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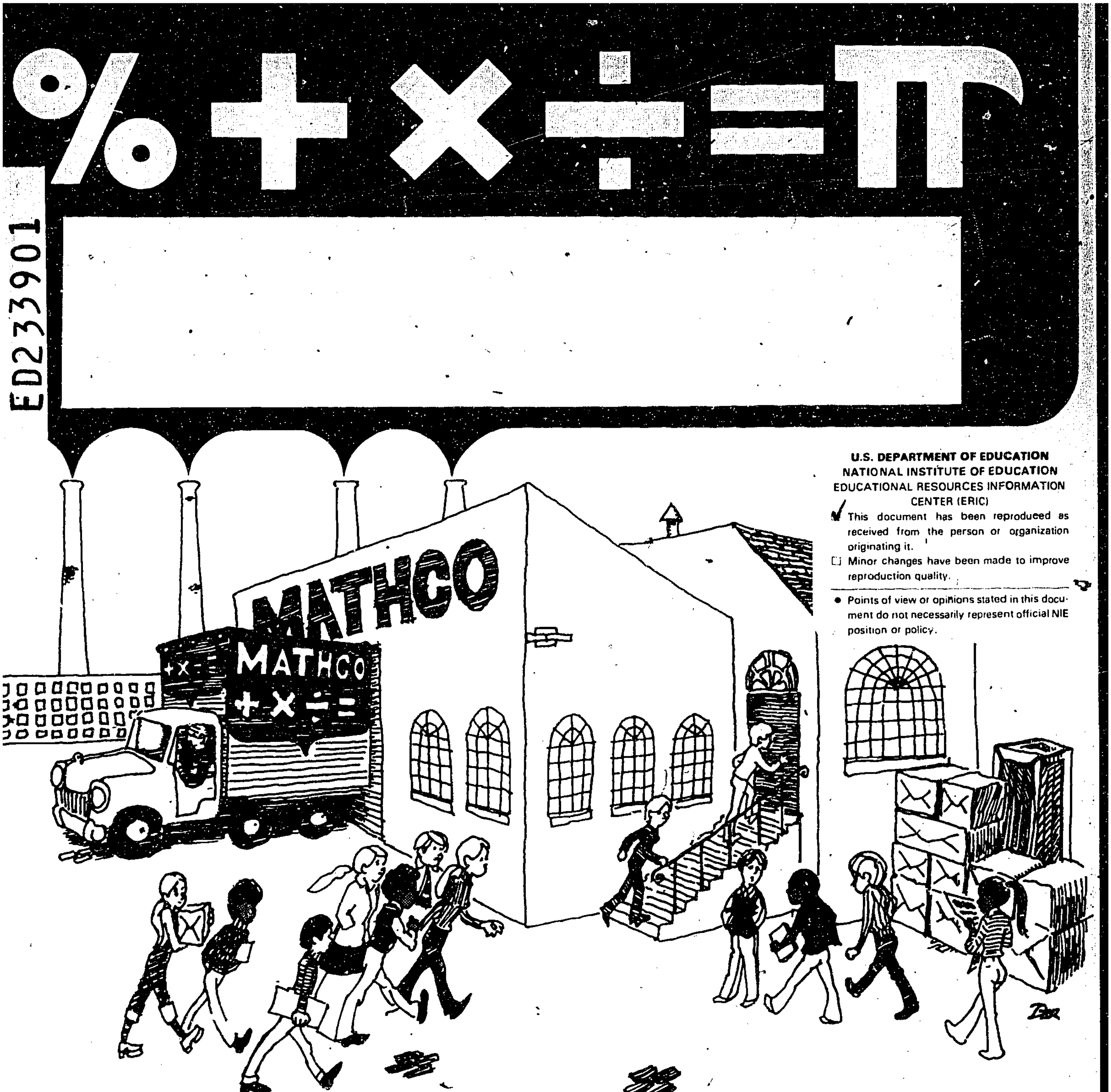
ABSTRACT

MATHCO is a motivating series of audiovisual and print materials designed to overcome the negative effects of sex bias and stereotyping on the attitudes, interests, and aspirations of girls toward mathematics and mathematics-related careers. The materials teach mathematics skills, demonstrate relationships between mathematics and other subjects, and provide exposure to mathematics-related careers. They are useful for boys as well as girls at the pre- and early-adolescent stage; they are both multiethnic and nonsexist in text and illustrations. Following a summary of materials, program objectives, how to use MATHCO, and a sample time line, background information on sexism in schools, sex stereotyping in mathematics textbooks, teacher behaviors, and other factors affecting the mathematics attainment of females is given. Mathematics anxiety and avoidance is discussed, as are sex-related differences in achievement and performance. What teachers can do is noted. Module 1 is then developed, with an overview, an audiovisual script, a questionnaire with a prediction guide, and suggestions for displaying wall charts. (MNS)



MATHCO

University of Oklahoma
Southwest Center for Human Relations Studies
Norman, Oklahoma

Women's Educational Equity Act Program
U.S. Department of Education

MATHCO TEACHER'S GUIDE
MODULE 1
Math and Careers

Carole Hall Hardeman, Ph.D., Project Director

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Southwest Center for Human Relations Studies
University of Oklahoma

WOMEN'S EDUCATIONAL EQUITY ACT PROGRAM
U.S. DEPARTMENT OF EDUCATION

T. H. Bell, Secretary

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The curriculum developers, whose imaginative and creative activities are the core of MATHCO.

The mathematics teachers, schools systems, and hundreds of students throughout the United States who assisted us by testing and evaluating MATHCO materials.

The MATHCO National Review Board, consisting of a cadre of professionals of the highest caliber, without whom we could never have developed this curriculum.

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We dedicate this curriculum to the University of Oklahoma Regent's Professor, Dr. Glenn R. Snider, who created the Southwest Center for Human Relations Studies, based upon the premise that educational equality is essential in a democratic society.

Carole Hall Hardeman, Ph.D.
Project Director, MATHCO

STATEMENT OF ENDORSEMENT

The National Review Board has carefully examined and heartily endorses MATHCO as a high-quality and motivating series of audiovisual and print materials designed to overcome the negative effects of sex bias and stereotyping on the attitudes, interests, and aspirations of girls toward mathematics and math-related careers.

These materials have been designed to teach math skills, demonstrate interrelationships between math and other subjects, and provide exposure to a wide variety of math-related careers. These informational and skill-building activities are valuable for boys as well as girls and are both multiethnic and nonsexist in text and illustrations.

We believe that the use of these materials with pre- and early-adolescent students can help to alleviate the math anxiety and avoidance that are characteristic of girls at these ages, resulting in their disproportionately small numbers in high-level mathematics courses and math-related careers.

Over the past two years, the Board has provided advice and assistance to the MATHCO staff as it has conceived, developed, and validated these materials. We are confident that our enthusiasm for this project will be shared by educators throughout the country.

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CONTENTS

PART A

INTRODUCTION TO MATHCO:

A PROGRAM TO ENHANCE STUDENTS' UNDERSTANDING OF INTERDISCIPLINARY USES OF MATH IN CAREER CHOICES

DEVELOPMENT OF MATHCO

MATHCO materials were developed at the Southwest Center for Human Relations Studies, University of Oklahoma, through a grant from the U.S. Department of Education, Women's Educational Equity Act Program. The staff for the development of the program were:

Dr. Carole Hall Hardeman, Project Director

Barbara T. Laquer, Project Specialist

Kristin Y. Carl, Editorial Assistant

Sonya J. Cohlmia, Secretary/Typist

The staff used the services of individuals currently working in middle schools or in higher education to develop MATHCO materials. It was felt that these people were most familiar with the special needs and concerns of middle school and junior high school youngsters. These consultants were:

Vivian V. Coulter, Research and Curriculum Development Consultant

Jean Hubinger, Research and Curriculum Developer

Jennetta K. James, Research and Curriculum Developer and Revisions Consultant

Gary M. Kramer, Research and Curriculum Developer and Audiovisual Artist

Linda Williams Kramer, Research and Curriculum Developer

Margaret A. Smith, Visuals Director

Cheryl Sweetser, Research and Curriculum Developer

A National Review Board, comprising individuals from across the nation, was formed to evaluate the project's progress at all stages and to review all MATHCO materials. Their expertise helped to ensure a finished product appropriate for use nationwide. The names of the members of the National Review Board can be found on page vi of this module.

During the initial development period, MATHCO materials were tried out in pilot projects in six Oklahoma school districts:

Teacher	School	Administrator
Josephine Adamson	Crooked Oak Public Schools	Jerry Miller, Principal
Carolyn Stuckey	Little Axe Public Schools	Larry Garner, Principal
Orville M. Roper	Millwood Public Schools	Lynn Good, Superintendent

Teacher	School	Administrator
Jennetta K. James	Moore Public Schools	Estelle Bewley, Math Consultant
Diane M. Lewis	Norman Public Schools	Jacquelyn Lovett, Math Consultant
Edna Barnes	Oklahoma City Public Schools	John M. Lockhart, Math Consultant

The cooperating middle school math teachers, curriculum advisors, and students from these districts provided the staff with feedback, which was taken account of as materials were further developed, revised, and refined.

After MATHCO materials had been produced and packaged in near-final form, they were validated using large groups of middle school youngsters from across the nation, representing a diversity of racial, cultural, and socioeconomic strata. These validating schools were:

Teacher	School	Administrator
John Watkins	Woodlawn Middle School Baltimore, Maryland	Elliott Y. Merenbloom, Principal
John Bunker	Frank V. Thompson Middle School Boston, Massachusetts	Gerald Hill, Principal
Lucy Cookson Betty Kantrowitz	The Edward Devotion School Brookline, Massachusetts	Gerald S. Kaplan, Principal
Theresa Johnson	Myra Bradwell Elementary School Chicago, Illinois	Valcar Bowman, Principal
Shirley Cousins	Jackson Junior High School Houston, Texas	Betty C. Hall, Instruction Specialist, Math
Treva Bowman Camilla Heid	Indianapolis Public School #61 Indianapolis, Indiana	Marge Jackson, Math Consultant
Ernest Arnold	Martin Luther King Junior High School Kansas City, Missouri	Dr. Jack Casner, Director of Curriculum
Robert L. Lundblad	Brownsville Junior High School Miami, Florida	Dr. Walter Oden, Principal

Teacher	School	Administrator
Leonard Buie	Madison Junior High School Oakland, California	Fannie Dawson, Principal
Sherry D. Wells	Fremont Junior High School Portland, Oregon	Iris Collins, Secondary Math Coordinator
June Moore	Allison Junior High School Wichita, Kansas	Sam Spaght, Director, Office of Staff Development

The evaluations of the cooperating teachers and students from the above schools entered into the decision-making process as MATHCO materials were put into final form. All materials were then turned in to the U.S. Office of Education for dissemination.

SUMMARY OF MATERIALS

MATHCO CAREER WALL CHARTS

Six colorful 18" x 24" career wall charts provide a unique focal point for the math classroom. Various careers are highlighted and described at a level appropriate for middle school youngsters, who are just beginning to develop some ideas regarding potential occupations. The main theme, emphasized repeatedly on these charts, is that some level of mathematical involvement and skill is needed in each of these many and varied careers.

FIVE INTERDISCIPLINARY MODULES

MATHCO provides five interdisciplinary modules that relate mathematics to other middle school subject matter areas and to future career possibilities

- Module 1: Math and Careers
- Module 2: Patterns, Sequences, and Equations (Math and Language/ Fine Arts)
- Module 3: Math in Your World (Math and Social Sciences)
- Module 4: Close Encounters with Everyday Math (Math and Practical Arts/Life)
- Module 5: Math and Science

The teacher may present these modules in any desired order. However, the MATHCO developers recommend that the Math and Careers module be covered first, as this module best sets the stage for the exploration of the topics of the other four modules.

Each MATHCO module consists of the following elements:

1. A motivational FILMSTRIP PRESENTATION, which should be viewed by students prior to their exploring the accompanying module activities.

