activities for Elementary School Children provides experience for students in integrating career-related activities with the elementary school mathematics curriculum.

Part C: Supplementary Materials for the Instructor consists of supplementary materials (e.g., a sample letter, a selected bibliography, published articles, and an audiotape on the subject) for the instructor's use.

A variety of learning activities has been included for use by a class, small groups, or individuals.

COMMENTARY AND NOTES

Use recent clippings from your local newspaper that present this picture, if possible.

Additional copies of "Startling Statements" are available from EQUALS, Lawrence Hall of Science, University of California, Berkeley, CA 94720.

Expect that students may feel some anxiety about carrying out this assignment. Reassure them that even those people whose career centers on interviewing probably felt uneasy about the <u>first</u> interview.

Students can usually locate an appropriate interviewee. You might have on hand a few names and telephone numbers of people you know who would be willing to be interviewed in case a student can't locate such a person.

A sample letter of introduction from you is included in Part C of the Instructor's Text. Students often feel more comfortable in approaching an interviewee when they have such a letter from you.

The interview form provided in Student Materials is to be viewed only as an example. You may decide not to have your students use this particular format, or you may decide to use only some of the questions and make up others.

PART A: MATH AS IT RELATES TO CAREERS

BEGINNING THE PROGRAM

Introduce the information that more women are working outside the home now than ever before in United States history. Give the most recent facts (i.e., about 50 percent of adult women work outside the home). Introduce the idea that women have not had access to high-paying jobs by asking students to respond to "Startling Statements" (in Student Materials). This list, prepared by EQUALS for wide use, illustrates women's positions in the hierarchy of careers. Answers to "Startling Statements" are provided on the page following the statements.

Provide the opportunity for students to describe their reactions to "Startling Statements." Go on to discuss careers. Ask such questions as: What does <u>career</u> mean? How many careers did you know about before making your career choice? What was important to you in deciding on a career? Who provided information about careers for you? Did you talk about your ideas for a career? With whom--mother, father, teacher, counselor?

Respond to students' statements and ideas in ways that indicate you have heard and accept their ideas. Your role is to facilitate a discussion about careers.

INTERVIEWS

Introduce the idea of getting more information about careers. Ask students to think about someone they know who is a woman over 30 and who works regularly and has a career. Tell the students you have an interesting assignment for them--to interview such a woman. Discuss the purposes of the assignment: to develop a job description and relate it to math, to investigate career and decision-making processes, to develop a profile of a contemporary career and family situation, to obtain an overview of a woman as she sees herself and her life, and to gather descriptive demographic data. Ask students if they have ever interviewed someone before.

Have students turn to "Interviewing Tips" (in Student Materials, Part II, page 5) and discuss with them the attitudes and general procedures that are described on this sheet. Ask how they might feel if they were to be interviewed. Emphasize getting the information called for while maintaining a comfortable tone in the interview. State the importance of maintaining confidentiality regarding the information they obtain.

Have students turn to "Profile of a Career Woman" (in Student Materials, Part II, page 6). Role play an interview, having one of the students play the career woman, or having a colleague be the interviewee. Ask students if they have questions or comments. (Allow about 20 minutes for this role-play interview.)

PART A: MATH AS IT RELATES TO CAREERS

BEGINNING THE PROGRAM

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Set the date for turning in the interview assignment. We suggest a date of two weeks from this introduction. However, you may want to discuss a timing that seems more appropriate for your students.

DISCUSSIONS

When students return with their completed interviews, discuss their experiences and their information. (Don't be surprised if the students report finding angry/frustrated/disappointed women.) Ask such questions as: What career did you learn about? What influences seemed to shape the woman's career decision? What role has math played in her career? Does the career you learned about seem to have a future--could this woman advance in her current job? Does the woman seem satisfied? What seem to be the sources of satisfaction (dissatisfaction) for her? What factors seem to influence her handling of career and marriage/family responsibilities? Based on what you've learned, what advice would you give to young women with respect to career planning and career choices?

Have students begin to generate a list of jobs that require some math skills. Usually before the list gets too long, it becomes apparent that almost all jobs now require some math skills. Jobs that are traditionally "female," such as dietitian, home economics teacher, seamstress, and nurse, require math as much as do jobs that are traditionally "male," such as engineer, surveyor, industrial arts teacher, carpenter, and electrician. Emphasize the sex-neutral value of math as preparation for careers.

Additional activities you may consider for your class include these:

1. Code each page of the interview form, divide the class into subgroups, and have each subgroup write a report or summary statement on the answers given to the questions on one of the five pages.

2. Put the questionnaires on file and have the students read them.

3. Make a few charts in class to summarize the class findings.

READINGS

A bibliography on math and careers is provided for your use (see Part C). You will be able to make additions to this list from a variety of sources, such as professional meetings and journals.

Your students could probably read many of these papers. We have found the following particularly useful and have included them for your convenience. (See Part C: Supplementary Materials for the Instructor, Section I, pp. 29-49.)

Burton, G. "Regardless of Sex." Mathematics Teacher 72 (April 1979): 261-70.

Fox, L. H. "Women and the Career Relevance of Mathematics and Science." School Science and Mathematics 76 (April 1976): 347-53.

These two articles are reproduced in Part C of the Instructor's Text.

LISTENING

Introduce the audiotape (Getting from Here to There) by telling students that it can be useful for children to get ideas about math and careers while they're in elementary school. This audiotape (10½ minutes) illustrates a role-playing activity for elementary school children that your students may wish to use. The script for the audiotape is included in Part C: Supplementary Materials for the Instructor, Section I, pages 50-56.

COMMENTARY AND NOTES

Students will suggest such professions and careers as paramedic, nurse, hospital administrator, hospital ward clerk, dentist, lab worker, and pharmacist. Be certain to keep the discussion sex neutral; equal opportunities should be available to men and women. The discussion should include references to the sex-role stereotyping that has occurred in the past. Encourage students to share their own experiences.

Our discussion of how to involve pupils was initiated by suggesting that students elicit questions from their pupils. Other suggestions might include field trips, interviews, guest speakers, reading assignments, and a discussion of "What do you want to be when you grow up?"

Note that the elementary school teacher might assume that these skills are a part of the children's skill repertoire; then this lesson would be considered an application of those skills. It is possible, too, that this lesson might be used to introduce a new topic, with the career (and the writing of the prescription) a motivation for learning the new topic.

PART B: CAREER-RELATED MATH ACTIVITIES FOR ELEMENTARY SCHOOL CHILDREN

USING MATH IN A CAREER

This activity asks students to consider how math is used in a particular career (that of medical person) and how math problems related to that career can be applied in the elementary school setting, that is, with students' own pupils.

Begin by introducing medical careers to students. Discussion might be initiated by such questions as: What do you know about the uses of mathematics in this field? What kinds of jobs are available in this field? Which of these fields are open to women? Is there any reason why a woman could not or should not plan to become a [any career]?

Say: "More careers are open to women today. Math is used in most careers, and women should not automatically limit their opportunities by limiting their math education."

Ask students to suggest ways of getting their pupils involved in a discussion of the uses of math in various careers.

Say: "Today we are going to consider a particular career and the ways in which math is used in that field. The career is that of medical person."

Ask students to describe some of the things that a medical person does. There are a number of specific math behaviors that should be identified. For example:

- A medical doctor prescribes medication, which involves measurement using the metric system.
- A pharmacist fills a prescription.
- A medical person records bodily functions on charts.
- A medical person reads bodily functions from such measuring instruments as a calibrated test tube, a clock, a thermometer, scales, and a sphygmomanometer (an instrument for reading blood pressure).
- A medical person takes a patient's pulse.

The specific behaviors developed in the worksheet "Math and Medical Careers" (see Student Materials) are writing and interpreting a prescription. Ask students to turn to the worksheet. Tell them to work the problems individually. Then discuss the material, paying particular attention to the following:

1. The grade-level appropriateness of the material.
2. The mathematical skills needed to attain the objective.
3. The mathematical skills that can be taught or exercised using this material.

COMMENTARY AND NOTES

Encourage your students to ask the kinds of questions that might occur to young learners.

The student worksheet begins as follows:

Math and Medical Careers

Behavior: A physician prescribes medication.

As a physician you are licensed to prescribe appropriate medication for your patients. You must calculate the dosage accurately to ensure that the medicine does what it is supposed to do. The dosage is based on the weight and/or age of your patient.

1. Your asthma patient, I. M. Ill, must take theophylline. You must know the following:

   a. Theophylline is dispensed in 100 mg tablets.

   b. The dosage is 5 mg per kg of body weight, every six hours. A doctor writes "q6h" for "every six hours."

   c. I. M. Ill weighs 20 kg.

   Write a prescription for a one-month supply of tablets so that it can be taken to the pharmacy to be filled.

Telephone ____________

Doctor ____________

Address ____________

Name I.M. ILL ____________ AGE ______

Address 3 Cardiovascular Freeway DATE ______

GENERIC EQUIVALENT MAY BE SUBSTITUTED

℞ LABEL CONTENTS

Refill ___ Dr. ____________

____

COMMENTARY AND NOTES

It would be desirable to hold up a centimeter cube to illustrate an object that weighs 1 milligram. Another reference for 1 mg is the contents of a sugar-substitute packet.

It is sufficient for students to know that 1 kilogram is a little more than 2 pounds.

This is an opportunity to review the meaning of ratio, proportion, and equality of fractions. Review, also, the method of solving proportions.

You may wish to pose the following questions to help students solve the problem presented in the worksheet:

1. What does mg stand for? (Milligram)

2. Would a person who weighs 20 kg be considered an adult or a child? (A child) How do you know? (Students should know that 1 kilogram is slightly more than 2 pounds.)

3. How many times each day is the medicine taken? (4)

   This basic problem is suitable for pupils in the early grades. Multiplication or division is involved:

   $$24 \div 6 = 4$$

   or

   $$4 \times 6 = 24$$

4. How many times per month is the medicine taken? (120)

   Use multiplication. Consider 30 days to one month.

30	x	4	=	120
(days)		(times per day)		(times per month)

5. What is the dosage for a person who weighs 20 kg? (100 mg)

   The process is multiplication. How do you know how much medicine to give? For each kg of body weight, give 5 mg. So, for 20 kg of body weight, give

   $$20 \times 5 = 100, \text{ or } 100 \text{ mg}$$

   In the fifth or sixth grade, children may be ready to use ratio and proportion:

   $$\frac{5}{1} = \frac{n}{20} \qquad n = 100$$

Say: "The use of correct medical terms is an important part of motivating pupils to use mathematics and of creating interest. Always use factual information. Research when necessary. It is important that the children really play their parts."

Tell students that the elements of a bona fide prescription are these symbols:

disp: dispense

sig: the label

You can list the first four symbols and then see if students who are familiar with Roman numerals can continue the pattern. The dots are a double check of the number intended.

A genuine prescription would read:

sig: tab. p.o. q6h

(p.o. means per os, that is, orally)

Telephone __________

Doctor __________

Address __________

Name I. M. ILL AGE ____

Address 3 Cardiovascular Freeway DATE ____

GENERIC EQUIVALENT MAY BE SUBSTITUTED

℞ LABEL CONTENTS

Refill ___ Dr. __________

Dispense instructs the pharmacist to dispense the quantity of medication. The label tells the patient how often to take the medication and often contains the name of the medication as well.

Doctors use the following notations to avoid error in the interpretation of their instructions:

$\dot{\overline{\mathrm{I}}}$ means 1, as in $\dot{\overline{\mathrm{I}}}$ month supply

$\ddot{\overline{\mathrm{II}}}$ means 2

$\overset{\cdots}{\overline{\mathrm{III}}}$ means 3

$\overset{\cdots\cdot}{\overline{\mathrm{IV}}}$ means 4

The final prescription should read:

Theophylline 100 mg
disp: $\dot{\overline{\mathrm{I}}}$ mo. supply
sig: $\dot{\overline{\mathrm{I}}}$ tab. q6h

The pharmacist will then compute the number of tablets per month (see preceding computation in question 4 on page I-17).

Discuss with students how they can modify the question for pupils who are at a less sophisticated math level. For example:

If a child needs one tablet of medication every six hours (q6h), how many tablets should the child be given in one day?

in two days?

.
.
.

in a one-month period?

Emphasize that this is but one prototype problem. For particular grade levels, only parts of this problem will be appropriate. Furthermore, the teacher can change the numbers to adjust for levels of difficulty. Point out to students that although the questions and the numbers can be varied, the facts should be accurate.

COMMENTARY AND NOTES

It may be appropriate to review the relationship 3 tsp. = 1 tbs.

Tell students that another problem can be developed, as follows:

Suppose a child cannot swallow a pill. A liquid dose can be supplied in the following quantities:

1 tbs. provides 81 mg of medication

1 tsp. provides 27 mg of medication

Approximately what should be the dosage for I. M. Ill?

1 tbs. + 1 tsp., or 4 tsp.

or sig: $\dot{\mathrm{T}}$ tbs. and $\dot{\mathrm{T}}$ tsp. p.o. q6h

2. Write a prescription for children's aspirin, given $1\frac{1}{4}$ grains per tablet.

Dosage: 1 grain per year of age (up to age 10), every 4 hours.

Telephone ____________

Doctor ____________

Address ____________

Name *I. M. ILL* ____________ AGE ____

Address *13 Cardiovascular Freeway* DATE ____________

GENERIC EQUIVALENT MAY BE SUBSTITUTED

℞ LABEL CONTENTS

Refill ____ Dr. ____________

____

You might pose the following questions to help students solve the problem:

1. How many grains are needed for a 5-year-old? (5)

This is a very simple problem, suitable for pupils in the first grade. Based on the given dosage, these related questions can be asked:

COMMENTARY AND NOTES

Ask your students to suggest ideas that might be suitable for pupils to discuss in class during a lesson similar to this one. For example, the teacher might ask children to recall when the doctor has prescribed aspirin for them.

How many grains are needed for a 1-year-old? (1)
How many grains are needed for a 2-year-old? (2)
How many grains are needed for a 3-year-old? (3)

. . . .
. . . .
. . . .

How many grains are needed for a 10-year-old? (10)

The mathematical skill used is called counting.

2. How many aspirin tablets provide the necessary dosage of 5 grains? (4)

   The skill used here is division, but since we are dividing by $1\frac{1}{4}$, the suitable grade level is fifth or sixth grade.

$$5 \div 1\frac{1}{4}$$

$$= 5 \div \frac{5}{4}$$

$$= \frac{5}{1} \times \frac{4}{5}$$

$$= 4$$

   Four tablets are needed. Observe that 4 tablets may be a large number to take at one time.

3. How many times per day is the aspirin taken? (6)

   The skill used is division: $24 \div 4 = 6$

4. How many tablets are taken in one day? (24)

   This is a simple multiplication problem: $4 \times 6 = 24$

5. How many tablets make up a one-week supply? (168)

   This also involves multiplication: $24 \times 7 = 168$

Completed prescription:

Children's aspirin $1\frac{1}{4}$ grains

disp: $\dot{\text{I}}$ week supply

sig: 4 tab. q4h

COMMENTARY AND NOTES

Allow a few minutes for students to read over the assignment. Then clarify any areas that are unclear. Assign a date for the completion of the assignment.

It is important for your students to know that there is evidence that young women continue to enroll in math classes once they are convinced that mathematics is needed in careers of interest to them.

The following is a variation of the basic problem on page I-21 (Write a prescription for children's aspirin, given $1\frac{1}{4}$ grains per tablet).

6. An adult aspirin contains 5 grains per tablet.

   a. How many tablets of children's aspirin contain the same amount of medication as one tablet of adult aspirin? (4)

   $$5 \div 1\frac{1}{4} = 4$$

   b. At what minimum age would it be feasible to substitute adult aspirin? (At age 5, substitute 1 adult aspirin.)

Problems 2 and 6 require division of fractions. This would be appropriate for pupils in the sixth grade. Point out that the teacher can alter the problem by choosing numbers that are appropriate for the math level of the children.

TEACHING A MATHEMATICS-IN-CAREERS LESSON

Once you have discussed the mathematics involved in prescribing medication, students should be ready to plan to teach a mathematics-in-careers lesson to pupils.

Say: "We have considered a single career and some of the mathematics needed for that career. Now you are going to be asked to select a career that uses mathematics, to plan a lesson, and to teach it to children. Turn to the pages entitled 'Teaching Mathematics in Careers' in the Student Materials, Part II, page 13, and 'Examples of Mathematical Behaviors in Careers,' also in the Student Materials, Part II, page 14. You have been provided with a list of some of the mathematical behaviors displayed in various careers. Read over the assignment."

Devote a subsequent class session to a discussion of the students' teaching experiences. Be sure to point out how the mathematics used in careers can be included in the day-to-day mathematics activities of the elementary school.

PART C: SUPPLEMENTARY MATERIALS FOR THE INSTRUCTOR

SAMPLE LETTER OF INTRODUCTION

(To be typed on your letterhead)

Date:___________________

Dear ___________________:

As part of a project dealing with mathematics, we are collecting information on how women use math in their careers and how their careers have developed.

Let me introduce ___________________________________, who would like to interview you, with your permission. Please feel free to skip any questions that you are uncomfortable about answering. I would like to assure you that your answers will be confidential and that any summary of our interview data will not contain names.

I very much appreciate your willingness to assist in this effort. Please feel free to contact me directly if you have any questions.

Again, thank you for your time and effort in our project's behalf.

Sincerely,

(Your Name),

Project Director

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REGARDLESS OF SEX*

An overview of where we have been and where we should be going in our efforts to assist young women in their study of mathematics.

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Today, more than ever before, the study and appreciation of mathematics are vital to the intellectual development of a society and to its scientific, industrial, technological, and social progress. It is essential that teachers, counselors, supervisors, educational administrators, parents, and the general public work together to provide the best mathematics education possible for all students, regardless of sex.

—NCTM Statement on Counseling
January 1976

The study of mathematics is vital to the intellectual development and the career progress of individuals regardless of sex. Nonrequired courses on this subject, however, are not now, nor have they ever been, heavily populated with females. Concerned teachers of mathematics are beginning to seek remedies for this condition.