2. TEACHER ACTIVITY SHEETS for each of the activities contained in the module. These sheets provide the teacher with the following information:

    - an overview of the activity
    - a listing of the math skills that will be used in the activity
    - an approximation of the amount of time that should be set aside to complete the activity
    - the objectives of the activity

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- a list of materials that will be needed

- vocabulary words and definitions that the teacher may wish to review with students

- a self-concept builder reflecting accepted middle school philosophy regarding transadolescent development

- comprehensive teacher directions for successful activity implementation

- a list of occupations that use skills similar to those applied in the activity; this list provides the teacher with information useful in leading the classroom discussion that follows each MATHCO activity

- some suggested independent activities for those students who wish further to pursue topics related to the in-class activity

3. STUDENT ACTIVITY SHEETS* for each of the activities contained in the module. Similar to the Teacher Activity Sheets, they provide students with the following information regarding each activity:

   - an overview of the activity

   - a listing of those math skills that they will need to remember

   - a list of materials that the class as a whole will need, as well as a list of those materials that each student will need

   - a list of vocabulary words and definitions

   - an explanation of what students will be able to do after completing the activity

   - directions for completing the activity

   - space to record (1) occupations that are related to the activity and (2) school subjects that will lead to the achievement of each of these occupational goals; students fill in this section following classroom discussion

   This exercise helps students to realize that they really can aspire to any career that interests them. It also makes them aware that certain high school subjects (most particularly mathematics) will help them achieve their career goals. In

*These are also available under separate cover for each module, so that students may have their own books.

addition, students will come to realize that well-trained women and men can do the same jobs with equal success.

- an "Exploring on Your Own" section, which suggests some independent activities

4. INFORMATION SHEETS AND WORKSHEETS are included with many of the MATHCO module activities. The Information Sheets provide students with relevant background information for certain activities or witl statistics and other data necessary to do some of the activities; the Worksheets provide a vehicle for structuring many of the activ ities.

MATHCO TEACHER'S GUIDES--MODULES 1 THROUGH 5

The MATHCO Teacher's Guides provide a complete package of all MATHCO materi for the teacher's planning for the implementation of MATHCO in conjunction with the school's regular math curriculum.

PROGRAM OBJECTIVES

1. To provide up-to-date, validated information on the universal and interdisciplinary nature of math and its relationship to careers.

2. To refute historical attitudes and myths that mathematics is not a discipline to be excelled in by women and girls.

3. To promote the acceptance of competent persons, regardless of sex, in light of our changing society and the changing relationships of men and women.

4. To provide adaptable materials that are appropriate for use both by math teachers and by teachers of other disciplines.

5. To increase teachers' awareness of the tremendous influence they have on young women's developing attitudes about mathematics.

6. To provide current research-based information about careers that women have traditionally not been encouraged to enter or have been reluctant to enter.

7. To encourage young women to pursue the study of mathematics in high school by taking nonrequired math courses.

Many students go through school never understanding or appreciating the life-oriented and interdisciplinary nature of mathematics. MATHCO's aim is to help both female and male middle school youngsters overcome any fears they might have of studying mathematics before these students enter high school. The philosophy of the program is based upon the concept of exploration. By leading students to discover the relationship of mathematics to both their everyday world and their future vocations, MATHCO aims to discourage math avoidance and to encourage students to select careers based upon their own unique interests and abilities, rather than basing such decisions on outdated notions of what are "appropriate" occupations according to traditional sex-role stereotypes.

The success of the MATHCO program depends to a great extent upon the sensitivity and enthusiasm of the teachers. This book provides teachers with some background information on factors that tend to encourage math avoidance, especially among girls (see Part B of this module). It is hoped that as teachers become increasingly aware of the tremendous influence they have on students' attitudes regarding mathematics, they will use MATHCO--in conjunction with their schools' regular math curriculum--to provide a nonbiased approach to mathematics education.

It has been shown that a teacher's encouragement can often influence a young person to choose elective mathematics courses in high school. As more girls begin selecting such courses, the schools will begin better to fulfill their promise of equal educational and occupational opportunity for all.

HOW TO USE MATHCO

MATHCO has been designed to provide maximum flexibility for teachers usi
the materials. Its ultimate purpose is not to teach mathematical skills
per se, but to utilize those skills already learned and being learned by
middle school youngsters. More than providing a mere review of skills,
MATHCO activities are based upon interdisciplinary, utilitarian, and att
tudinal approaches to the study of mathematics.

Module 1 provides an audiovisual presentation, a career-related activity
and MATHCO wall charts--all of which serve to introduce students to the
gram. Modules 2, 3, 4, and 5 may be covered in whatever order the teach
prefers. In making up the long-range plan for the school year, the tea
should arrange to give a module audiovisual presentation every 5 to 7 we
From the array of corresponding module activities, the teacher should se
those to be done by the students based upon their interests, needs, and
abilities.

MATHCO materials have been tested in large groups of sixth, seventh, eig
and ninth grade students and have been found to be, in general, most ef
tive with seventh and eighth grade students. However, MATHCO materials
worked very well with some sixth grade and ninth-grade student groups.

MATHCO materials may be taught by the math teacher in a variety of ways
Some teachers like to draw upon the resources of specialists in art, mu
science, etc., to help team-teach certain activities. Other math teach
prefer to develop a formalized, team-teaching approach to the MATHCO pr
working with social studies, language arts, fine arts, science, and oth
appropriate subject matter taught on a regular basis. Still other math
teachers have enjoyed working with MATHCO strictly on their own, in con
tion with the regular math curriculum. A teacher who has a self-contai
class and who teaches all subjects is in a unique position fully to uti
the interdisciplinary structure of the MATHCO materials.

Rather than being applied haphazardly, MATHCO materials work best when
ers incorporate them directly into their mathematics education program
regular and consistent basis.

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SAMPLE TIME LINE

BEGINNING OF SCHOOL YEAR

September

- Module 1 Audiovisual shown to students
- Module 1 Activity (MATHCO Wizard's Career-O-Scope) done with students
- MATHCO Wall Charts presented

October

- Module 4 Audiovisual shown to students
- Module 4 Activities selected and covered with students over a 5- to 7-week period:*

  Module 4, Number 7 - Checking the Check
  Module 4, Number 2 - Adjusting Recipes
  Module 4, Number 5 - Ordering from a Catalog
  Module 4, Number 14 - Calling Long-distance
  Module 4, Number 15 - Auto Math
  Module 4, Number 6 - Markups

November

- Module 2 Audiovisual shown to students
- Module 2 Activities selected and covered with students over a 5- to 7-week period:

  Module 2, Number 1 - Equations and Substitutions
  Module 2, Number 2 - Art/Color Theory Equations
  Module 2, Number 3 - Language Arts/Basic Grammar
  Module 2, Number 4 - Patterns and Sequences
  Module 2, Number 7 - Language Arts/Poetry
  Module 2, Number 5 - Art and Music

December

*Activities within a module need not be taught in any particular sequence (except when specifically stated within the module).

SAMPLE TIME LINE
(continued)

January	Module 2, Number 9 - Fractions/Math Module 2, Number 12 - Graphs and Fractions/ Art and Drama
	▶ Module 3 Audiovisual shown to students ▶ Module 3 Activities selected and covered with students over a 5- to 7-week period:
February	Module 3, Number 14 - Population Growth Module 3, Number 6 - Allotted Classroom Area Module 3, Number 3 - Planning a Trip Module 3, Number 7 - Scale Drawing: Dream House Module 3, Number 11 - Commercials on Television
March	▶ Module 5 Audiovisual shown to students ▶ Module 5 Activities selected and covered with student over a 5- to 7-week period: Module 5, Number 2 - Bicycle Gears Module 5, Number 7 - Silly Pulley Module 5, Number 13 - Litter Study
April	Module 5, Number 5 - Lung Capacity Module 5, Number 9 - Hygrometer
May	Module 5, Number 14 · BONUS ACTIVITY - What Do You Get When You Cross...?
June	END OF SCHOOL YEAR

PART B

BACKGROUND INFORMATION FOR MATH TEACHERS, EDUCATORS, AND OTHERS INTERESTED IN NONBIASED MATHEMATICS EDUCATION

EDUCATIONAL PRACTICES THAT DISCOURAGE YOUNG WOMEN (AND YOUNG MEN) FROM PURSUING MATHEMATICS STUDIES

SEXISM IN THE SCHOOL

The subject of sexism in the school has become, in recent years, a major concern of people interested in child development. There is a growing awareness of the possibility of damage to individual growth when children are channeled into narrow roles according to their sex. To be sure, the school is but one facet of a child's world that may contribute to stereotypical and/or sexist notions. However, because young people spend so much of their early lives in school, the messages that are transmitted to children there carry a lot of weight. Schoolchildren do not need to be taught overtly the differential status of women and men--they learn it simply through attending school and noting the school's authority structure (Levy, 1976).

In general, the school's message to girls is to be obedient, accepting, "ladylike," and dependent. The message to boys is often somewhat more complex and conflicting. Boys should be aggressive, active, achievement-oriented, and independent; at the same time, boys are told that "good pupils" are quiet, passive, and conforming.

> The long-lasting result is potentially more positive for boys, since the masculine characteristics are related to intellectual development and self-actualization, whereas the strong, consistent pressures on girls to be "feminine" and "good pupils" promote characteristics that inhibit achievement and suppress females' full development (Levy, 1976, p. 27).

One mechanism of sex-role reinforcement is segregated classes and activities. Even with classes that are not sex-segregated, certain activities and subjects are encouraged primarily for girls (cooking, sewing, English) and others for boys (woodworking, math, science, sports). It has been found that even in "free schools," where there is no conscious attempt to encourage sex typing, the policy of allowing children to follow their own interests usually has the effect of condoning the pervasive sex-typed activities that children have learned outside of school. The separation of boys and girls for seating, hanging up coats, locker assignments, choice of classroom helpers, and so on calls attention to the questionable sex distinctions and sex roles.

In the past, institutional structures in our society have demanded, reinforced, and encouraged the traditional sex-role stereotyping of "feminine" and "masculine" traits that are polar opposites--negatively correlated and very stable. The assignment of these traits is made according to gender, and the traits themselves are widely believed to be biologically determined. Both women and men become trapped in this "prison of gender." However, this prison is far from being symmetrical. In many economic, social, and psychological ways, men are advantaged by the traditional division of functions and traits between the sexes.

Perhaps society should take steps to promote the idea of a dynamic and flexible orientation to life, in which assigned gender is less relevant and individuals can express their human qualities without fear of societ retribution for violating sex-role norms. Then we would all be consider human beings first--and males and females second. Hefner, Rebecca, and Oleshansky (1975) refer to this concept as sex-role transcendence. The sex-role-transcendent person feels free to move from one situation to an other, behaving and feeling appropriately and adaptively. Therefore, h or her choice of behavior and emotional expression is not determined by rigid adherence to "appropriate" sex-related characteristics. Very few people in our society possess these transcendent characteristics, but it a concept that deserves our consideration.

Do teachers who like math and enjoy teaching it nevertheless expect the male students to do better than their female students? Females often as cribe the major influences determining extreme attitudes toward mathema to the attitudes of particular teachers, some of whom were math teacher others of whom were not. Teachers who have poor attitudes about math th selves, or inaccurate perceptions about girls' abilities in math, canno help but communicate these feelings to their students.

Teachers represent true-to-life role models for their students, and the attitudes and interests affect the students with whom they come in cont Apart from family members, female teachers often are for girls the most visible role models and the only female role models whom they get to kn personally.

Obviously, the most ideal way to learn mathematics is to do so without veloping real or imagined fears about it.

> One (of the) most important reason(s) for learning mathematics...is this: If art is the arrangement of parts into pleasing wholes, then there is no other art with the scope and power of mathematics. Inherent in mathematics is a particular quality of beauty, a sense of harmony and "thusness" immensely satisfying to the mind. This is the fascination of mathematics (Lazarus, 1974, p. 22).*

Yet within the complex social system that we call "The School," forces at work producing many people who are math-fearing and/or math-avoiding Having anxieties about mathematics and subsequently avoiding mathematic limits the range of employment opportunities for these people and makes very difficult for them to be well-informed citizens capable of making reasoned political and economic decisions. That more females than male are math-avoiding indicates a school setting that is not meeting the pr and future needs of over half our population.

It is possible that our math-teaching community is exhausted by its innovative period over the past 15 years, during which "New Math" was developed and introduced. It may, at first glance, seem rather foolhardy to expect this community to undertake yet another redesign of our elementary and secondary math curricula. Yet in light of the large scope of the problem of math anxiety and math avoidance, this undertaking may be necessary.