Research supports the folk knowledge that in the elementary school years girls do at least as well as boys in all subjects, including mathematics. However, during the secondary school years, young women do not achieve as well as young men in the study of mathematics (Maccoby and Jacklin 1974; Callahan and Glennon 1975; Mullis 1975; Fox 1976). Moreover, female participation in mathematics courses declines steadily after grade eight. At the junior high school level, there are about as many girls as boys in first-year algebra classes. By the time the senior year rolls around, the ratio of males to females in advanced mathematics courses approaches three to one (Fennema and Sherman 1976). Data from Berkeley indicate that although 57 percent of the freshman males had taken four years of high school mathematics, only 8 percent of the females had (Sells 1973). By the third semester of college, the male/female ratio in mathematics courses is six to one (Fennema and Sherman 1976). In 1976, although a heartening 6509 (40 percent) bachelor's degrees in mathematics were awarded to women (Grant 1978), female students earned only 2.2 percent of the degrees in engineering (Eiden 1976) and were grossly underrepresented in fields that use mathematics as a tool, such as the natural sciences and economics (Ernest 1976). A study that included all students with declared majors on seven of the campuses of the University of California revealed a highly significant ($p < .0001$) difference in course-taking behavior by sex. Thirty-two percent of the variance in female representation in major fields was accounted for by the number of prerequisite mathematics courses (Hedges and Majer 1976).

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Is there something in the nature of mathematics—a discipline characterized by abstract logical arguments, aesthetic beauty, and original thought—that precludes young women from its study? Immanuel Kant stated:

> All abstract speculations, all knowledge which is dry, however useful it may be, must be abandoned to the laborious and solid mind of man . . . for this reason women will never learn geometry.

But it was a woman, a poet, who wrote:

> Euclid alone has looked on Beauty bare
> Let all who prate of beauty hold their peace. [Millay 1956, p. 605]

The inability of women to think logically is, of course, a bit of hallowed mythology in our culture, the foundation of many a cartoon and situation comedy. Another shaper of educational philosophy, Rousseau, believed that women were unfit, because of the feebleness of their brains, for research into abstract and speculative truth or the principles and axioms of science. Martin Luther (who believed that women were created with big hips so that they could stay home and sit on them) declared, "No dress or garment is less becoming to a woman than a show of intelligence" (Mount 1973). From Aristotle through the Renaissance through Descartes, tradition held that the province of men is the mind and that of women, matter.

Despite the social convention, there have always been some women who have delighted in the study of mathematics as a recreation (Perl 1977) or as a career (Osen 1974). Aesthetic beauty and intuitive thought have, of course, always been considered the province of "the gentle sex."

Is there, then, some innate factor that predisposes young women to forsake the rigors of mathematics in the early adolescent years? In the not-distant past it was supposed that women were unsuited for the study of this subject because their heads were smaller than men's, their nervous systems too delicate, or their intellectual capabilities not sufficient to the task (Leland 1904; Smith-Rosenberg and Rosenberg 1973). Such theories have, for the most part, fallen into disrepute. The major explanation proffered today is the existence of a genetic effect favoring males in the area of spatial-visual ability. This explanation for sex differences in mathematical ability is not universally accepted (Elliot and Fralley 1976; Sherman 1977). Even if such an effect should exist, it would account for only a small portion of the difference in mathematics achievement between males and females (Fennema and Sherman 1976).

> Young women underrate their ability in mathematics.

Other research, moreover, provides evidence that the cognitive power necessary for mathematical endeavors is not foreign to the female sex. Mathematical ability correlates highly with general intelligence (in which no consistent sex differences are found). It is also correlated with deductive reasoning (in which there are no consistent sex differences), verbal ability (in which a sex difference in favor of females is often found), and spatial ability (in which a sex difference in favor of males appears during, but not before, the adolescent years). Performance on Piagetian tasks also fails to yield consistent sex differences (Maccoby and Jacklin 1974; Armstrong 1975). There seems little to indicate that innate differences explain a major portion of the variance in mathematics achievement between the sexes. The effects of environment must be carefully examined.

Effects of Home Experience

Parents play a major role in developing or hindering the later mathematical progress of their daughters (Casserly 1975). Ravenna Helson, in a 1971 study of women mathematicians, found that almost every one of them had grown up in homes where parents had a strong respect for learning and cultural values. As little girls, most of them had been rewarded for intellectual successes. Osen (1974) reports a similar finding in a history of women in mathematics. The treatment of boys and girls differs along many dimensions, from the type of toys provided to the amount of independence allowed for males and females.

Especially crucial is the difference in the socialization of personal traits. Females in our culture have traditionally been socialized to conform rather than to contradict, to be popular rather than to excel academically, and to accept as the most appropriate goal raising a family rather than pursuing a career. The result of successful socialization according to this pattern is not apt to encourage achievement in "masculine" subjects during the high school years. As Alice Rossi states:

> If we want more women to enter science, not only as teachers of science but as scientists, we must encourage the cultivation of the analytical and mathematical abilities science requires. To achieve this means encouraging independence and self-reliance instead of pleasing feminine submission in the young girl, stimulating and rewarding her efforts to satisfy her curiosity about the world to the same extent her brothers' efforts are, cultivating a probing intelligence that asks why and rejects the easy answers instead of urging her to please others and conform unthinkingly to social rules. A childhood model of the quiet, sweet, "good" girl will not produce many women scientists or scholars, doctors or engineers. [1972, p. 79]

It will not produce creative mathematical thinkers, either. And it will not produce students who have the courage to ignore stereotypes in order to find personal satisfaction. Teachers, however, although cognizant of the importance of parent-child interactions, have little input in that area. They must work for change elsewhere.

Mathematics As a Masculine Domain

One reason women fail to take nonrequired mathematics courses is that in the United States and Canada, as in most countries of the world, the study of mathematics is an endeavor that has been decreed masculine (Keeves 1973; Fox 1976). It is hard to understand why this should be so, since the tools of a mathematician, unlike the tools of a bricklayer or geologist, are not of excessive weight. The tools of the mathematician are, indeed, exactly the tools of the teacher or the secretary--books, pencils, and paper. The mental equipment required is essentially the same as required for the historian or the poet--a creative and analytical mind. Yet, as Lynn Osen states in the preface to *Women in Mathematics*, "Many women in our present culture value mathematical ignorance as if it were a social grace." Secondary teachers of mathematics know this statement is not farfetched. They see daily the effects of advice such as that found in *Fascinating Girl*:

> Don't compete with (men) for scholastic honors in men's subjects. It may be all right for you to win over a man in English or Social Studies, but you are in trouble if you compete with him in math, chemistry, public speaking, etc. Men may admire women who excel in them but they are not apt to ask them for a date. Why? Because they have defeated them in their own field. [Andelin 1970, p. 164]

One of the saddest facts about this quotation is that it is true. In a study of 350 women mathematicians, Luchins (1976) found that not only had almost half of them been discouraged by teachers and peers on the grounds that "boys wouldn't like them," but that these women received *less* positive attention from men as they advanced to higher levels. The turn towards mathematics often comes during the adolescent years. Eighty-eight percent of Luchins's respondents reported that their interest in mathematics had begun before the end of their high school years. Indeed, by the time of high school graduation, 36 percent of the women had decided on a career in mathematics. Many more young women may have decided the choice just wasn't worth the price.

Asked to respond to the question "What can be done at the precollege level to encourage women to consider mathematics as a career?" 36 percent of the mathematicians stated, "Change the attitude toward mathematics as unfeminine"; 21 percent suggested that teachers and advisors be made more aware of career opportunities in mathematics; and 17 percent thought that more female role models would help. The major reason for the relatively small number of female mathematicians, listed by 73 percent of the respondents in Luchins's study, was "Mathematics is not considered feminine."

When there is potential for conflict between academic achievement, particularly in "masculine" areas, and popularity, achievement tends to suffer (Fox 1976). Whether the concern is valid or is an incorrect perception on the part of the young woman, the effect is the same (Levine 1976). Indeed, young women tend to underrate their ability in mathematics, even when it is exceptional (Maccoby and Jacklin 1974; Robitaille 1976; Ernest 1976).

The most telling case history that supports the thesis that mathematics is a masculine domain comes out of the Money studies at Johns Hopkins. A patient who had been reared as a female was, during adolescence, determined to be a genetic male. Upon the discovery, a social conversion began. There was an immediate and dramatic change in his school record. Previously a mediocre student, he became an excellent one. In fact, in mathematics, where he had done poorly as a girl, he rose to the top of his class (Oakley 1972).

Belief in the stereotype becomes a self-fulfilling prophecy. Women do not enter the field of mathematics; thus mathematicians and engineers tend to be men, and the fiction that mathematics is an esoteric science women cannot understand is reinforced. Belief in the stereotype "encourages the notion that to enjoy mathematics in its many forms is to be, in some obscure way, at variance with one's womanhood" (Osen 1974, p. 165).

Gifted women are discouraged from studying mathematics.

Despite the acceptance by the public at large of mathematics as an improper realm of achievement for females, the mathematics education community in general holds an opposite view (Conference Board of the Mathematical Sciences 1975). The current state of affairs need not predict the future. Among the strategies that offer promise for increased participation by young women in mathematics courses on the secondary level are these:

1. Encouraging students to enroll in nonrequired courses
2. Providing students with good role models
3. Informing students of the career relevance of mathematics
4. Helping math-anxious students overcome their fear

Encouragement

Many students breathe a sigh of relief when they have accumulated the one or two years of high school mathematics necessary for graduation. A lack of four years of college preparatory mathematics, however, effectively eliminates a student from beginning study in a wide variety of college majors, including astronomy, engineering, biochemistry, physics, and, of course, mathematics. The student who has strenuously avoided taking mathematics courses during high school is also the least likely person to take extra courses later to remedy a mathematics deficiency. Support and encouragement from a mathematics teacher may help able students to keep a maximum of career options viable by continuing to take mathematics courses in high school.

Some high school personnel, with the best intentions in the world, have steered students away from advanced courses in mathematics or postponed their initiation into the mathematics sequence. In an ETS (Educational Testing Service) study of female high school students gifted in mathematics, Patricia Casserly (1975) found that even these young women were often counseled out of advanced mathematics courses. Counselors and teachers suggested that serious study might detract from the fun of senior year, cautioned that the student might spoil her scholastic record, or expressed fears that a woman trained in mathematics or science might steal a job away from a man.

Female mathematicians reported that they had had similar experiences. One professor of mathematics stated that in elementary school she had been discouraged from skipping a grade because she was told she probably wouldn't be able to learn long division. Another professor who won an award in a competitive mathematics examination when she was an undergraduate was informed "girls weren't supposed to get the prize." A third mathematician indicated that at her university women graduates were recommended for jobs only at women's colleges and that only certain professors were "willing to take on girls" (Levine 1976).

In the past, assumptions, often unconscious, about which behaviors and goals are appropriate for young women have restrained both teachers and counselors from suggesting additional courses in mathematics and has prompted them to question the suitability of such courses when they have been selected (Ernest 1976; Fox 1976). Teachers asked to describe good female junior high school students used adjectives such as poised, cooperative, sensitive, and thorough. Asked to describe good male junior high school students, these same teachers used adjectives such as adventurous, assertive, curious, and inventive (Sadker and Sadker 1974). This study replicates, on the secondary school level, the classic Broverman (1970) study of adult mental health. Recognition of the prevalence of such assumptions may itself go a long way towards eliminating them. Counselors who are convinced of the worth of the study of mathematics, even from a pragmatic career perspective, will prove a valuable ally to mathematics teachers seeking to encourage students to take advanced, nonrequired courses.

Role Models

Role models are powerful influences on human behavior. Even in audiovisual presentations, the presence of a female role model has a positive effect on high school women (Plost and Rosen 1974). The effect of *in vivo* models is even stronger (Casserly 1975; Levine 1976). In a 1976 National Science Foundation (NSF) project designed to assess strategies used to increase women's participation in mathematics and science, the presence of role models during the high school years appeared to be the most effective (Fox 1976). Young women who aspire to the study of mathematics may see few role models among the teachers in their high school. There are few in their textbooks (Rogers 1975) and even fewer in the history of mathematics. As Osen states:

> In almost any age, it has taken a passionate determination as well as a certain insouciance, for a female to circumvent the crippling prohibitions against education for women, particularly in a field that is considered to be a male province. In mathematics the wonder is not that so few have attained proficiency in the fields, but that so many have overcome the obstacles to doing so. We can only speculate about the multitude who were dissuaded from the attempt. [1974, p. 163]

Although it is true that approximately one-half the membership of NCTM is female, many of those members are elementary teachers, supervisors of mathematics, or college professors. Unless particular care is taken to expose young women to those women, they pass unnoticed and do not fulfill their potential as role models. In mathematics-dependent fields such as physical science or engineering, the available models are much fewer (Westervelt 1975; Eiden 1976).

Although there are many elementary teachers who love mathematics and whose enthusiasm is the spark that inspires others to pursue studies in that that area, many others are, to put the the kindest face on it, negative role models. Many elementary school teachers, most of whom are women, are terrified of mathematics; they feel that a mathematician must be either a genius or a lunatic (Levine 1976). This attitude, spoken or silent, can affect how young girls view the study of mathematics.

Early exposure to adults who lead satisfying lives both as women and as professionals in mathematics-dependent careers will provide proof of the appropriateness of mathematics as a field of study for females as well as males (Westervelt 1975). Lecturers for science assemblies do not have to be men, or, even more devastating, do not have to be introduced as curiosities: "Here is a *woman* mathematician!" The importance of seeing and hearing such role models early is emphasized by Casserly (1975), who found that most high school women in advanced placement classes expressed strong interests in mathematics or science before the age of twelve.

It will not be surprising that peer role models are also effective. For a young woman bright in mathematics to meet other young women who share a similar talent may well provide the support she needs to continue her pursuit of the subject. The converse is also true. The use of mathematically competent and confident juniors and seniors to encourage elementary school students and younger secondary school students is particularly powerful (Casserly 1975). This is especially true if the peer models are popular with other students, both male and female, as well as academically successful.

Career Relevance

Teachers of mathematics have long known that at least three years of high school mathematics are required for entrance into engineering, science, and mathematics majors at most colleges. They also realize, better than most, that even for entrance into the social and behavioral sciences, long the haven of the math-wary, mathematics is now required. Those who fail to take sufficient mathematics in high school at best delay their entrance into most college majors. Those who have avoided taking mathematics in high school are also the least likely to elect it in college.

Peer role models are important.

Male high school students believe that mathematics will have career relevance. Female high school students are not as convinced that this is true (Hilton and Berglund 1974; Ernest 1976; Fennema and Sherman 1977). Those not interested in mathematics or science as a career may not recognize a need for mathematics for careers in teaching or the social sciences. Yet, as Gelbaum and March (1969) state in the preface to *Mathematics for the Social and Behavioral Sciences*:

> It was once appropriate, and still is rather conventional, for a parent or counselor to advise a student who finds mathematics uncongenial to consider studying the social and behavioral sciences. The advice has the virtue of providing a neat solution to a difficult problem; it has the vice of being misguided. Within the past decades mathematical models, statistics, and computation have become the standard tools of the professional; failure to understand those tools places substantial parts of the current literature out of reach.

And this warning does not even take into effect the less-than-encouraging prospects of finding a job in education or the social sciences. Presently, graduates of teacher education programs outnumber available jobs two and a half to one, and positions in engineering outnumber engineering graduates three to one; one-third of all females graduate from college with a bachelor's in education (Kreinberg 1976). A book such as Susan Splaver's *Non-Traditional Careers for Women* may help expand the career awareness of young women and their counselors. To bring the message home to many students, teachers should not shrink from discussing the monetary advantages of learning mathematics.

Although counselors are not as influential as classroom teachers in encouraging reluctant students to take mathematics courses (Casserly 1975), they exert a great deal of influence on students who have chosen a course in mathematics. Forty-two percent of the gifted young women studied by Fox had been *discouraged* by counselors from taking advanced mathematics courses, despite the fact that they had already expressed an interest in a career in mathematics.

Such discouragement does not come from overt antifemale attitudes as much as from a lack of awareness of the facts of life with regard to the work future of women. It is important that all who work with young women realize that 90 percent of the young women now in school will work a significant portion of their lives. Those who remain unmarried will work an average of forty-five years; those who marry, twenty-five years.

The counseling literature contains many excellent articles on providing nondiscriminatory counseling to young men and women. Verheyden-Hilliard's recent discussion in *American Education* (1976) is especially relevant. A useful reference is the *Handbook on Sex Equality in the Schools*, an outgrowth of the Sex Equality in Guidance workshops. This booklet is available through the American Personnel and Guidance Association and would be a valuable addition to the school's teacher reference library. Much of the literature on career counseling, in response to Title IX requirements, addresses the issue of providing nonbiased counseling and meeting the special needs of young women. Teachers of mathematics might inquire of counselors in their schools about the ways interest and attitude inventories are adapted so as to permit a nonbiased use of the present instruments.

Aware counselors are excellent allies as mathematics teachers seek to alert students to the financial and academic opportunities available to them. The counselor may also be the appropriate person to arrange career days or special speakers or to distribute material describing mathematics-related careers. For students considering such careers Casserly (1975) suggests that teachers in advanced courses are excellent sources of information on scholarships and programs in these fields. Such teachers may wish to share this information with the counseling staff in their school or in the district office.

Teachers of advanced mathematics courses might also enlist the aid of counselors in recruitment efforts. The most successful long-term efforts seem to be those that start at the junior high school level and continue in each of the required courses. Visiting so many classes may well be impossible for teachers; it may be a most acceptable addition to the counseling practices in a given school.

Once a student has expressed an interest in mathematics or a mathematics-related career, many teachers act as mentors, helping the students clarify their goals, choose a college, fill out forms, and attend to many other details. Counselors may appreciate being called on as resources in this capacity as well. Finally, many teachers have gone beyond the call of duty and have contacted parents who were unaware of the potential of their daughter or who regarded mathematics as an inappropriate career choice. Counselors may also be pleased to use their training in this capacity.

Mathematics teachers and counselors might also collect literature on mathematics-dependent careers for display in their classrooms and make it available to other teachers and to student groups. A list of speakers on careers for which mathematics is essential might be compiled as a class project. One helpful source for both materials and speakers in this area is the MAA-sponsored program called Women and Mathematics (WAM). WAM, directed by Dr. Eileen Poiani of St. Peter's College, Jersey City, New Jersey, is funded by IBM and maintains a list of women speakers from a variety of fields who address students on the importance of continuing the study of mathematics in high school. Two free booklets, "Careers for Women in Mathematics" and "Math in High School You'll Need for College" (prepared by the Mathematical Association of America [MAA] with the cooperation of NCTM), may be obtained from the MAA by writing them at 152? Eighteenth Street, NW, Washington, D.C. 20036. Permission has been given for local reproduction of "Math in High School." It might be worthwhile to consider putting a copy of this leaflet in the hands of every first-year algebra student in your school. Since those whose chosen careers in science have usually crystallized their choices before the age of fourteen (Borow 1966), it is especially critical to share this career information with junior high school students. It is worth noting that of the mathematical sciences, computer programming and statistics have been found the least stereotyped according to sex and may be the least threatening of the mathematical fields for young women to pursue.