We as educators need to ask ourselves: What are the objectives of education as it is related to mathematics? Are we providing equal opportunity in math education both in its training and its counseling components? Are we sufficiently aware of the significant ways in which mathematical training relates to equal employment opportunities? Faced with a growing awareness that sexism indeed exists in our society, parents, teachers, and all concerned citizens and educators need to examine those "regular" practices in the school that have been taken for granted but that are contributing to (if not causing) such undesirable outcomes as math anxiety and math avoidance.

At present, most educators do not seem to be worrying too much about math anxiety and math avoidance, at least not at the public school level. It is possible that educators do not perceive that a problem exists, or perhaps if the problem is perceived, it is viewed as a particularly "female" phenomenon, and hence not quite as important as other issues. In the past, reading has been recognized as a subject in which boys do not generally excel. Addition of extra reading teachers, reading labs, and other specialized intervention programs has evolved nationwide over the years to address this problem. This response is certainly in marked contrast to the minimal or nonexistent attempt to provide help for girls in mathematics (the subject in which they are thought not to excel).

The school is an effective instrument of social control. Created not to change society, but to maintain it, the school tends not to improve dramatically the "life chances" of girls, minority groups, or the poor. Rather, the school tends to perpetuate the existence of dominant social groups (Levy, 1976). Because the school is a microcosm of society itself, many educational philosophers and historians agree that the school tends to maintain social and economic inequalities.

SEX STEREOTYPING IN MATH TEXTBOOKS

Books and textbooks serve as vehicles for presenting societal values to children. Books not only provide role models for children's present lives, but role models for the lives they presumably will lead as adults. Unfortunately, books often present obsolete and/or misguided information about society. Extensive research has documented well the existence of considerable sex stereotyping in school texts and in children's books. Although of late many steps have been taken to rewrite books in a nonstereotypical way, this is one area not covered by Title IX (on the grounds that to prescribe what must be in textbooks would abrogate the First Amendment guarantee of freedom of speech).

Research indicates that, in the past, females have often been portrayed as second-class citizens. Sometimes this discrimination has been blatant; more often, it has been quite subtle. Yet its persistent presence has denied girls the encouragement and opportunity to develop to their fullest potential.

Kepner and Koehn, at the University of Wisconsin, undertook a study to see if sexism had been eliminated from elementary mathematics textbook series published from 1971 to 1975. This review of the first, fourth, and seventh grade texts from eight popular series indicated that sexism is still very much in evidence. Some of their observations are as follows:

1. Males and females were seldom treated equally in the illustrations and problems in these texts. The number of males identified was far greater than the number of females identified in 20 of the 24 texts examined.

2. Males participated in a wide range of activities and occupations. Female roles tended to be passive, and females were portrayed as not having a wide range of interests, traits, and capabilities.

3. Few situations existed where males and females participated together in an activity except in family situations.

4. While specific mathematicians were identified only in seventh grade texts, they were all shown as male.

5. One good note: There was little evidence of sexist language. However, this finding might be attributable to the fact that the standard math text format is predominantly one of examples and computational exercises (Kepner and Koehn, 1977).*

These same researchers have updated their findings by analyzing the revised editions of these same series that have come out between 1975 and 1977. The most noticeable change observed was a greater variety of occupations shown for females in illustrations and in problems. Although not equal in number, the percentages of females and males shown were more balanced than had been the case previously. There was a small increase in females shown engaged in physically strenuous activities. However, the researchers noted that although new roles are now being assigned to females, there was little indication that male roles are also changing, nor was there an increase in joint male-female activities.

The WEAL Fund reports that a 1974 study in Lexington, Massachusetts, found that a widely used algebra text for grades eight through ten contained numerous sex stereotypes and biases. The attitude of the text seemed to

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*Reprinted from Arithmetic Teacher 24 (May 1977):379-385. Copyright 1977, National Council of Teachers of Mathematics. Used by permission.

indicate that boys work, earn high grades, paint, and push mowers, and girls spend money and diet. The report also cited another example of sexism that can affect career aspirations--a lack of sufficient and positive female role models.

Not only have textbooks been found to be offensive, but so have other instructional materials such as films, transparencies, recordings, workbooks, games, periodicals, posters, bulletin boards, and library materials. It is possible that sex stereotyping in math texts and other materials used in the school compounds what is already looming as a potentially serious problem for girls, that is, the feeling that somehow mathematics is really not for them.

TEACHER BEHAVIOR IN THE CLASSROOM

Good, Sikes, and Brophy conducted a study designed to examine the effects of teacher sex and student sex on classroom interaction. Utilizing the Brophy-Good Dyadic Coding System, the study was conducted in sixteen junior high school classrooms during 10 instructional hours. Their major finding:

> Male and female teachers behave differently in some ways, although they show similar patterns in their treatment of boys and girls. High-achieving boys, relative to other students, received the most favorable teacher treatment (Good, Sikes, and Brophy, 197[illegible] 74).

While conducting their study, these three researchers were aware of two diametrically opposed theories about teacher behavior put forth by Biddle and Heider. Biddle's role theory suggests that since teacher training and expectations of the school principal regarding the role of the teacher are quite similar, male and female teachers should "behave similarly in similar situations." Heider's balance theory predicts that a male teacher will be more likely to accept minor aggression than would a female teacher, "since males are more aggressive and presumably more comfortable with this behavior in others" (Good, Sikes, and Brophy, 1973).

Good et al. collected their data in the seventh and eighth grade classrooms of four female and four male math teachers, and four female and four male social studies teachers. This design was chosen in part because it had been suggested that student achievement and subject matter typically affect the nature of teacher-pupil classroom interaction. Although these researchers had originally felt that sex-of-teacher and sex-of-pupil variables were most important, the most potent variable that emerged from the study was that related to subject matter:

> Mathematics teachers asked more direct questions and more products questions, while social studies teachers asked more open questions and more process questions. They [social studies teachers] also obtained a higher percentage of correct and partly right answers than mathematics teachers, who obtained more wrong answers

and failures to respond. However, mathematics teachers gave a higher percentage of feedback to students' responses, while social studies teachers more often failed to provide feedback. When students misbehaved, social studies teachers were more likely to warn students, while mathematics teachers were likely to criticize them more intensively (Good, Sikes, and Brophy, 1973, p. 77).

These subject matter differences tend to emphasize some widely held stere types of the two subjects. According to Hardeman (1979), "Mathematics teachers, especially on the senior high school level, tend to treat the overall subject of mathematics as mystical, highly intellectually oriente and within the realm of understanding of only the gifted or near-gifted student." Hardeman laments, "Sadly, many junior high mathematics teacher quite often are allowed to teach mathematics although they were not mathe matics majors in college and they do not feel comfortable teaching mathematics. This uneasiness is perceived by their students."

The sex-of-student variable proved to be potent in the study by Good et a In eight out of ten significant interactions among subject matter, sex of student, and student achievement level, a definite pattern was establishe

1. Boys of all achievement levels were more active in math classes than were girls of corresponding achievement levels.

2. Boys received more of all types of interactions with teachers than girls received.

3. Boys initiated more questions and contacts with teachers, called out more answers, and guessed more frequently than girls did.

4. Teachers provided more opportunities for boys to respond.

5. Boys received more direct questions, open questions, self-reference questions, procedure, process, and product questions.

6. Boys, as a group, received both more positive and more negative feedback from teachers. When teachers did give feedback to gir it tended to be positive (Good, Sikes, and Brophy, 1973, pp. 84

The quality of classroom life as determined by teacher-pupil relationshi in the sixteen classrooms was much higher for the high-achieving boys th for the high-achieving girls and the lower-achieving girls and boys.

The study did not produce any evidence that teachers favor students of t own sex. Both female and male teachers tended to treat high-achieving b most favorably and low-achieving girls least favorably. It was suggeste by the researchers that teachers may be allowing student behavior and ro expectations to shape their own behavior.

OTHER FACTORS THAT MAY COMPOUND THE PROBLEM OF MATHEMATICS FOR FEMALES

Females Tend to Regard Their Futures Somewhat Differently Than Do Males

Of the vast array of possible occupational futures, only certain fields and jobs have been traditionally thought of as appropriate for each sex. Therefore, because sex implies such radically different futures--not only for the infant, but for his or her parents as well--sex is definitely one of the first things noticed at birth (Bart, 1974).

In a doctoral dissertation for Stanford University, Hinder questioned teenagers about their attitudes toward mathematics. He concluded:

1. Boys see more connection between math and future careers than do girls.

2. Parents and teachers emphasize math more for boys and are more unhappy with boys if they decide to stop taking math courses ("Why Susie Can't Add," 1977, p. 36).

Girls, for the most part, are evidently not fully aware of the relevance of mathematics and quantitative training to their employment futures.

The world into which young women are now emerging is very different from the conventional model, which predicts that they will marry, have children, and remain at home supported by their husbands. We are suffering from cultural lag. We cannot afford to continue to permit young women to condemn themselves to traditionally lower-paying, "female" jobs and careers, when the odds are that many of them will, of necessity, be self-supporting and/or work much of their adult lives outside the home.

There is little doubt that sexism is prevalent in American society. U.S. Department of Labor statistics show that in 1975, the national median income for men was $12,770; the figure for women was $7,531. Surprisingly, the gap widens still further for college-educated people. In this group, the men's median income was $17,891, whereas the women's was $10,861 (U.S. Department of Labor, 1970). These discrepancies were explained, for the most part, by noting the various kinds of jobs held by men and women. Our country's males work in a wide range of careers. Although in recent years women have begun to enter mechanical and technical trades and higher-paying professions, most female professionals are still clustered in a small number of lower-paying occupations.

Females must come to realize that preparation in quantitative fields opens up a large number of job possibilities not available to those persons prepared solely in the humanities. Equal Educational Opportunity means that schools must educate and provide <u>all students</u> with skills leading to a wide array of possible jobs and careers from which they can choose.

"There, there, little girl. Don't you worry your pretty little head with all these numbers." Society has long expected females to take little interest in mathematics. Certain myths, such as "Women don't have mathematical minds" and "Women aren't supposed to be good in math," still prevail in the United States. These beliefs are perfect excuse mechanisms which allow females to drop out of math programs without encountering disapproval.

The notion that mathematics is for boys can play an important role in a girl's conception of herself as one who is not supposed to be interested in or competent in math. Sells, in a recent pilot project at the University of California at Berkeley, reported the open-ended responses of several upper-division social science students to the question "In summary, what do you consider to be the most important factors which influenced your interest in and aptitude for doing mathematics in high school?" A general summary of the responses of these students (the overwhelming majority of whom were women) have been placed into three categories, and are as follows (Sells, 1973):

<u>Group 1</u>: Those Who Took Advanced Mathematics and Did Well in It

Many of these students' responses mentioned good grades and the encouragement of teachers, enjoyment of mathematics, confidence in their ability to handle mathematics, self-motivation, parental support, competition among other students in advanced math classes, high grades in math, and the enthusiasm of the math teacher and his or her ability to communicate that enthusiasm to the students. A particularly telling response indicated that "it helped to have fellow students excited about their work."

These very positive reactions from high achievers in math support the observations of Fink, who postulated that there exists a definite relationship between self-concept and academic achievement. Fink stipulated that an adequate self-concept is related to high achievement and an inadequate self-concept is related to low achievement (underachievement) (Fink, 1962).

<u>Group 2</u>: Those Who Took Advanced Math and Performed Poorly in It

The following is a typical response from this group:

> I felt less intelligent than males and some females in the class, but this gave me incentive. I still feel this way, but no longer get incentive from this inferior position. A math teacher called me stupid in front of the class once and this had a great negative effect on my opinion of my intelligence.

Other comments from these low achievers were that math classes were predominantly male-oriented, that math was taught by males who had low expectations for the girls, that girls were perceived as "stupid" by the math teachers, and that girls experienced low expectations from their parents.