Mathematics is, of course, an equally important subject for those who do not wish to go to college. Many of the technical trades demand mathematical ability. By taking several mathematics courses in high school, the non-college-bound student also keeps a maximum of career options available.

Math Anxiety

Many people, regardless of sex, suffer such a fear of mathematics that they are all but paralyzed when confronted with even the simplest of situations involving the application of mathematical concepts (Ernest 1976). A cause as well as a symptom of math anxiety is the unwillingness to take courses in mathematics. Although men as well as women suffer from math anxiety, women admit to the syndrome more often than men. It is, after all, "masculine" in our society to be competent in mathematics. Society is known to "understand" female incompetence in this area. A 1975 pen advertisement, for example, used this approach:

> You might as well give her a gorgeous pen to keep her Checkbook unbalanced with. A sleek and shining pen will make her feel prettier. Which is more important to any girl than solving mathematical mysteries.

Teachers who explain to those students who are uncomfortable with the prospect of taking mathematics that fear of the subject is far from uncommon, that it is a phenomenon that has affected students from kindergarten to the doctoral level, and that it can be conquered, are both honest and helpful. One way of alleviating math anxiety is to desensitize the student. Focusing on the roots of the anxiety, individually or through a discussion group, is often effective. Such a discussion group might be offered as an after-school workshop or as a minicourse. The leader's role would be merely to provide a supportive, nonthreatening atmosphere for group interaction on this sensitive issue. Facilitating a math anxiety group is an appropriate extension of either a teacher's or a counselor's role.

Teachers should discuss the monetary advantages of learning mathematics.

One of the best ways to reduce math anxiety in students currently taking mathematics is through good teaching. Teaching the subject in a meaningful way and insuring that all prerequisite knowledge is part of the student's repertoire is extremely helpful in promoting positive attitudes towards mathematics. Teacher enthusiasm and high expectations for student success also go a long way toward dispelling uneasiness.

Toward Tomorrow

NCTM planned an entire strand at the April 1978 San Diego conference on women in mathematics. Sessions on women in mathematics have also been held in recent meetings of AERA (American Educational Research Association), MAA, and AAAS (American Association for the Advancement of Science). Math anxiety clinics are currently in operation across the country, from Connecticut to California and at points in between. (A booklet describing some ongoing programs designed to alleviate math anxiety is available from the Math Learning Center, 325 13th Street, NE, Room 302, Salem, Oregon 97301. They will also send the Spring 1977 Center Report, *Women and Math*, to any who request it.) Literature in this area is appearing in journals and in the ERIC system at an increasing rate. Government agencies such as NSF, NIE (National Institute of Education), and WEEA (Women's Educational Equity Act) are funding programs that will directly or indirectly increase the number of women in mathematics courses and in careers that are mathematically dependent.

But in the final analysis, it is those who teach and counsel young women in the secondary schools who will make the difference. The gentle persuasion of secondary school teachers of mathematics will transform the NCTM statement on counseling (see Appendix) from rhetoric to reality. Encouragement and support can open new worlds to the student who without them might consider the study of mathematics irrelevant, inaccessible, or inappropriate.

APPENDIX

Guidance/Counseling Statement for Both Counselors and Mathematics Teachers at the Secondary School Level

Today, more than ever before, the study and appreciation of mathematics are vital to the intellectual development of a society and to its scientific, industrial, technological, and social progress. It is essential that teachers, counselors, supervisors, educational administrators, parents, and the general public work together to provide the best mathematics education possible for all students, regardless of sex, ethnic group, national origin, or ability. All students should be encouraged to keep options open by studying mathematics so as to make maximum use of their talents. Specifically, it is suggested that students include in their high school programs a maximum of mathematics appropriate to their abilities and interest.

The educational, vocational, personal, and social choices and decisions made by students should lead to satisfying and worthwhile lives. The important members of the guidance team in each school, including both the school counselor and the mathematics teacher, are responsible for helping students gain insight and an understanding of themselves and their environment in making these decisions. Therefore, they must work cooperatively in several ways:

1. Planning mathematics programs from individual students
2. Placing students in mathematics courses appropriate to their needs and abilities
3. Anticipating developments in mathematics and in fields that use mathematics
4. Conferring with the school administration with regard to mathematics course offerings
5. Planning a mathematics program designed for a specific field
6. Securing, evaluating, and making available to students a variety of career publications
7. Planning career-oriented activities
8. Keeping students informed about--
   a. secondary school and college mathematics programs
   b. mathematics requirements in vocational and technical school
   c. college entrance requirements in mathematics
   d. mathematics requirements for majoring in specific areas
   e. procedures for obtaining college credit for mathematics courses taken in high school
   f. career opportunities in mathematics
   g. mathematics needed for specific fields and professions

Copies of the NCTM Position Statement on Guidance Counseling are available free of charge by writing to Counseling, NCTM, 1906 Association Drive, Reston, Virginia 22091.

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Women and the Career Relevance of Mathematics and Science*

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A popular phrase heard at meetings of persons interested in career education, particularly for girls, is "be anything you want to be." One thing very few girls seem to want to be is mathematically talented, or at least employed in professional careers in mathematics and science. Yet boys and girls do not appear to differ with respect to reported liking for mathematics as a school subject in the elementary and secondary school years (Ernest, 1975). When mathematics courses become optional in high school and college, however, far fewer females than males elect to take them (Haven, 1970; Ernest, 1975). The difference becomes greatest at the doctoral level. In 1968-69 only 3.4 percent of the degrees earned in the physical sciences (including mathematics and engineering) were awarded to women (Centra, 1974). It is interesting that girls should report liking mathematics as much as boys, yet avoid taking the courses when they can.

Although it does appear that more males than females exhibit precocious mathematical reasoning ability in adolescence (Stanley, 1973), the gap between the sexes in achievement and career attainment in mathematics and science cannot be explained entirely by differences in aptitude. Many women who are quite talented in mathematics and science simply do not elect to develop their skills in these areas.

Career Relevance, Mathematics and Science

In a study of the differences between well-above average ability girls who elect or not elect to take high school mathematics courses Haven (1972) found that the two most significant predictors of course-taking were the value of mathematics for future studies and careers, and greater interest in the natural sciences than social studies. Girls who elected to take advanced courses in mathematics did so because they saw the courses as directly relevant to their career goals.

As early as grades seven and eight, boys and girls who exhibit high academic potential appear to differ dramatically with respect to career interests and aspirations, values and perceptions of the importance of mathematics for their future. Academically able girls are far less likely than their male cohorts to express a preference for a career of a mathematical or scientific nature on questionnaires (Fox and Denham, 1974). Girls are more likely than boys to aspire

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toward careers of a social or artistic nature. Since more boys than girls aspire to scientific careers it is not surprising that boys also perceive the study of mathematics as more relevant to their future goals than do girls (Haven, 1972; Fox, 1975a).

Although academically talented girls do differ significantly from their male counterparts with respect to expressed career goals, it is important to note that academically able girls also differ strikingly from adolescent girls in general with respect to career interests. In a study using the Strong-Campbell Interest Inventory (Fox, Pasternak and Peiser, 1976), gifted girls showed much stronger interest in science and mathematics on the general interest scales than a random group of adolescent girls and boys did, but less interest than gifted boys. Girls who have well-above average mathematical ability appear to be attracted to both "masculine" and "feminine" career areas.

Thus, the girls who have the greatest potential for achievement in the physical sciences and mathematics appear to experience more conflict in career interests than less able girls or very able boys. This conflict seems to result from the fact that the underlying values of girls are not consistent with their intellectual talents. The majority of women in any sample tend to score higher on measures of social values and lower on theoretical values than men on the Allport-Vernon-Lindzey *Study of Values* (1970), and this is true of gifted girls as well. Gifted boys, however, tend to score low on the social value scale and high on the theoretical value scale which is consistent with mathematical and scientific endeavors (Fox, 1975b). Theoretical value orientations have been shown to be significantly related to creative achievement in mathematics (MacKinnon, 1962).

Therefore, at least part of the reason why girls who have the talent fail to develop their ability in mathematics and science seems to be a function of differential career interests and underlying values. Although it is not completely clear as to why women and men differ so greatly with respect to these interests as early as grade seven, it does appear that many social-cultural influences help to reinforce these differences over time.

Haven (1972) found that girls who take advanced mathematics courses are those who receive encouragement from parents, guidance counselors, mathematics teachers, and peers. Thus, having the support of significant others is necessary to encourage girls who have somewhat deviant (i.e., rare or masculine) career interests.

Encouragement: A Key Factor

In general, how supportive are parents, teachers, and peers of girls' interest in mathematics and science? In a study of a small sample of gifted students Astin (1974) found that parents of boys were more likely than parents of girls to have noticed, and fostered, their child's scientific interests. Gifted boys are more likely than gifted girls to perceive their parents as favorable toward accelerative educational experiences in mathematics (Fox, 1975a).

Studies of women who have received the doctorate (Astin, 1969) and of creative women mathematicians (Helson, 1971) indicate that identification with professional fathers, encouragement from appropriate female role-models, and parental support were important factors in the development of these women. Many successful women mathematicians are first generation Americans, or daughters of first generation Americans. Many are also oldest daughters in all-girl families. It has been hypothesized that families which have no sons and immigrant families are more likely than other types of families in the United States to encourage their daughters' educational and career aspirations.