One female student's response to the question was quite descriptive:

> General feeling from parents was that all the members of the family did well in the humanities, poorly in math. This was not a sexist orientation, but very influential. Have since found out that I have a very strong natural bent for math. I grew up feeling that I was not inclined toward math--feeling that other academic areas were more interesting--that I wouldn't have much use for a lot of math--all this even though I did very well in arithmetic in early school years. My interest in math consistently declined--feelings from peers and from parents were anti-math--not overly sexist--nevertheless, I never considered getting a degree in a field that was a predominantly male field--probably because of a mostly covert sense of the feminine role--absolutely no encouragement from teachers, parents, peers, or anyone.

This student's observations coincide with Fennema's contention that it is commonly accepted that mathematics is stereotyped as an activity more appropriate for males than for females and that females believe to a lesser degree than males that mathematics is personally useful (Fennema, 1974).

Group 3: Those Who Did Not Take Advanced Math in High School

These Berkeley students offered the following reasons for opting not to elect advanced math while in high school:

> My good aptitude for math was not encouraged. My A's in math were generally ignored. My social science A's were heartily encouraged.

> Everyone told me it was hard and complicated. Although I got good grades in it, I didn't really apply myself and very early believed that I didn't understand it and it was over my head.

> I had very poor, apathetic math teachers who never gave technical or psychological help. There was no inspiration to learn and no help when I didn't understand something.

> My school gave excessive drill and emphasis on efficiency and skill, rather than math for fun and creativity.

As another student observed:

> There was a kind of (basically unspoken) pressure from peers, parents, faculty, etc., for males at my school to continue the study of math, but a smaller amount of pressure for females. Females were not overtly discouraged, but very infrequently encouraged to study mathematics in high school.

Hence, socialization factors, fear of math, lack of encouragement, perceptions of math as a male subject, lack of female role models, lack of knowledge of careers requiring math, and a perception of mathematics as being useless were responses prevalent in this group.

The relationship between social support, the taking of advanced high school math courses, and success in math is striking. Most females in Sells' study (1973) who took advanced math and did well in it indicated that they were strongly encouraged to do so by parents and/or teachers.

Through corresponding with a large number of female mathematicians, Ernest found that, like their male counterparts, these women had many and varied reasons for being attracted to mathematics. Few of these reasons had anything to do with their sex. Yet over half of his respondents indicated that they had experienced some form of discrimination in their professional lives, and essentially all of them indicated that they had experienced sexist attitudes of some sort. Ernest noted that many of these mathematicians referred to the positive influence of their fathers on their intellectual development; that is to say, their fathers were their intellectual role models (Ernest, 1976).

> Some 50 years ago, one of the greatest mathematicians of all times, Emmy Noether (1882-1935), encountered opposition to her admission to the faculty at the University of Gottingen solely because of her sex. The distinguished mathematician David Hilbert, a professor at Gottingen, was incredulous: "Meine Herren, I do not see that the sex of the candidate is an argument against her admission as a Privatdozent. After all, the Senate is not a bathhouse." Emmy Noether was not admitted (at that time) to the all-male faculty at Gottingen, although she delivered many series of advanced lectures on her work, which had to be announced under the name of Hilbert (Ernest, 1976, p. 1).

Myths about women and mathematics have been with us for a long time. So, too, have certain attitudes prevailed that conceive of only certain occupations as being "appropriate" for women. These factors are among those that serve to make many females math avoiding and unaware of the importance of mathematics to their future employment opportunities.

Success Is Not Thought to Be "Feminine"

It has been found that many females have a motive to avoid success. They become anxious about achieving success because they expect negative consequences such as social rejection and feelings of being unfeminine as a result of succeeding. This anxiety regarding success apparently increases when a female must compete with males in a "male" area at school or on the job. Work with mathematically gifted girls at Johns Hopkins University has shown that even these girls find it difficult to continue their studies in math due to fears of some kind of social recrimination (Donady and Tobias, 1977).

> The prevalent attitudes and perspectives found throughout history, amidst both scholarly and popular circles, on the nature of women, their special qualities, potential abilities, and roles seem, with few exceptions, to have converged on the idea that femininity and individual competitive achievement are two desirable but mutually exclusive goals. This is especially true of achievements reflecting intellectual competence and leadership potential. The aggressive and, hence, masculine, overtones inherent in a capacity for mastering intellectual problems, attacking difficulties, and penetrating to the heart of the matter are considered obvious. Almost by definition, therefore, competence in intellectual matters or decision-making prowess have been equated with qualities antagonistic to, and incompatible with, those defined as feminine (Horner, 1974, p. 44).

Thus, for females. math avoidance may be an expression of conflict between seeking success and being considered feminine.

Research has also shown that there are sex differences in the expectation of success, with the male generally overestimating his chances to succeed and the female generally underestimating her chances to succeed. It has been discovered that among students doing poorly in math,

1. Girls are far more likely to belittle their abilities. Success is attributed to luck, failure to lack of ability.

2. Boys have higher self-concepts regarding math, tending to take full credit for their successes, while blaming external forces when they don't do well. Success is attributed to ability, failure is due to bad luck (Smith, 1976).

Too often, females feel punished both for being too "smart" in math classes and for being too "dumb." For many, an average middle-of-the-road path through the required math courses seems to be their safest bet.

Females Are More "Verbal"

For most females, language was the first and remains the most comfortable source of knowing. Studies indicate that parents talk to girl babies more than they do to boy babies. For a predominantly verbal child, advanced math seems disturbingly ambiguous in the way it applies words. A young person's trust in mathematics can disappear when the vocabulary of math fails to correspond to a previously assumed "logic of language." For this reason, females do not seem to trust their intuition when working with math problems. Often, if a female thinks she sees an obvious way to solve a problem or an intuitive guess flashes into her mind, she thinks it is bound to be "wrong," because "I can't trust my intuition in math" (Donady and Tobias, 1977).

Some scientists believe that the very way that math skills are taught and tested in the school is alien to most females. Although this very serious matter has not been adequately researched to date, scores have been shown to improve for girls when math problems are placed in more familiar contexts (Kagan, 1974).

Who Helps Whom with Math Homework?

Until sixth grade, children usually turn to their mothers for help with their math homework. In junior high school, however, girls continue to turn to their mothers, while boys increasingly turn to their fathers (Smith, 1976). This switch implies that the influence and cultural attitudes of previous generations are passed on to children, culminating in the idea that females don't have mathematical minds.

It Is Assumed That Boys "Naturally" Like Math More Than Girls Do

It is a myth that boys in junior and senior high school like math better than girls do. So concluded Ernest (1976), who found that in terms of liking mathematics, preference patterns were almost identical for second grade through twelfth grade boys and girls. This finding was, incidentally, in marked contrast to significant differences in stated preferences for other subjects such as English, science, and social studies. Ernest found that mathematics was the only subject polled that exhibited almost no sex-related preferences. A chart showing male-female preference patterns for mathematics is shown below (Ernest, 1976).

Preference Patterns for Mathematics

Rating for Mathematics	Boys	Girls
Liked best	30%	29%
Liked second best	23%	24%
Liked third best	19%	18%
Liked least	28%	29%

Furthermore, Ernest found that the overall popularity of math went down in the high school years for both sexes. He concluded that there is nothing "intrinsic" in arithmetic or mathematics that makes it more appealing or enjoyable to one sex than to the other.

Therefore, the large difference in the numbers of girls and boys taking elective high school math courses reflects something quite different from an assumed "fact" that a great number of boys "like" math. The most likely explanation is that a greater number of boys realize the potential significance of mathematics training to their futures. Girls are somehow not acquiring this realization and are not being encouraged to take math to the extent that boys are.

WHAT IS MATH ANXIETY/MATH AVOIDANCE?

Much attention in recent years has begun to focus on math anxiety, a phenomenon affecting both females and males. Mathophobia, as it is sometimes called, "is an irrational and impeditive dread of mathematics" (Lazarus, 1974, p. 16). It is a rather unspecific fear based upon a projected feeling of inadequacy when faced with some contemplated experience involving mathematics. Math anxiety is a nonrational distaste for and avoidance of math and math-related subjects. Kogelman, in his master's thesis in social work for Smith College in 1975, stated that math-anxious people exhibit many of the same symptoms associated with a phobia or inhibition of ego functions (Donady, Kogelman, and Tobias, 1976).

For any of many reasons, a student can develop this emotional and intellectual blockage, which makes further progress in mathematics and math-related fields extremely difficult.

> The student then actively turns away from mathematics, opts for nonmathematical courses whenever possible, and rapidly develops fatalistic attitudes about his/her problems with mathematics, fully expecting to do badly. This attitude itself, quite apart from other factors, can seriously impair performance (Lazarus, 1974, p. 16).

Lazarus believes that as a result, the student sees his or her pessimism justified, the attitude worsens still more, and a vicious cycle becomes established.

People with math anxiety usually try to avoid mathematics after leaving school, and their fear of math is often a significant handicap in the ordinary adult life of our society. Mathophobia is a very emotional and crippling "disease" and people suffering from it often experience panic, resentment, or embarrassment when they are forced to face even the simplest of mathematical problems during the course of their day-to-day living.

Thus, the math-anxious person cannot help but experience a real impediment in trying to cope with and survive in a technological society such as ours. It is difficult for the math-anxious person to come to grips with important issues of the day. "Nearly every important issue of the day--ecology, inflation, poverty, education, defense, international trade, and food supplies, to name just a few--has a strong mathematical component" (Lazarus, 1974, p. 22).

Math anxiety should not be confused with an attitude of "disdain" for mathematics, technology, and science, although these feelings may coexist in the same person. Nor should math anxiety be confused with dyscalculia--an inability to perform even the most simple arithmetic operations. Math anxiety differs from dyscalculia in at least two ways: (1) It is often experienced by people fully capable of doing elementary mathematics, and (2) It has an emotional component that is not a part of dyscalculia (Lazarus, 1974).

Among individuals, math anxiety can vary both in level (the height of a person's mathematical ceiling, or the level of ability achieved before running into serious difficulties with mathematics) and in intensity (the strength of the emotional block against pursuing mathematics further). However, once math anxiety has appeared in full force, it is unlikely to disappear spontaneously (Lazarus, 1974).

HOW WIDESPREAD IS THIS PROBLEM?

Math anxiety has long been recognized by educators, but it has only recently been named and defined. It is interesting to note that the terms "math anxiety" and "mathophobia" are instantly recognizable for what they represent. People upon hearing these terms generally know exactly what is being talked about. Now that it is "out of the closet," it becomes apparent that math anxiety affects many children and adults in our society. Tobias reports that in response to a math anxiety article she wrote for a popular magazine, she received literally hundreds of letters from women of all ages describing their own fear and terror of math. This confirmed her suspicion that there is a vast, untapped group of math-anxious and math-avoiding women who can be helped if they come forward. Other writers report similar responses from women and men to articles they have authored.

Exactly how many people are mathophobic? Lazarus (1974) admits that there are, at present, no hard data on this question--nor are there firm criteria to judge just who is mathophobic and who is not. He suggests that a person is mathophobic if he or she (1) strongly dislikes math in school, (2) goes out of his or her way in school or on the job to avoid having to do math, (3) regards math as a mystery or a secret beyond his or her access and comprehension, or (4) speaks openly of his or her aversion toward and difficulty with math.

Lazarus also states that, based upon the above criteria, the children and adults who should be judged mathophobic in the United States probably constitute a clear majority. He feels that it is likely that math-anxious people outnumber by far those people who feel comfortable with mathematics. Mathophobes include many people whose opportunities for schooling were limited, as well as many people who have been very well educated. Yet very little is known about math anxiety apart from a great many recorded and unrecorded personal experiences. Despite its apparently widespread occurrence, there has been practically no formal research on the subject to date.

The generally high incidence of math anxiety shows up most clearly on college and university campuses, "because it is there that many people are brought into forcible contact with relatively advanced mathematics" (Lazarus, 1974, p. 18). Yet Lazarus goes on to conclude that even though math anxiety is most apparent on the college campus, it most surely has its roots in elementary and secondary education. The more elementary the math course, the easier it is for students to get by through memorizing rules and formulas long enough to be tested on them. Unfortunately, this tactic becomes increasingly unworkable in time and eventually breaks down at some point further along the way. "Implicit here is the important point that mathophobia can pass through a latency stage before becoming manifest, in a manner analogous to that of some physical disease."

Math anxiety can arise at any time during a person's school years. Some children acquire it very early and never develop a complete understanding of even the simplest arithmetic operations. Without intervention, these children can expect to be troubled with and by math throughout their entire lives. More frequently, however, children get off to an apparently satisfactory start, and then begin to encounter serious difficulties with math later on along the way.

> By the time a student leaves school, the chances are good that he will have acquired mathophobia at one point or another during his education. That is, he will have reached some level in his mathematical training beyond which he finds progress extremely difficult (Lazarus, 1974, p. 16).

Expressed feelings about mathematics are best understood as representing a wide range of emotional responses. The following continuum is offered as representing, to some degree, this wide range of feelings about mathematics as expressed by math-anxious people:

Indifferent to all things mathematical	Is mildly anxious; feels reluctant and uncomfortable when faced with math problems	Finds math distasteful; dislikes it	Is highly anxious about math; goes out of way to avoid it	Feels paralyzed when confronted by anything mathematical

Many people seem to regard their own math anxiety as not being a serious matter and speak quite openly about their past difficulties with the subject in school and of their present inability to handle matters dealing with math. Many parents believe that it's "natural" to have difficulty with numbers. This casual and indifferent attitude surrounding math anxiety is extremely significant in that it virtually assures the transmission of mathophobia to succeeding generations (Lazarus, 1974).

For an educational community that is just beginning to become sensitized to women's issues, it has become imperative to discover what has caused such great differences in mathematics preparation and participation. Besides isolating the fact that high school mathematics is a "critical filter" into the American job market, Sells (1973) concluded that women often choose the humanities and other nonquantitative majors and careers not because they are "people-oriented" as is so often stated, but because they are fearful of math and wish to avoid using mathematics.

One obstacle to the prevention of math anxiety is the difficulty of early diagnosis. Our current educational practices do not provide us with much indication of whether a student really understands math concepts or not. If a student does not thoroughly understand the math concepts she or he is studying and this lack of understanding is not detected by educators, the student will almost inevitably experience consequent failure and frustration, and math avoidance is likely to follow. "In this respect--and in other respects as well--the educational system inadvertently promotes mathophobia" (Lazarus, 1974, p. 19).

WHAT CAUSES MATH ANXIETY/MATH AVOIDANCE?

Because the problem of math anxiety is a relatively new area of concern and very little formal research has been done on the subject to date, it is rather difficult to determine with any precision the exact causes of math anxiety at this time. However, researchers who are currently working in this area have suggested various factors as contributing to the incidence of math anxiety and avoidance.

Many children are forced to establish early a "school survival strategy" when they realize they need not only to find an answer, but to find it quickly. To gain their teacher's approval, many students do a lot of memorizing and learn above all never to ask any "dumb" questions. This pattern of learning, once it has been established, can continue (frequently with much success as measured by grades) until such time as true understanding becomes imperative. Then the whole facade collapses (Smith, 1976).

Lazarus calls this the "sudden death" phenomenon in the math learning process. A student fails to understand thoroughly some portion of a math concept she or he is studying, but remains docile, relying on memory (a situation made easier since test questions tend to repeat themselves) until such time as a new operation is encountered whose mastery requires an understanding of that previously unmastered skill. At this point, the student becomes convinced that "I'll never get it--no point in going back. It's hopeless." Lazarus senses that it's almost as if the students are relieved that they have failed. They knew they would, anyway (Smith, 1976).

Once a student is experiencing feelings of anxiety, stupidity, fear, defectiveness, or embarrassment, it becomes very difficult to learn. If the student is no longer able to listen to and concentrate on what the teacher is saying, it is impossible to learn. It is recommended that teachers use simple and easily understood problems, make math both fun and relevant, recognize the successes of their students (no matter how meager they may be), make students aware of how mathematics relates to their future lives, and by all means concentrate on observing the thought processes of their students rather than only checking for "correct" answers.

DeLeeuw, at Stanford, hypothesizes that math achievement and nonachievement are related to the split-brain research being conducted by Sperry and others at the California Institute of Technology. DeLeeuw believes that in order to perform well in mathematics at any level, the student needs to take material presented to the left hemisphere of the brain and translate it into material suitable for right hemisphere manipulations.

> Students who perform poorly in math . . . do not use both hemispheres in their various appropriate functions but try, for example, to compensate for poor visualization through memorization, rather than understanding. According to this theory, generally it would seem that for the math-anxious that intake is verbal, and goes therefore to the left side but goes no further. It is simply memorized-replayed, while for the math-able it goes from the left to the right hemisphere where it is synthesized so that it is understood and then returned to the left for verbalization (Smith, 1976, pp. 7-8).

Dougherty (1977) believes that math anxiety occurs when there is a "nonfortuitous match" between a person's mathematical sophistication and his or her formal instruction in math. Most typically, our schools provide (regardless of individual backgrounds and corresponding "mathematical baggage") a relatively uniform set and sequence of formal instruction in mathematics. Because students do not have the same sets and sequences of informal experiences in math, mismatching occurs. Students do not have the same potential, nor do their minds develop in exactly the same ways as they grow. These factors may also contribute to mismatching.

Dougherty recommends that schools greatly expand both the numbers and kinds of options available to students of mathematics. Many informal mathematical experiences should certainly be made available. In addition, the variety of ways in which math is presented formally can and should be significantly expanded. He recommends that teachers of mathematics try approaches that rely almost entirely on numerical modes of communication. Such an approach would treat math almost as though it were a foreign language (as compared to the most common approach, which is a mixture of a 60-percent verbal mode and a 40-percent numerical mode). He also recommends an approach that uses a 50-percent visual-spatial mode in mix with the numerical and/or verbal mode.

Jerry McCollum, a blind mathematician, observed that he has found, both as a student and as a teacher of math, that if there were a significant pause provided after each new idea was presented, the chances were greatly increased that the student would get used to the new idea, play around with it in his or her relevant cognitive map, and fit it into an appropriate place (Dougherty, 1977).

Many math-anxious people remember being intimidated by timed tests, by the formidable emphasis on "right" answers, by the feelings of competitiveness among their classmates, and by being penalized for using what their math teachers thought were "math crutches," e.g., counting on their fingers (Donady and Tobias, 1977). Intimidation is often enhanced by the cumulative property of mathematics instruction. Frequently, a student gets no second chance if she or he is unlucky enough to have missed just one important concept because of physical illness or emotional problems, distractions at home, inadequate teaching methods, or some other reason. He or she is likely to be left by the wayside permanently because, in contrast with many other subjects, which allow the student to make a fresh start each year, mathematics tends to build on itself cumulatively. A student is forced to master whatever material is presented each year in order to have any chance of succeeding in the years that follow (Lazarus, 1974).

Math instructional programs tend to vary widely from school system to school system and from state to state. This variation presents a potentiality for failure in our mobile society, where many children must change schools several times during their years of education. Individualized mathematics programs may tend to make these transitions easier, but most children are forced to plug into an ongoing program in a new school. Most certainly this factor must contribute to certain individuals' developing math anxiety (Laquer, 1978).

Also contributing to mathophobia are the attitudes of parents and teachers. The most important influences on a child's attitudes and values, by far, are the attitudes and values of his or her parents. In many cases, what is important to the parents becomes important to the child. Likewise, what the parents dislike, the child may also dislike. If parents have convinced themselves that mathematics is unessential or unimportant, their child is quite likely to grow up feeling the same way. "One can hardly expect the child to motivate himself in the face of his (her) parents' apathy" (Lazarus, 1974, p. 20).

Lazarus states that "according to many elementary teachers, parents are often more upset at weak grades in a subject having a comparatively narrow scope of application, such as geography, than at outright failure in mathematics." If the parent did not do well in math while in school, he or she does not fully expect the child to do well, either. "Here, again, we catch a sense of the attitude that mathematics is the province of an arcane cult, inaccessible to ordinary people, and not that important, anyway."

Lazarus goes on to state that even if a parent realizes that math is likely to be an important factor in the child's life and pleads with the child to learn math, the approach is unlikely to be successful if the parent is only paying lip service to the matter.

Along with the attitudes of parents, teachers' attitudes may also play a role in contributing to math anxiety and avoidance.

> The teacher who takes no joy in mathematics, to whom mathematics is only a set of units to be "covered" by a certain date, is unlikely to be effective in the ways that matter the most (Lazarus, 1974, p. 22).

Enthusiasm is contagious; but so, too, is indifference. Since many students take their cues from teachers, an expressed or implied dislike for a subject is often the seal of death. Lazarus goes so far as to state that many elementary and high school teachers are probably mathophobic themselves.

J. Ernest, a professor of mathematics at the University of California at Santa Barbara, distributed questionnaires to future teachers who were taking a math course designed especially for them. Although no statistically significant sex differences were noted in their responses, Ernest was discouraged to find that 26 percent of these prospective teachers indicated that they were indifferent toward mathematics, and another 14 percent stated that they actually disliked or hated math. He concluded that 40 percent of these teachers of the future would probably be likely to transmit "something less than a positive attitude toward mathematics to their students" (Ernest, 1976, p. 8).

Using a similar questionnaire with a large number of undergraduate students, Ernest asked them to indicate what they felt were the major influences determining their attitudes toward math. Among those students who indicated extreme attitudes (either loving math or hating it), one of the most frequently mentioned factors was a particular teacher whom they had had in the past. It is, therefore, quite likely that a child can, at some point, be detrimentally influenced by one or more of his or her math teachers. If, indeed, many teachers continue to assume that their male students will do better than their female students in math, their potentially negative influence on girls may be presumed to be that much stronger.

Lazarus feels that some people will probably claim that the school is not in any way at fault--that math anxiety is a "learning disability" like dyslexia--a dysfunction of the individual child for which the school cannot be held accountable. But he reminds us to consider that the number of math-anxious people seems to exceed by far the number of people who are not anxious about math.

> The claim that all of these people suffer from cases of individual dysfunction amounts to an assertion that the generality of mankind is predestined to dislike mathematics, save for an abnormal few (Lazarus, 1974, p. 20).

It is difficult to take this conclusion seriously.

Obviously, the presumed causes of math anxiety and avoidance are many, varied, and interrelated. It is clear that people who do well in mathematics also think it is fun--two states of mind completely incomprehensible to the mathophobic individual. It is also clear that "mathophobia is a highly communicable condition, to which the young are especially liable" (Lazarus, 1974, p. 20).

SEX-RELATED DIFFERENCES IN MATHEMATICS ACHIEVEMENT AND PERFORMANCE: MYTH OR REALITY?

Basing their conclusions upon many studies, researchers in past years have found that girls generally do better in verbal and linguistic studies, whereas boys show stronger numerical and spatial aptitudes and perform better on tests of mathematical reasoning. This has led many educators and teachers of mathematics to proceed under the assumption that boys are "naturally" better in mathematics and that mathematics is a predominantly "male" endeavor. Yet research conducted during the past 15 years ultimately challenges these long-held assumptions.

The results of a longitudinal study conducted in Princeton, New Jersey, which began in 1961 with fifth graders and ended in 1967, when these same students were in eleventh grade, indicated that at grade five there were no differences in mathematical achievement. However, from that point on, the boys pulled ahead, and parallel differences emerged in the percentage of students perceiving mathematics as interesting and as likely to be helpful in earning a living (Berglund and Hilton, 1967).

Based upon their study, Berglund and Hilton reached the following conclusions:

1. The reading of books on science and scientific magazines was more frequent among male students.
2. More male students were interested in mathematics and more females felt that math courses were boring.
3. More males thought that math courses would be useful in helping them earn a living.
4. Talking about science with friends and parents was more frequent among males.
5. Parents more frequently favored a continuation of education beyond high school for their sons.

The researchers discovered that all of the obtained differences in mathematical ability were generally negligible at the seventh grade level, but that these differences increased with age. It became apparent to Berglund and Hilton that the growing differences in math achievement took place in concert with increasing differences in interest in and/or attitude toward mathematics.

Aiken explained the above congruence in the following way:

> The relationship between attitudes and performance is certainly the consequence of a reciprocal influence, in that attitudes affect achievement and achievement in turn affects attitudes (Aiken, 1970, p. 558).

With the isolation of interest as a possible major factor affecting mathematical performance, further research began to explore this area. By 1969, Tyler had concluded from his study that:

1. Differences between the sexes in these areas were not large when compared with differences within each sex group.

2. In the realm of interests, attitudes, and personality characteristics, differences between comparable male and female groups were more striking than they were for achievement and abilities (Keeves, 1973).