Whether or not gifted girls receive much special encouragement at home to aspire toward professional careers, they are not likely to get much special career counseling in school or special encouragement in mathematics classes. Teachers believe that boys are better at mathematics than girls (Ernest, 1975) and thus probably fail to notice and encourage those girls who do have real aptitude for mathematics. Even in these supposedly "liberated times," gifted girls who attempt to accelerate their mathematics education may be ridiculed or discouraged by insensitive teachers or peers. Clearly, many girls anticipate rejection for appearing different by moving ahead in mathematics (Fox, 1974a; 1974b).

In elementary school, girls think girls are better and boys think boys are better at mathematics (Ernest, 1975). In a junior-high-school age sample of gifted students, both boys and girls thought the sexes were about equal in ability (Fox, 1975a). By the ninth grade, both boys and girls think boys are superior to girls in mathematics (Ernest, 1975). Thus, for senior high school students, mathematics appears to be labeled as a masculine domain. Girls who have talent and even interest in mathematics and science and who wish to appear "feminine" may find few rewards from peers for being deviant (i.e., masculine). In a study of college students Hawley (1972) found that women who choose to major in mathematics and the sciences were less likely to view careers in these areas as unfeminine than were women majoring in the non-science areas.

Thus, girls aspire less than boys toward careers in mathematics and science partly because their own early interests deter them, but perhaps partly because they receive so little encouragement to do so. Even girls who are very talented and interested may find the road to achievement in mathematics and science difficult unless they develop a strong sense that liking mathematics and science is not unfeminine and inappropriate. At this point the problem seems circular. Girls avoid mathematics and science in high school, college, and graduate school because they perceive it as unrelated to their career goals. As long as they avoid the courses, they are unable to compete for careers in these areas at a later time. The fewer women who aspire and attain careers in the sciences, the less likely attitudes and views of these career areas as "masculine" will change. As long as these career areas are perceived as masculine, only a few young women will be encouraged to aspire toward them.

Planned Intervention Studies

The question of interest, then, is how to break the chain. If society is truly committed to encouraging women to develop all their talents more fully, how can this be done? Removing external barriers, such as sex discrimination in hiring, will not automatically cause women to surge forth to fill the ranks of scientists.

If it is desirable to increase women's participation in the world of science and mathematics at a professional level, special efforts are needed to encourage women to think seriously about these career areas. Since the decline in both mathematical interest and achievement appears to occur at about the time girls begin secondary school, programs aimed at increasing women's participation in careers should probably begin early, even as early as the elementary school years. Efforts directed only at the young girls are likely to be less successful than programs which aim to change attitudes of parents and educators as well.

In the last few years, some efforts have been made to develop career education programs to increase women's participation in the sciences. Most of these projects are so recent, it is too soon to evaluate their long-term effectiveness. Preliminary results, however, are encouraging.

Some attempts to foster precocious achievement in mathematics among bright adolescent girls have been successful. Such efforts, however, have been considerably more effective when girls have been taught by attractive women mathematicians in either all-girl classes or in classes in which girls were not in the minority, than when girls have been taught by men in classes where the girls were outnumbered by boys (Fox, 1974a; Fox, 1974b; Stanley, 1976). These classes were special accelerative ones where motivation was necessary for success. The sex of teacher and classmates may not be at all important in standard mathematics classes. On the other hand, advanced placement courses in some senior high schools may be very similar to the experimental accelerated classes, and it is precisely those types of advanced courses which girls tend to avoid in high school.

Just telling bright girls that they are good at mathematics or science, telling them about interesting career possibilities, and exposing them to appropriate female role-models may have some immediate impact upon their career aspirations.

In one study, seventh-grade girls were invited to a special accelerated algebra class. Mathematicians and scientists, both male and female, spoke to the girls about interesting careers which require mathematical expertise. Girls who completed the course scored higher on a standardized test of algebra than a control group of gifted girls who took algebra in the regular school day in twice as many class hours of instruction. The program had a definite effect on career aspirations of those girls who had not previously realized that they were good at mathematics (Fox, 1974b).

In a pilot study of a career education and mathematical skills project for gifted fifth- and sixth-grade boys and girls, two male and two female mathematicians taught short courses on non-parametric statistics, geometry, probability, and computers. Students in the program, especially the girls, became more positive toward mathematics and much more interested in careers in mathematics and computer science (Fox, 1975c).

A number of research projects aimed at increasing the participation of women and minorities in careers in the sciences were funded by the

National Science Foundation in 1974. It is hoped that th results of these studies will be made available soon and will provide great insight into how to plan and conduct career education efforts.

What Educators Can Do

On the basis of current evidence it appears that, in order for more women to become scientists and mathematicians, girls must develop interests in these career areas at an early age, so that they do not self-select themselves out of mathematics and science courses in high school. Girls will be more likely to develop these career interests if they are encouraged by parents and teachers to view these careers as realistic goals for women. Contact with appropriate feminine role-models is likely to promote this end.

Since most girls value social interests and careers of a social service nature, attempts to teach girls about the ways in which mathematics and science can be used to solve social problems would seem desirable. Thus, it might be appropriate to initiate courses in applied mathematics and science at the junior- and senior-high school levels. Statistics and computer science both have great appeal to young girls and boys. Courses in environmental problems, psychology, oceanography, medical science, operations research, health statistics, and so forth, could be offered, perhaps as mini-courses, to stimulate interest in the applications of mathematics and science to real world problems. The teaching of such courses might be greatly enhanced by visits with scientists in their laboratories.

Teachers of mathematics and science at all levels should examine their own classroom behaviors to see how they can foster greater interest in mathematics among girls. Teachers should also examine their textbooks for sexism, as well as their own casual remarks in class. They might make an effort to include a unit on the history of mathematics and science which includes mention of the contributions of women, as well as men.

Mathematics and science teachers could join forces with counselors to create special career counseling programs for girls. Girls may need special counseling to help them see how important mathematics and science courses are as background for a wide variety of careers. Women scientists and other professionals might visit the school to talk with girls about their careers. Teachers and counselors might make special efforts to encourage girls and their parents to think about educational and career opportunities in fields such as engineering, statistics, accounting, and so forth.

Career education is an important need for all of today's youth. Effective career education programs need not be costly. Many communities have access to persons with varied skills and interests who might be willing to donate time for such a worthwhile cause. Some large companies, labor unions, professional and educational organizations, and other community organizations might be quite willing to sponsor certain aspects of such a program. Schools which devise truly innovative programs might be eligible for federal funds.

Mathematics and science are exciting career fields. Women, however, need help in learning that jobs with intellectual and social challenges in science and mathematics exist for them, as well as for men.

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GETTING FROM HERE TO THERE

Audiotape Script*

Characters

Mary, a student

Nancy, a student

John, a student

Teena Jackson, a computer programmer

Ann Goldman, a Ph.D. in statistics

Mr. Riley, a sixth grade teacher

Mrs. Conte, a high school home economics teacher

. . . .

ANNOUNCER: This tape is one of a series developed as part of the Teacher Education and Mathematics project at Queens College of the City University of New York. These tapes are designed for use in classes or as part of discussion groups.

This tape, Getting from Here to There, lets us hear how three sixth grade students have handled their class assignment. They needed to learn about career opportunities and particularly about careers in mathematics. Let's listen as they work in a committee to organize their assignment.

. . . .

NANCY: Well, the three of us are supposed to do a class presentation on careers in math.

MARY: Careers for men and women.

JOHN: Yeah, it's going to be hard because there are so many careers.

MARY: I know--accountants, bookkeepers, engineers, math teachers. There are so many different jobs.

NANCY: What if we just present a few different jobs--but describe them in detail?

JOHN: I like that. It makes more sense than getting a long list.

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*Written by Sheila Crowell, Elenor Rubin Denker, and Ellen Kolba.

MARY: Do you think we could find people with careers in math to talk to them about their jobs? It would be more fun than looking it up in the library.

NANCY: That's a great idea, Mary.

JOHN: Hey, I just had a brainstorm! Do you think we could invite them here for a panel--like on television?

NANCY: Oh, I don't know if Mr. Riley would like it.

MARY: I do, I do! We would be the best group. Let's ask him. Mr. Riley, we have an idea.

MR. RILEY: Yes, Mary?

MARY: John suggested we invite three people who actually have careers in math to come to speak to the class--like on a panel.

MR. RILEY: I think that's a fine idea.

NANCY: I think that math is usually considered a man's thing. What if we invited only women, just to prove that women can be good in math, too?

JOHN: Hey, my next-door neighbor works with computers--maybe she would come to talk to us.

MR. RILEY: I have a friend who has her Ph.D. in math and works for the Public Health Department. I bet she'd like to be part of your panel.

MARY: My mother teaches home economics in the high school, and she keeps telling me how much math she has to know. That's why I've always really studied math. Could we invite her?

MR. RILEY: I think that would be fun. Sounds like you three are doing fine. Let me know what other plans you make.

JOHN: (whispering) I think he likes it.

NANCY: I'm so excited! Okay--what do we have to do now?

MARY: Well, I think we should write letters to invite them.

JOHN: Good idea. We should also know a little about their careers before they come.

NANCY: Maybe we should each read about one of the three careers and prepare some questions.

JOHN: Then we can ask the questions in front of the class.

MARY: Great!

(FADE OUT)

ANNOUNCER: Two weeks later, in front of the class.