Minuchin (1966) designed a study to explore sex differences in elementary school and found that girls and boys in a more traditional school behaved differently from children in a more modern school. Given a problem-solving task, the boys in the traditional school dominated the problem solving, whereas in the modern school, the girls were actively involved in the problem-solving activity on an equal basis with the boys. This finding led Minuchin to suggest that schools have an influential impact on the course of student development whether the schools are aware of it or not.

Fennema and Sherman (1977), in a project supported by the National Science Foundation, conducted research that has been viewed as highly significant in the areas of sex-related differences in math achievement, spatial visualization, and affective factors. These researchers, after a careful review of existing literature, concluded that the belief that males are superior in mathematics may have been based upon faulty research that did not control for an important variable related to achievement in high school mathematics, i.e., the previous study of math.

In their study, Fennema and Sherman gathered data for three cognitive variables (math achievement, general ability in the learning of math, and spatial visualization); eight affective variables (attitude toward one's own success in math, stereotyping of math as a male domain, perceived attitudes of mother, father, and teacher toward one as a learner of math, effectance motivation in math, confidence in learning math, and usefulness of math); and three other variables (number of math-related courses taken, number of space-related courses taken, and the amount of time spent outside of school in math-related activities).

Their collected data from four high schools do not support the generalized belief that females cannot do as well as males in mathematics. The groups compared in their study were similar in verbal and general ability. Whereas males in all four schools scored higher in mathematics achievement, the differences were significant in only two of the schools. In almost every comparison, males rated mathematics more of a domain of interest than did females, and this difference was significant in all four high schools. In each comparison but one, boys scored higher in mathematical confidence, and these differences were found to be significant. Mothers' and fathers' attitudes toward the female subjects as learners of mathematics were perceived negatively by the girls, who also reported that they felt mathematics was less useful to them than did the boys at three high schools.

The findings by Fennema and Sherman suggest that the existing opinion that females have less aptitude for mathematics than do males needs to be modified. In their study, when only students of similar mathematical background were considered, differences between male and female groups in mathematics achievement were very small and were significant in only two of the four high schools studied. There were more sex-related differences in confidence about one's ability to achieve in mathematics than in the actual math achievement area. The lesser confidence of girls in their ability to perform in mathematics was consistent with their lesser confidence generally--an attitude not necessarily changed even when girls were performing at a level equal to or superior to that of boys.

Fennema and Sherman attribute the finding that half of their student groups did not show sex-related differences to the fact that their study took into consideration the students' math backgrounds. The sex-related differences that did show up were very small, and score distributions overlapped considerably. These researchers report that their study suggests that long-accepted beliefs about the validity and importance of "sex differences" need reexamination in a variety of ways. If there are biological reasons for differences in mathematical ability, they have not yet been proven.

Fennema noted that "the question of whether or not there are sex-related differences in mathematics is more complicated than it first appears." She stated that while it is true that there are many more males than females involved in studying post-high school mathematics or employed in math-related occupations, it is unclear whether this "unequal representation of females and males in post-high school studying and using of mathematics is due to females' less adequate learning of mathematics or to deliberate choice by females not to study mathematics" (Fennema, 1974, p. 69).

The directors of the National Longitudinal Study of Mathematical Abilities (NLSMA) were taken to task by Fennema, who claimed that their data had been inadequately reported and interpreted by J. W. Wilson. At first glance, the NLSMA study tended to support the belief that females do not achieve as well as males in mathematics. Fennema criticized Wilson for not reporting "the size of the differences between the mean female and male performance scores and the educational significance of that difference" (Fennema, 1974, p. 69). Wilson's study concluded with the following statement:

> Differences favoring girls were for variables at the comprehension level (the lowest cognitive level tested) and the differences favoring the boys were for variables at the application and analysis level (Fennema, 1974, p. 69).

However, the study failed to offer statistical data to substantiate causative factors. Fennema expressed just indignation when she contended,

> The directors of this federally financed program abrogated their responsibility to females when they followed the above remarks with this statement: "Interpretation and comment on this pattern will be left to persons involved in the women's liberation movement" (Fennema, 1974, p. 69).

Fennema believes that the "positive proof" that many researchers have in the past offered to support their beliefs in male superiority to females in mathematics reflects the same degree of questionable research that has been reported on racial supremacy in overall intelligence.

Fennema maintains that although the mathematical skills required on Scholastic Aptitude Test instruments cover areas taught only in grades one through nine, it is obvious that if boys continue their mathematical studies throughout high school in much greater numbers than do girls, they have an ultimate advantage. For by continuing to use their math skills, the boys retain them and score much higher than girls taking the tests who have perhaps not studied math for the past year or two.

In 1978, Fennema drew the following conclusions based upon several years of in-depth, scholarly research:

1. There are no sex-related differences evident in the elementary school years. This takes into account all cognitive levels from computation to problem solving. This conclusion has been accepted for a number of years.

2. After the elementary school years, differences thought to be sex-related do not always appear.

3. Starting at about the seventh grade, if differences do appear, they tend to be in the males' favor--particularly on tasks involving higher-level cognitive skills.

4. There is some evidence that sex-related differences in mathematics learning in high school may not be as large as reported in 1978 as they were in previous years.

5. Conclusions reached about males' superiority in mathematics have often been gathered from old studies or from studies in which the number of mathematics courses taken was not controlled. Therefore, a better mathematically educated group of males was being compared to a group of females who had not participated in as much math education. In reality, then, what was being compared was not females and males--rather, students who had studied math for one to three years in high school with students who had studied math from two to four years in high school (Fennema and Sherman, 1978).

While conceding that there are sex-related differences in the studying of mathematics, Fennema goes on to conclude that "if the amount of time spent learning mathematics is somehow equated for females and males, educationally significant sex-related differences in mathematics performance will disappear."

It should be noted here that virtually no differences in math ability and interest in mathematics appear until puberty--a time of sexual identification. Differences that do show up appear to be no accident, for children display inhibitions about learning subjects they feel are inappropriate for their sex (Kagan, 1974). Besides,

> Everyone knows that girls are not good at math, which may be precisely why a lot of them aren't ("Why Susie Can't Add," 1977, p. 36).

Experts in the field of sex-related differences seem to be zeroing in on 'cultural conditioning' as the most probable cause of the lack of participation and/or lack of success of females in mathematics.

To date, most of the research in sex-related differences has been conducted in the United States. However, in 1964 and 1970, the International Association for Evaluation of Education Achievement collected data from countries around the world in order to further the understanding of sex-related educational achievement in the areas of mathematics and science.

Keeves (1973) used data from ten of these countries--Australia, Belgium, England, the Federal Republic of Germany, Finland, Japan, the Netherlands, Scotland, Sweden, and the United States--in a study he conducted. He noted that feminist movements beginning at the end of the nineteenth century led to demands by women for increased matriculation at universities around the world. Research conducted as a result of this activism showed only small differences in the levels of male and female general intelligence. Yet data from the above ten countries clearly show that mathematical study and the study of science during the first year of university are largely male activities.

Because Keeves found very marked differences in the numbers of females participating in higher mathematics and science depending upon which country they were from, he concluded that the predilection of male students to study math and science "arises not from inherited differences, but from environmental and cultural factors" (Keeves, 1973, p. 51). He went on to suggest that sex differences in math and science participation rates indicate disparities in educational opportunities.

> While legal restrictions do not, in general, exist to prevent girls from taking part in any form of education beyond the compulsory age limit, there would seem to be a variety of pressures at work. In so far as these forces militate against female participation, it would appear that some girls and women are denied opportunities in education and professional life that they might otherwise wish to have (Keeves, 1973, p. 51).

Keeves was led to postulate that sex differences in achievement and attitude in the areas of mathematics and science are attributable to the differences in role expectations and unquestioned traditional practices of countries, communities, and other individuals or groups.

> It seems unsound to propose physiological or psychoanalytic explanations for the differences in achievement and attitudes in mathematics and science between the sexes when there are disparities between countries in the magnitude of the sex differences reported. The most likely explanation would seem to arise from the

> expectations which "western" communities hold for the respective roles of men and women. While it is possible that the origins of observed sex differences are cultural, the factors involved are not immediately obvious (Keeves, 1973, p. 60).

Hence, we are led to observe a pattern that extends to countries outside of the United States. It becomes imperative for us as educators to explore cultural and other factors that may be wholly or in part responsible for the lesser participation of females in mathematics.

For the past 5 years, Casserly has been studying schools whose girls score as well as their boys on the Scholastic Aptitude Test and Achievement Tests. From her two studies, An Assessment of Factors Affecting Female Participation in Advanced Placement Programs in Mathematics, Chemistry, and Physics and Factors Related to Young Women's Persistence and Achievement in Mathematics, with Special Focus on the Sequence Heading to and through Advanced Placement Calculus, Casserly has isolated the following characteristics of teachers and counselors in these schools:

1. They do not let girls believe that math requires a special cast of mind or love for the subject.

2. At the same time, they point out that it took the human race literally centuries to discover or invent the mathematical "truths" of today. Mathematics is not particularly easy; it takes time and careful study, to which students can make useful contributions, gaining both from the help of others and from helping others.

3. They encourage students to continue the study of mathematics to keep later career options open, pointing out the increasing range of fields, not just math and science, that mathematics serves. Ensuring the availability of options is especially important for girls, in whose lives marriage may precede, but not preclude, a later career.

4. They relate responsibly and actively with students' parents and other math teachers in their community, seeking to strengthen both their current students' learning and the preparation of their younger siblings in lower grades (Casserly, 1979, p. 24).

Casserly's findings coincide with the recommendation of Fennema and Sherman, who urge educators to offer more opportunities to junior high school girls and boys to perceive math as useful and universal. These researchers feel that girls, when in a setting with boys, need special and more positive reinforcement and encouragement which will affect their ability to achieve in math. This reinforcement is vital because of the direct correlation between the study of mathematics in high school and young women's career aspirations and achievements. Fennema has concluded from her research that there is nothing inherent that prevents females from learning mathematics at the same level as males. She recommends that intervention programs be designed and implemented within the school, geared to encourage female participation in mathematics. "These programs should include female and male students and their teachers. True equity can only occur when such intervention programs are incorporated into mathematics education" (Fennema, 1974, p. 81).

More thought must be given to the objectives of mathematics education to determine whether the current patterns of sex roles in society and, in turn, the imposed expectations are compatible with our desired educational goals.

> If equality between the sexes is sought in the educational and occupational opportunities available to men and women in western society, then certain educational aims and objectives might well be re-examined (Keeves, 1973, p. 61).

Keeves believes that new child-rearing practices and socialization patterns will gradually evolve as the society in general becomes aware of our current situation. Educators must certainly take the lead in familiarizing themselves with the "female and math" syndrome and take steps to alleviate the problem.

The following statement from the Phi Delta Kappa Teacher Education Commission on Education and Human Rights presents a challenge to all teachers, educators, and concerned citizens:

> If human potentialities are to be realized, society must be concerned not only with theoretical and philosophical concepts of human rights, but equally with translating these concepts into realities expressed in the behavior of free men and women. It is imperative that human beings live together in ways which accord each person, irrespective of biological and cultural differences, full dignity, respect and value, simply because he or she is human. This objective cannot be achieved unless each human being has the opportunity through education to develop his or her abilities and talents (Phi Delta Kappa, 1975, p. 1).

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PART C

MODULE 1

MATH AND CAREERS

MODULE 1 OVERVIEW

Module 1 is introduced by a 12-minute sound filmstrip entitled "Math and Careers." The colorful, collage-type pictures and thematic music of this presentation immediately capture students' attention. The introspective mood fostered by the narrative encourages students to think about themselves and about the career decisions they must make in the future. "Math and Careers" stresses doing one's best while studying mathematics in school and points out to students that each scholastic accomplishment now leads to even greater accomplishments in the future.

After viewing the Module 1 audiovisual presentation, students should do the MATHCO Wizard's Career-O-Scope activity in the following manner:

1. Students should answer the 50 multiple-choice questions on their MATHCO Wizard's Career-O-Scopes (see page 57). These questions explore students' current interests and personal attitudes in a variety of ways.