MARY: Nancy and John I were on the Math Careers Committee. We decided to invite three professional people who use math to talk to all of us about their careers. We also decided to invite just women, since most people think that only men use math. John will introduce each of them.

JOHN: First, I'd like to introduce Miss Teena Jackson, who is a computer programmer. Next is Dr. Ann Goldman, who isn't a medical doctor--she has a Ph.D. in statistics and works at the Public Health Department. And third is Mrs. Helen Conte, who teaches home economics in our high school. You may also recognize Mrs. Conte as Mary's mother.

NANCY: We'd like to start by asking Miss Jackson some questions. What do you like best about your job?

MISS JACKSON: There are so many things--I hardly know where to begin. I guess the most important thing to me is the feeling of independence I have. I can work anywhere and for almost any kind of organization--business, research labs, airlines, government, universities--they all use computers and they all need programmers.

NANCY: When did you decide to become a computer programmer?

MISS JACKSON: Well, to tell the truth, I kind of fell into it. When I left high school, I couldn't afford to go to college right away. I needed to make money, and becoming a keypunch operator seemed to be the best way.

NANCY: Why did you choose that?

MISS JACKSON: Well, first of all, it didn't take long to train for--only six months. Secondly, I was able to get a student loan. And I guess I liked the idea of working in a young field--there'd be more chances for me, I thought. When I got my first job, it paid so well, I felt pretty good about the decisions I'd made.

NANCY: What's the difference between a keypunch operator and a computer programmer?

MISS JACKSON: Keypunch operators are like typists. They feed the information into the computer, but they don't decide what information the computer should have. The person who does that is the programmer.

NANCY: How did you become a programmer, then?

MISS JACKSON: My supervisor, Mr. Foley, at the bank saw that I really liked working with computers. I guess I always asked a lot of questions about <u>why</u> I was doing certain things. And once or twice I asked to take special courses in how to fix some of the machines. So he suggested that I take night courses in programming at our local community college.

NANCY: Did you have to learn much new math?

MISS JACKSON: Some, and I had to learn to write in computer language.

NANCY: I didn't know they could talk.

MISS JACKSON: (laughing) They can't, but they have to be supplied with information in a certain way--we call that a language.

NANCY: What's it like?

MISS JACKSON: It's made up of symbols--like the ones used in math.

NANCY: Were you a good math student while you were in school?

MISS JACKSON: I was pretty good. I wasn't any Einstein, though. I just always liked fooling around with numbers. I guess that's why I felt I could handle the technical side of programming.

NANCY: Thank you, Miss Jackson. I'm sure the other students will have more questions for you after the rest of the panel speaks.

MARY: Dr. Goldman, how did you decide to be a statistician?

DR. GOLDMAN: I think I was probably luckier than a lot of girls. I loved math, and I knew I was good at it. I always wanted to do something in math when I grew up.

MARY: Did your teachers encourage you?

DR. GOLDMAN: In grade school they did, but when I got to high school things were different. One guidance counselor didn't think there was any point in my taking an honors math course. So in my school, it worked out that there were mostly boys in honors math.

MARY: But doesn't that close off a lot of opportunities for girls later on?

DR. GOLDMAN: Of course it does. My math teachers encouraged me, though. And I'm very grateful they did. When you stop to think about it, most jobs require some math skills. If a woman wants to advance in any field, she needs to feel sure of herself in handling figures.

MARY: How did you happen to get into your particular field?

DR. GOLDMAN: One of my summer jobs was taking opinion polls during an election campaign. I remember how excited I was when I saw that my predictions about which candidates would carry which precincts came true.

MARY: It must be like magic.

DR. GOLDMAN: Yes, even now I think that's the part of the job that I enjoy the most.

MARY: You work for the State Department of Public Health. What do you do there?

DR. GOLDMAN: Well, actually, I chart the contagious diseases in the state to see if we have the makings of an epidemic on our hands. My department also keeps track of population trends so that we can make recommendations about where new medical facilities should be located.

MARY: Do you use computers in your work?

DR. GOLDMAN: Oh, yes. Computers, and computer programmers like Miss Jackson are indispensable in our work.

MISS JACKSON: For example, a computer could be programmed to tell you instantly how the population in a neighborhood had changed in the last five years.

MARY: (interested) How would a computer do that?

MISS JACKSON: First you would have to store the right kind of information in it--birth and death records, hospital records, school registration--data like that. Then you could ask the computer questions like "How many families with school-age children use the emergency room?" or "How many older people on Social Security live in the neighborhood?"

DR. GOLDMAN: And when we get the answers we also get an idea of how much an area needs a bike safety program or a meals-on-wheels program for the elderly or whether a medical facility is underutilized or overutilized.

MARY: Thank you, Dr. Goldman, and you, too, Miss Jackson. We didn't realize you two could really work together.

JOHN: Mrs. Conte, how does a home economist use math?

MRS. CONTE: Well, John, there are many ways. For example, to work in food science means to understand calories and amounts of protein or carbohydrates. You have to be able to measure food and develop diets and menus. Nowadays, it's especially important to understand the metric system because food is weighed in grams.

JOHN: How did you get interested in the field?

MRS. CONTE: Well, that's a long story. Before I got married, I worked for General Mills in their kitchen doing some experiments. I realized that I wanted to know more about the area. So when my children were growing up, I went back to school and studied home economics. Then when Mary started first grade, I took the job at the high school, teaching.

JOHN: Are there other ways you use math, Mrs. Conte?

MRS. CONTE: Oh, yes, many. For example, one of the major areas is clothing and textiles. You need to understand the different blends of cloth, which are usually explained by percents. You have to know how to read graphs and charts so you can understand information the government provides in this area.

JOHN: Did you have to learn about money?

MRS. CONTE: Yes, John. And that's an excellent example of how math is important to my work. I teach about budgeting family money and also about how to be a good consumer. Certainly, to be a good home economist or a good homemaker, you have to understand math.

MR. RILEY: Thank you, Mrs. Conte, Dr. Goldman, and Miss Jackson. We enjoyed your talks. Please have some of the cookies and juice we made for you--I'm sure there will be many more questions.

. . . .

ANNOUNCER: This tape was produced by the Teacher Education and Mathematics project, Queens College of the City University of New York, under a grant from the U.S. Department of Health, Education and Welfare, Office of Education, under the auspices of the Women's Educational Equity Act. Opinions expressed herein do not necessarily reflect the position or policy of the Office of Education or the Department, and no official endorsement should be inferred.

61

TEAM

WOMEN, MATHEMATICS, AND CAREERS

II

STUDENT MATERIALS

STARTLING STATEMENTS*

1. How many women are among the 1,250 living members of the National Academy of Sciences?
2. Women are 52% of the U.S. population. What percentage are they of the U.S. engineering force?
3. What is the average yearly salary offer to a student with a 1980 bachelor's degree in petroleum engineering?
4. What is the average yearly salary offer to a student with a bachelor's degree in the humanities?
5. For a woman to make more than the median income of a man with 8 years of elementary school, how much education must she have?
6. Between 1950 and 1979, the number of male workers in the labor force increased by 35%. What was the corresponding figure for women?
7. What percentage of secretarial jobs are held by women?
8. What percentage of people working in apprenticeships in California in 1980 were women?
9. What percentage of working lawyers are women?
10. What percentage of employed doctors are women?
11. What percentage of employed electricians are women?
12. What percentage of employed architects are women?
13. Women are 98% of employed dental assistants; what percentage of practicing dentists are women?
14. What percentage of bachelor's degrees in engineering were awarded to women in 1977?
15. Women are 51% of secondary school teachers; what percentage are they of secondary school principals?
16. What percentage of school superintendents in California are women?
17. What percentage of college or university presidents are women?
18. What percentage of the world's income is received by women?
19. What percentage of the world's property is owned by women?

ANSWERS TO STARTLING STATEMENTS

(Letter in parentheses indicates source)

1. 32 (2.6% of current membership) (d)
2. 2.7% (f)
3. $23,832 for men; $23,928 for women (e)
4. $12,504 for women; $13,452 for men (e)
5. 4 or more years of college (a)
6. 136% (c)
7. 99.3% (c)
8. 4.6% (b)
9. 12.8% (c)
10. 10.7% (c)
11. 1.3% (c)
12. 6% (c)
13. 4.6% (c)
14. 4.5% (h)
15. 1.7% (i)
16. 1% (g)
17. 6% (1)
18. 10% (j)
19. 1% (k)

SOURCES

(a) A Statistical Portrait of Women in the United States: 1978, Table 9-3, U.S. Department of Commerce, Bureau of the Census, Current Population Reports, Special Studies Series P-23, No. 100, issued February 1980.

(b) Active Apprentices and New Registrations and Reinstatements, June 30, 1980, Table 9, State of California Department of Industrial Relations, Division of Apprenticeship Standards.

(c) Employment and Unemployment Trends During 1979, Special Labor Force Report 234, U.S. Department of Labor, Bureau of Labor Statistics.

(d) Increasing the Participation of Women in Scientific Research: Summary of Conference Proceedings, October 1977, and Research Study Report, March 1978, National Science Foundation.

(e) Manpower Comments, Vol. 17, No. 7, September 1980, Scientific Manpower Commission.

(f) Occupational Outlook Quarterly, Summer 1980, U.S. Department of Labor, Bureau of Labor Statistics.