2. Students should total their "A" responses, "B" responses, and "C" responses and plot these totals on their Career-O-Scope Answer Charts (see page 66).

3. Using their Career-O-Scope Prediction Guides (see page 67), students now discover the MATHCO Wizard's predictions about the possible careers in their futures.

Not designed as a scientific study, this exercise does serve to indicate to students some careers that seem to match the kinds of activities they prefer at present. It is pointed out to students that they will continue to grow and to change, and their career goals will probably change as well. What is certain is that students will discover some things about themselves that they have probably never thought about before.

At this point, it is recommended that the teacher display the six MATHCO Career Wall Charts in the math classroom and provide some class time for students to become familiar with them (see page 70). A classroom discussion about the charts and other career-related activities (at the individual teacher's discretion) completes this introduction of students to MATHCO.

MODULE 1 AUDIOVISUAL SCRIPT

MATH AND CAREERS

VISUAL	AUDIO
Begin audio with black frame, which follows focus frame.	(Music)
Frame 1 - The smiling faces of four teenagers are shown.	(Music)
Frame 2 - The smiling faces are now shown with a long winding road in the background.	(Music)
Frame 3 - The smiling faces are again shown. This time, a long winding road and some steps are pictured in the background.	(Music)
Frame 4 - (TITLE FRAME) Math and Careers	(Music)
Frame 5 - COLLAGE: Student sitting in a math classroom, a math teacher, a graduating senior, a photographer, the door to an employment agency, and job applications.	Sometimes while sitting here day after day, Trying hard to listen to what teachers say About formulas, theories, and symbols and such, The thought will come, "Hey! There isn't much Time left to be a student around here!" And then I start thinking about my life and career.

VISUAL	AUDIO
Frame 6 - COLLAGE: A group of students, a high school graduate, scenes of Washington, D.C., an "Elect Me President" sign, and some movie stars.	My time as a student is over half spent. Do I still think I'll grow up to be President Of the United States? Will I be a star?
Frame 7 - COLLAGE: A mansion, an imported car, and two "celebrity" tennis players.	Will I have a great mansion and an imported car? Will my dreams to be famous really come true? Will I play doubles tennis with a film star or two?
Frame 8 - COLLAGE: A novelist, a detective, the cover of <u>Time</u> magazine, a scientist, and some people being presented with Oscars.	Will I write a great novel? Solve the unsolvable crime? Will I ever be pictured on the cover of <u>Time</u> For curing glaucoma or stopping a war? Will my film win an Oscar? Perhaps three or four?
Frame 9 - COLLAGE: Young people attending a concert, an athlete, a spy, and a photographer.	Will I be plagued by groupies who pull at my clothes? Be an athlete? A spy? Or a person who goes Around taking pictures for magazine ads?
Frame 10 - COLLAGE: A fashion model, a skateboard, a television set, and a high-rise dormitory.	Will my clothes set the fashion? Will my hobbies start fads? Will you watch my adventures on the news on TV? Will midwestern schools name their dorms after me?

VISUAL	AUDIO
Frame 11 - COLLAGE: Construction workers, a house in the process of being built, and construction tools.	And, if fame eludes me, can I still be content Tuning up engines or mixing cement? Shingling rooftops or carpeting floors? Or painting the trim around windows and doors?
Frame 12 - COLLAGE: A truck driver, a house that is for sale, a newspaper containing stock market data, and an assembly line.	Will I get satisfaction from driving a truck? Or will I get excited by trying my luck With land speculation or stock market trading? Will I work in a factory and watch things parading Down the assembly line...past what I do, On, with a hundred more hands to go through?
Frame 13 - COLLAGE: A person sleeping, an alarm clock, an executive at work, and two people sunbathing.	Will I get up each morning to work nine to five For fifty weeks yearly, 'til I'm sixty-five, And then retire to Texas to sit in the sun And not even remember the job that I've done Just for the money for the past forty years? That's the difference, I guess, between jobs and careers.

VISUAL	AUDIO
Frame 14 - COLLAGE: A man, a woman, and two construction workers eating lunch on the job.	A job's working hard for someone else. A career pleases you. You do it for yourself. Your own attitude keeps you proud of whatever you do. Because...just remember; no one does it like you.
Frame 15 - The faces of a group of young people are shown.	Your talents are special. You're unique...so am I. We're each something special, and so we should try To match our careers to what we are now And what we would like to be. It's interesting how What we are will determine the things we do.
Frame 16 - COLLAGE: A cruise ship, a photograph, a closet full of clothes, a clock, a calendar, and a person resting in a hammock.	For the job that I do will tell, too, about me; The places I go, the people I see; The way that I dress, the friends that I make; My daily routine, the vacations I take; The problems that bug me, the way I relax;

VISUAL	AUDIO
Frame 17 - COLLAGE: Some insurance and income tax forms, a partially eaten meal, and a checkbook.	My insurance coverage, my income tax; My phone bill, my meals, my business address; The way that I deal with problems and stress; My checking and savings accounts at the bank;
Frame 18 - COLLAGE: A wall covered with framed certificates, diplomas, and other mementos.	The people that thank me and the people that I thank; My Christmas cards, credit cards, cards on the table; The certificates telling the world if I'm able To do what I do because I've been trained;
Frame 19 - COLLAGE: Two people looking at their watches, a university building, a diploma, and the door to a law office.	The times that I'm rushed, the times I'm detained; The education I pay for, the knowledge I need; The advice that I offer, the advice that I heed;
Frame 20 - COLLAGE: People using their muscles to dance, to type, and to lift; a person having a good idea; and a person who looks confused.	The size of my muscles, and which ones are used; The times I think clearly, the times I'm confused;

VISUAL	AUDIO
Frame 21 - COLLAGE: A family, some people playing volleyball, and a symbolic clock.	The time for my family, the time for my friends; The time just for me when the working time ends; The times that I win, the times that I lose All are influenced by the career that I choose.
Frame 22 - Two staircases are shown; the words WHY? WHO? WHAT? HOW? and WHEN? appear on one staircase.	Choosing a career is like climbing some stairs. Each step's a decision that helps take you where Your dreams and plans and goals are all met. With each step you take...the closer you get.
Frame 23 - Staircases are shown branching out in all directions.	And from each new step, you can see other stairways That begin where you are, but go off on their ways Apart from the path you originally chose.
Frame 24 - A female is shown standing on one staircase surveying the staircases going off in other directions.	And if you decide to take one of those Alternate routes on your way to the top, You may find you like it. You may even stop For a while to enjoy where you are.
Frame 25 - A male is shown sitting near the base of a	Your choices are endless. You can go far

VISUAL	AUDIO
group of staircases extending in several directions.	As you like in any direction, Stay where you are, or make a correction And go back a few steps to begin something new. The decisions are yours. It's all up to you.
Frame 26 - A person's feet are shown "taking the first step."	But, "Watch that first step," as the old saying goes. It's the one that will lead you to others. And those Will lead on and on and on and on ...who knows how far? But miss that first step, and you stay where you are.
Frame 27 - COLLAGE: A man's face, a woman's face, someone rolling up his or her sleeve, and a staircase.	The first step, as others, is a decision to make. And making it wisely is going to take Thinking and planning, determination and guts.
Frame 28 - A young female is shown "taking the first step," which is labeled "100%."	The decision is this: No matter what's To be done in your day-to-day living, Decide that the thought and effort you're giving Is one hundred percent to do the job well. Because, you'll remember, you never can tell What new steps will rise from a job that's well done.

VISUAL	AUDIO
Frame 29 - COLLAGE: A person studying, a person carrying groceries, a person practicing a cello, and some garden tools.	Decide to work hard on whatever's begun, Whether homework, or lessons, or repetitive practice, A chore, or a job. Remember, the fact is
Frame 30 - COLLAGE STORY: "Jane & Tommy's Lemonade: 5¢," which leads to a billboard reading INTRODUCING J & T's LEMONADE DRINK, which leads to a large factory labeled "The J & T Manufacturing Center."	We don't know yet what will help us out later. Each accomplishment now leads to one that is greater. So, since you can't know whether you'll need it or not... If you try it at all, give it your best shot!
Frame 31 - COLLAGE: A math teacher, a math classroom, students, and math numbers and symbols.	And that brings me back to the old here and now, With my math teacher up there telling me how To multiply fractions, use decimals and percent. Now, how will that help me to become President?
Frame 32 - COLLAGE: The top portion of a person's face, some stairs, and some other picture segments repeated from earlier frames.	But I've decided to try it. I'll try anything once. And I'll spare them my usual groanings and grunts And complaints about studying this same old stuff. (Besides, if I try, it can't be that tough.) So I'll pick up some facts and pass the next test. I'm taking the first step. I'm doing my best.

VISUAL	AUDIO
Note: Frames 33-41, along with accompanying music, are geared to sum up the presentation.	
Frame 33 - Frame 5 is repeated.	(Music)
Frame 34 - Frame 24 is repeated.	(Music)
Frame 35 - Frame 9 is repeated.	(Music)
Frame 36 - Frame 20 is repeated.	(Music)
Frame 37 - Frame 27 is repeated.	(Music)
Frame 38 - Frame 14 is repeated.	(Music)
Frame 39 - Frame 6 is repeated.	(Music)
Frame 40 - Frame 8 is repeated.	(Music)
Frame 41 - Frame 15 is repeated.	(Music)
Frame 42 - CREDIT FRAME	(Music)
Frame 43 - CREDIT	(Music)
Frame 44 - CREDIT MATHCO developers	(Music)
Frame 45 - CREDIT MATHCO National Review Board	(Music)
Frame 46 - DISCLAIMER	(Music)
Frame 47 - THE END	(Music)

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Your Name ______________________________ Date ____________

MATHCO WIZARD'S CAREER-O-SCOPE

We all like having our fortunes told. Answer the MATHCO Wizard's questions truthfully, and the MATHCO Wizard will make a prediction about your future career(s).

Choose only one answer--A or B or C--for each of the following questions. Remember, these questions are about you, so be honest. No one will ever know how you answer any question unless you tell her or him.

Circle one answer (the A, the B, or the C) for each of the following questions.

1. The friends that I see away from school are:

   A. the same friends that I see in school
   B. different from the friends that I see in school
   C. few--I don't see many friends away from school