(g) "Salaries of Superintendents and Certain Other Administrative Offices in Public Schools of California for the Year 1978-1979," a report from the California State Department of Education.

(h) Science Education Databook, Table V-8, National Science Foundation.

(i) Abramowitz, S., and E. Tenenbaum, High School '77: Survey of Public Secondary School Principals, December 1978, National Institute of Education.

(j) San Francisco Sunday Examiner & Chronicle, July 13, 1980, Scene, page 3, "Unequal Chances for Education."

(k) Convention on the Elimination of All Forms of Discrimination Against Women, adopted by UN General Assembly, as reported in San Francisco Sunday Examiner & Chronicle, July 13, 1980, "World's Women Get Mere Sliver of Riches."

(1) Comment, March 1978, American Council on Education, Washington, D.C.

INTERVIEWING TIPS

Your purpose in conducting this interview is to gain understanding of the role of math in careers by finding out how one woman uses math in her work. When you and the other members of the class bring in your interview information, the group can share ideas and get a broader sense of math's usefulness.

In carrying out your interview, keep the following in mind:

- Give your interviewee your full attention by making sure you have read over your questions in advance.
- Pick a quiet place for talking--one where you're not likely to be interrupted.
- Make yourself and the person you're talking to comfortable (maybe have a cup of coffee together; adjust the lights or the windows to increase comfort).
- Be prepared to make some notes but do not write everything said. Rather, plan to make additional notes to complete the interview form right after you've finished talking.
- Explain that the purpose of your interview is for you to learn about careers. (Show the interviewee your letter of introduction and give her a copy of it.)
- Establish the kind of atmosphere for your interview that is relaxed, unpressured, and at the same time purposeful and pointed. (It's not a social chat.)
- Be open to what the interviewee is saying and try to understand the meaning of her statements from her point of view. (Try not to assume that you understand how an event was experienced, but ask how your interviewee felt about an important event.)
- Be sensitive to the interviewee's feelings so that you don't push for added information in an area that she doesn't want to discuss. (Remember: your interviewee always has the option of not answering a question, so you may ask a question.)
- Communicate your interest by showing your acceptance of what your interviewee is saying. (Avoid making judgments about what you're hearing.)
- Convey your appreciation of her time and effort in helping you to learn something new.

PROFILE OF A CAREER WOMAN

The first part of this assignment is like detective work: Find a professional woman with an established career. She should be over 30, so that she will have been working long enough to have some answers to the questions. She should use math in her work--but since many people do, that shouldn't be a problem.

Once you've found a woman, find out if she is willing to be interviewed. Explain that you are taking a course, and that you're interested in people's attitudes toward math. Explain that you'd like to know how she decided on her career and what the key influences were. Also say that you'd like to discuss in general the experiences of a "career woman."

Remember, although the questions may seem innocent, they are really very personal. Be respectful and understanding. If someone doesn't feel comfortable answering a question or talking about some topic, don't be pushy. All the information you obtain is confidential. The women you interview should know this. You are bound to maintain this confidentiality.

It's not a good idea to interview a member of your family.

NAME OF INTERVIEWEE (optional)

DATE

NAME OF INTERVIEWER

TIME STARTED

A. BACKGROUND

1. How old are you? (Should be over 30.)

2. Are you married?

3. What is your ethnic background?

4. What has your educational experience been? (Probes: Which schools, majors, minors, degree(s), etc?)

5. Is this the field you started in?

6. I not, what were your last two jobs?

B. MATH HISTORY

7. How good are you at math?

8. Has your math skill always been like that (like answer to No. 7 above)?

9. Do you like math? Why?

B. MATH HISTORY (continued)

10. Do you think math is important for work? Why?

11. Do you think women should study math? Why?

C. PRESENT JOB

12. What work are you doing now? (Probes: What is the title? What are the main activities, responsibilities?)

13. What training, skills, or education was required? (Probes: In school? On the job? In special programs?)

14. In what ways do you use math in your present job?

15. Do you have a long-term career goal in mind?

16. Do you enjoy your job?

17. Would you recommend this career to other women?

18. Have you at some point in your career felt discriminated against because you're a woman? (Probes: In school, at work, because of salary, in a professional or business association?)

19. Do you see any drawbacks to a woman's having a career in your field?

D. CAREER DECISIONS

20. What people influenced your career decisions? (Probes: Their sex, their relationship to you?) What factors other than people influenced you?

21. Were there any other careers that you considered?

22. If so, what were the key decision points?

E. PRESENT FAMILY (When asking questions about husband, keep marital status in mind.)

23. How does (did) your husband feel about your working?

24. Has your husband been influential in your career decisions?

25. What is your husband's occupation?

26. How does your financial contribution affect your attitude toward your job? How does it affect your husband's attitude?

27. How flexible is your work schedule?

28. How have you arranged for child care while you work? (Ask only if relevant.)

F. OVERVIEW

In retrospect, would you ·ter any of the events which have led you to this point in time? Why?

TIME ENDED ______________________

70

Math and Medical Careers

Behavior: A physician prescribes medication.

As a physician you are licensed to prescribe appropriate medication for your patients. You must calculate the dosage accurately to ensure that the medicine does what it is supposed to do. The dosage is based on the weight and/or age of your patient.

1. Your asthma patient, I. M. Ill, must take theophylline. You must know the following:

   a. Theophylline is dispensed in 100 mg tablets.

   b. The dosage is 5 mg per kg of body weight, every six hours. A doctor writes "q6h" for "every six hours."

   c. I. M. Ill weighs 20 kg.

   Write a prescription for a one-month supply of tablets so that it can be taken to the pharmacy to be filled.

Telephone ____________

Doctor ____________

Address ____________

Name ____________ AGE ____

Address ____________ DATE ____

GENERIC EQUIVALENT MAY BE SUBSTITUTED

℞ LABEL CONTENTS

Refill ___ Dr. ____________

____

2. Write a prescription for children's aspirin, given $1\frac{1}{4}$ grains per tablet.

Dosage: 1 grain per year of age (up to age 10), every 4 hours.

Telephone ____________

Doctor ____________

Address ____________

Name ____________ AGE ____

Address ____________ DATE ____

GENERIC EQUIVALENT MAY BE SUBSTITUTED

℞ LABEL CONTENTS

Refill ___ Dr. ____________

____

TEACHING MATHEMATICS IN CAREERS

1. Select a career or field and one or more math behaviors appropriate for the age level of the pupils with whom you are working. See the list on the following pages for examples of math behaviors exhibited in careers. Your own investigation of a career should reveal other math behaviors as well.

2. Develop a plan for a lesson that incorporates these behaviors. It may be a lesson for a small group of children or for a whole class.

   a. The lesson should include a brief introduction to the career or field. Suggest that pupils interested in a particular field consult the librarian for further reading.

   b. Make it clear that each career is open to both men and women. Be sure to neutralize any sex-role stereotypes (such as the belief that "nurses are females and physicians are males").

3. Develop specific behavioral objectives and describe the activities you will use to help children attain these objectives.

4. Teach the lesson, using the plan developed above.

5. After you have taught the lesson, submit answers to the following questions:

   a. How successful were you in reaching your goals?

   b. Are there any modifications you would make in your lesson before teaching it again?

   c. If so, what are these modifications?

EXAMPLES OF MATHEMATICAL BEHAVIORS IN CAREERS

ARCHITECT

An architect reads floor plans.

An architect construct scale drawings.

BENEFITS OFFICER

A benefits officer records the value of fringe benefits for employees.

A benefits officer reports insurance premiums.

DEMOGRAPHER

A demographer charts the growth of a community.

A demographer measures population density.

INTERIOR DESIGNER

An interior designer takes room measurements.

An interior designer makes floor plans to scale.

LIBRARIAN

A librarian uses the Dewey decimal system to sort books.

A librarian calculates fines for overdue books.

MEDICAL PERSON (e.g., physician, nurse, paramedic)

A medical person records and interprets fluid intake and output.

A physician prescribes medication.

METEOROLOGIST

A meteorologist reads weather recording instruments (e.g., thermometer, barometer).

A meteorologist determines high and low temperatures for the day.

A meteorologist records data on graphs.

A meteorologist measures precipitation.

PAINTER

A painter calculates the cost of materials for a job.

A painter estimates the quantities of materials needed for a job.

PHOTOGRAPHER

A photographer determines appropriate f-stops and shutter speeds for taking pictures.

A photographer computes the cost of camera equipment and supplies.

A photographer measures flash to subject distance and camera to subject distance.

A photographer reads light meters.

PILOT

A pilot determines runway distances and locations by referring to points on the magnetic compass.

A pilot reads the cockpit display instruments (the altimeter gives height of the plane, the attitude indicator gives angle of plane in relation to the horizon, etc.).

QUALITY CONTROL ENGINEER

A quality control engineer tests sample products.

A quality control engineer statistically determines the acceptability or unacceptability of products.

REAL ESTATE AGENT

A real estate agent computes the commission she or he earns for selling a house.

A real estate agent measures the length of a wall in a house.

A real estate agent uses the seller's heating bills over one year to compute the average monthly heating cost of a house.

A real estate agent uses a floor plan to compute the area of the floor of a room.

SECRETARY

A secretary lists appointments by time.

A secretary estimates the number of words on a typewritten page.

STOCKBROKER

A stockbroker calculates purchase costs and selling prices for stock transactions.

A stockbroker calculates commissions for stock transactions.

A stockbroker predicts market trends.

A stockbroker reads balance sheets of corporations.