2. When I am with my friends, we are usually:

   A. working on something
   B. looking for a good time
   C. talking about something

3. My friends and I usually talk about:

   A. things
   B. other people
   C. ideas

4. My best friends are the ones who share my:

   A. interests
   B. other friends
   C. feelings

5. The number of my friends is:

   A. getting smaller
   B. getting larger
   C. staying about the same

6. The assignments in school that I like best are:

   A. individual projects
   B. group projects
   C. research projects

7. If given a choice, the group of classes that I would select would be:

A. science, industrial arts, and art
B. social studies, team sports, and music
C. math, literature, and history

8. The types of books that I prefer are:

A. adventure stories and "how-to-do-it" books
B. biographies and novels
C. fantasy stories and science fiction books

9. I would rather do my homework:

A. alone
B. with friends
C. at the library

10. If I were having trouble with a math problem, I would like to:

A. use a calculator
B. get help from a friend
C. get help from the teacher

11. My favorite part of a department store is the:

A. hardware department
B. clothing department
C. book and stereo department

12. When I get out of high school, I want to:

A. work for a while
B. travel for a while
C. go to college or to a vocational school

13. I think everyone should have a:

A. car
B. television set
C. savings account

14. When I get a gift or a gadget that needs to be put together, I usually:

A. figure it out for myself
B. ask for help
C. read the instructions

15. I would tell someone who was buying a car to think about how the car:

A. performs
B. looks and rides
C. will resell later on

16. On an airline, I would rather be the:

A. pilot
B. ticket agent or flight attendant
C. navigator

17. At the auto races, I would rather:

A. work with the pit crew
B. sell concessions (food and souvenirs)
C. be the timekeeper

18. When I read the credits at the end of a movie, I check to see who:

A. directed it
B. acted in it
C. wrote the script

19 When something I own breaks, my first thought is that:

A. it was poorly made
B. I have been cheated
C. I broke it

20. The people who work hardest at school are:

A. the custodians or janitors
B. the teachers
C. the administrators (principal, superintendent, etc.)

21. If my city could provide only one service, I would prefer that it be:

A. police and fire protection
B. parks and recreation areas
C. museums and libraries

22. If I were a salesperson, I would rather sell:

A. cars
B. clothing
C. insurance

23. The greatest invention so far is the:

A. automobile
B. telephone
C. electric light bulb

24. The most important things provided by my state are:

A. highways and public transportation
B. public health and welfare
C. schools and education

25. The tool that is most useful to me is:

A. a screwdriver
B. a comb or a pick
C. a pencil

26. When I see a mountain, I think about:

A. climbing it
B. how to describe it
C. creating a picture of it

27. If I saw a friend whose car had a flat tire, I could help by:

A. changing the tire
B. staying with my friend until help arrived
C. going to get help

28. At a party, I would rather:

A. eat
B. dance
C. talk

29. When I am in a new place, I look at:

A. the buildings and cars
B. the people
C. the signs and advertisements

30. I eat:

A. when I am hungry
B. when everyone else is eating
C. at mealtimes

31. I enjoy eating snacks when:

A. I make them myself
B. someone offers them to me
C. I'm studying

32. When I hear a police siren, I wonder:

A. what law has been broken
B. who is in trouble or hurt
C. what the emergency is

33. I think the person who would make the best politician is:

A. a self-employed person
B. someone who looks good and sounds good
C. a lawyer or a political scientist

34. When I visit someone else's home, I worry about:

A. spilling or breaking something
B. the way I will be treated
C. how I will fit into their routines and habits

35. I feel sorry for people who lived 200 years ago because they did not have good:

A. houses

B. hospitals

C. schools

36. When I am mad, I want to:

A. break something

B. yell at someone

C. be alone

37. A good time requires:

A. money

B. good friends

C. good planning

38. I would buy something if I liked the way it:

A. looked

B. had been advertised

C. met my needs

39. The best toy for a child would be:

A. building blocks

B. stuffed animals

C. games

40. The most important thing about gifts I receive is:

A. how much they cost

B. who gave them to me

C. how much I need them

41. On television, I would rather watch:

A. a sports program

B. a comedy-variety show

C. a talk show

42. I get most of my news from:

A. television

B. other people

C. newspapers

43. If someone were trying to sell me a new invention, I would wonder

A. how it works

B. who else was buying it

C. if I could improve it

44. When I see a beach, I think about:

A. swimming

B. picnicking

C. exploring it to see what I could find there

45. I would rather:

A. be rich

B. be famous

C. have influence on other people

Now, imagine that you have been told that you must stay in your room whole month. Pick one item out of each group of three below that you like to have with you during that month. Remember, you may select on out of each group.

46. A. a dart board

B. some magazines

C. a deck of cards

47. A. some modeling clay

B. some stationery (for writing letters)

C. a musical instrument

48. A. a jigsaw puzzle
    B. a joke book
    C. a book of crossword puzzles

49. A. some exercise equipment
    B. a telephone
    C. some books

50. A. a record player and some records
    B. a radio
    C. a camera and some self-developing film

Look back over the answers you have marked for the questions above. Count up how many A's you have marked, how many B's you have marked, and how many C's you have marked. Write your totals in the spaces below.

TOTAL NUMBER OF A's: ________

TOTAL NUMBER OF B's: ________

TOTAL NUMBER OF C's: ________

Now transfer these totals to the three columns in the Career-O-Scope Answer Chart.

CAREER-O-SCOPE PREDICTION GUIDE

Now that you have answered all of the MATHCO Wizard's questions and filled in your Career-O-Scope Answer Chart, study your Career-O-Scope Answer Chart to determine whether your answers were:

1. Mostly A's
2. Mostly B's
3. Mostly C's
4. Mostly A's and B's
5. Mostly A's and C's
6. Mostly B's and C's
7. Equally A's, B's, and C's

It is now time for you to match your answers with the proper category below to discover the MATHCO Wizard's predictions about the careers in your future.

MOSTLY A's

If most of your responses were A's, you are a person who enjoys a lot of physical activity and you are not afraid of a little hard work. You have a knack for working with machines and materials and you enjoy using your muscles as well as your mind. Your active life often leads you outdoors. You enjoy your possessions and take excellent care of things. You get satisfaction from the things you make and do for yourself, and your friends enjoy your self-reliance and natural ability to fix things. Some careers in your future may include: carpentry, farming and ranching, construction work, manufacturing, mechanics, transportation, studio or laboratory technology, printing occupations, and sports.

MOSTLY B's

If most of your responses were B's, you are a real "people person." You seem to have a natural ability to get along with people and to get them to do what you want them to do. You fill your life with music and laughter and provide entertainment to others in a crowd and to yourself when you are alone. You are sensitive and energetic and enjoy helping others. You work well with people and that makes you a sought-after team member. Some careers in your future may include: counseling, sales careers, acting, social services, management of personnel, psychology, and public relations.

MOSTLY C's

If most of your responses were C's, you are a person who, with enough time and thought, can solve any problem. You have a flair for creativity and a natural sense of organization. You work well with words, figures, and ideas, and enjoy the challenges of problem solving. Your agile mind and sharp wit bring you many friends, but you often prefer your own company. Some careers in your future may include: research and development, writing, law, science and medicine, economics, composing, editing, and design occupations.

MOSTLY A's AND B's

If most of your responses were A's and B's, you are a person who works well with people and machines. Although you sometimes treat people like machines and machines like people, you can get the best out of both. You respect the lives and property of others and have a very practical mind that can deal with almost any situation. Some careers in your future may include: hotel/motel management, food services, police and detective work, management and administration, theatre technology, clerical occupations, dentistry, and library science.

MOSTLY A's AND C's

If most of your responses were A's and C's, you are a clear thinker who can combine the abstract world of facts and figures with the concrete world of machines and materials. You are efficient and resourceful and often combine business with pleasure. You seem to be always busy. When you are not working hard physically, you are hard at work mentally. You are able to combine creativity with practicality and discipline with talent. Some careers in your future may include: architecture, engineering, computer science, medical technology, industrial research and design, fashion, advertising, and interior design and decoration.

MOSTLY B's AND C's

If most of your responses were B's and C's, your life combines an agile mind with an infectious personality. This puts you in a position to be a lot of help to a lot of people. Your friends are important to you, and your thinking and creativity are stimulated and influenced by the people in your life. Some careers in your future may include: teaching, medicine, journalism, banking, law, counseling, clergy, management and administration, and play writing and direction.

EQUALLY DIVIDED

If your responses were equally divided among A's, B's, and C's, you are a very well-rounded individual. This enables you to be very adaptable and versatile. It also makes you very complex and unpredictable. Your choice of careers is wide open, but you may be particularly drawn toward: education, medicine, law, social services, and the arts.

REMEMBER...

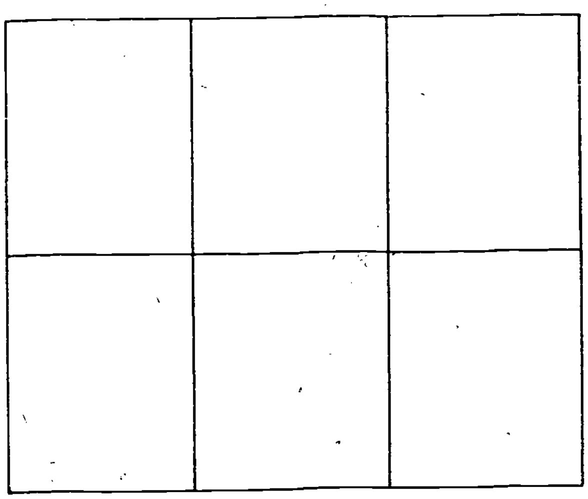
THE MATHCO WIZARD'S PREDICTIONS ARE BASED UPON YOUR INTERESTS AND ATTITUDES RIGHT NOW. BUT OUR INTERESTS AND ATTITUDES DO TEND TO CHANGE AS WE EXPERIENCE NEW THINGS, NEW PEOPLE, AND NEW IDEAS. THIS MEANS THAT YOU CAN BE ANYTHING YOU REALLY WANT TO BE. THE MATHCO WIZARD CAN ONLY PREDICT THE FUTURE. IT IS UP TO YOU TO MAKE THE FUTURE HAPPEN.

MATHCO CAREER WALL CHARTS

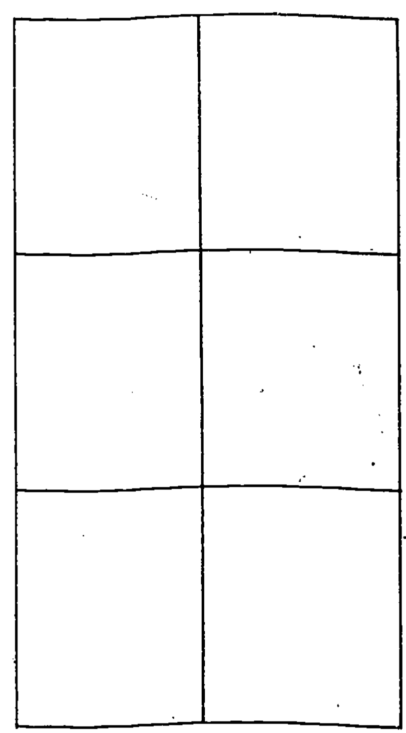
Six colorful 18" x 24" career wall charts will provide a unique focal point for your math classroom. Various careers are highlighted and described at a level appropriate for middle school youngsters who are just beginning to develop some ideas regarding the potential occupations in their futures. The main theme, emphasized repeatedly on the charts, is that some level of mathematical skills is needed in each of these many and varied careers.

These wall charts were designed to give the math teacher a great deal of flexibility for their display. Some arrangements you might want to consider are as follows:

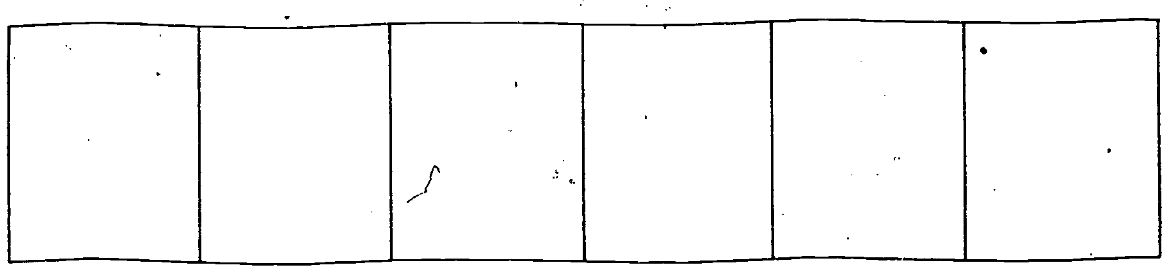
A



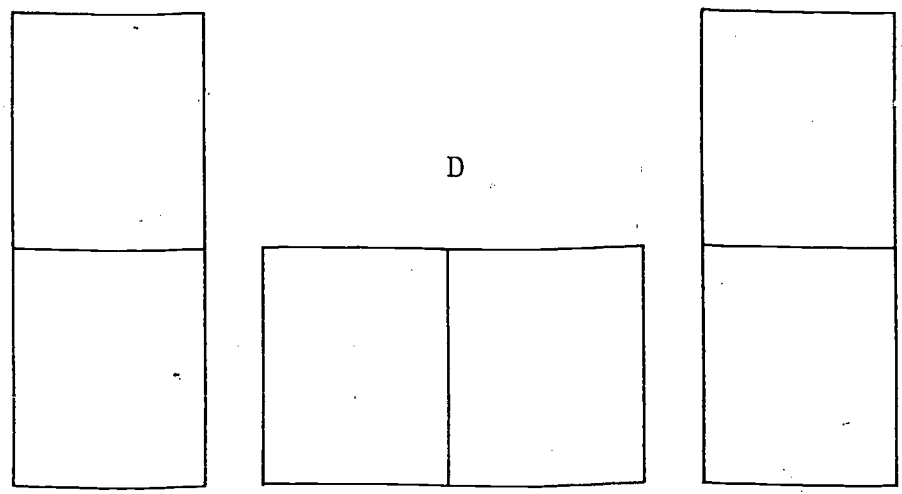
B



C



D



E