7921236

HARDEMAN, CAROLE HALL
THE EFFECTS ON MIDDLE SCHOOL STUDENTS OF "MATHCO": A PROGRAM TO ENHANCE YOUNG WOMEN'S UNDERSTANDING OF INTERDISCIPLINARY USES OF MATH IN CAREER CHOICES.

THE UNIVERSITY OF OKLAHOMA, PH.D., 1979

University Microfilms International 300 N. ZEEB ROAD, ANN ARBOR, MI 48106

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

THE EFFECTS ON MIDDLE SCHOOL STUDENTS OF "MATHCO": A PROGRAM TO ENHANCE YOUNG WOMEN'S UNDERSTANDING OF INTERDISCIPLINARY USES OF MATH IN CAREER CHOICES

A DISSERTATION

SUBMITTED TO THE GRADUATE COLLEGE

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

CAROLE HALL HARDEMAN

Norman, Oklahoma

1979

THE EFFECTS ON MIDDLE SCHOOL STUDENTS OF "MATHCO":
A PROGRAM TO ENHANCE YOUNG WOMEN'S UNDERSTANDING
OF INTERDISCIPLINARY USES OF MATH
IN CAREER CHOICES

APPROVED BY

Glenn R. Snider

[illegible]

Charles Butler

Jack F. Parker

DISSERTATION COMMITTEE

This thesis is dedicated to my parents, Rubye and Ira D. Hall, Sr. Their love, understanding, encouragement, and commitment to the pursuit of academic excellence provided the impetus with which this study was pursued.

ACKNOWLEDGEMENTS

To Dr. Glenn R. Snider, who directed this study, enormous gratitude is expressed for the encouragement, guidance, patience and sensitivity of which this writer was the recipient. Not only did Glenn Snider show interest in the writer as a student, but he helped the writer to grow as a person and as a professional on a university campus.

To Dr. Robert Bibens, Dr. Charles Butler and Dr. Jack Parker, the writer expresses deep gratitude for their guidance and contribution to the professional growth of this writer. As members of the doctoral program committee, they were always gracious in providing time and sharing their expertise with the writer.

To Dr. Donald J. Hall, director of the Southwest Center for Human Relations Studies, the writer expresses appreciation for his encouragement, persistence and belief in the writer.

The writer extends appreciation to Dr. Bill Fredrickson, Dr. Omer Rupiper, and Dr. Marzell Smith for their statistical expertise and assistance.

A very special thanks to MATHCO associates Kristin Carl, who labored many late hours typing the numerous drafts of the reading copy, and to Barbara Laquer who assisted the writer in countless ways throughout the study. Their total support cannot be enumerated in words.

Special gratitude is offered to Dr. Evangie McGlon for her continued support and encouragement; and to the writer's colleagues of the Oklahoma City Chapter of Jack and Jill of America, Inc., who, during all the years of study, provided much encouragement and who served as substitute mothers for the writer's daughter.

Finally, lots of love and a very special thanks is extended to the writer's daughter, Paula Suzette, who knows the true meaning of sacrifice. Her sacrifice was the greatest one of all; hopefully, she understands.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

LIST OF FIGURES

PROLOGUE

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 or talents.

- Phi Delta Kappa Teacher Education Commission on Education and Human Rights.

THE EFFECTS ON MIDDLE SCHOOL STUDENTS OF "MATHCO": A PROGRAM TO ENHANCE YOUNG WOMEN'S UNDERSTANDING OF INTERDISCIPLINARY USES OF MATH IN CAREER CHOICES

CHAPTER I

INTRODUCTION

The public schools in America have a basic responsibility to provide the education that will prepare young men and women to succeed in a society that is increasingly becoming more and more technological. Yet, each year, the number of students who excel in mathematics is decreasing at an alarming rate.

Most high school counselors will agree that a background of four years of high school mathematics will increase one's chances of succeeding in a college science program. Yet, untold numbers of young women, and many minorities as well, continue to be the victims of what sociologist Lucy Sells has termed the invisible "mathematics filter," which operates to deny them access to undergraduate majors in the sciences and hence, to related career opportunities.[1]

---

[1]Lucy W. Sells, "Mathematics - A Critical Filter" The Science Teacher, Volume 45, No. 2, (February, 1978).

Sells also contended that science and mathematics teachers at the junior high and senior high levels "must make their students understand that by choosing not to take basic courses in mathematics, they dramatically limit their career options, not only in science and technology, but also in business, landscape architecture, computer science, management, and a host of other fields."[1]

A career in the sciences requires considerable college level mathematics, including calculus. Many parents and students discover that the most efficient and effective way to qualify for the calculus sequence in college is to take advantage of the mathematics sequence offered in high school as electives. This discovery usually occurs after the student has completed high school.

In a recent survey conducted at the University of California at Berkeley, among the top 12.5 percent of high school graduates admitted to the University of California at Berkeley, 43 percent of the entering men and 92 percent of the entering women did not have the second year of algebra and the pre-calculus trigonometry background required to prepare for the standard freshman calculus course. Thus, 92 percent of the women in this class were effectively relegated to five fields: the humanities,

---

[1] Ibid.

music, social work, elementary education, and guidance and counseling.[1]

Recent data on SAT math scores tells a similar dismal story. Among high school seniors taking the test in preparation for 1975-76 college admission, 23 percent of the men scored over 600 on mathematics skills, compared with only 10 percent of the women. SAT scores are strongly related to the number of mathematics courses taken in high school and to the number of English composition courses taken in high school.[2]

Need for the Study

Much of the research indicates the need for programs which will encourage young women to develop their mathematics skills. For example, it was reported that between 1950 and 1974 the number of working women nearly doubled. However, according to the study, the majority of women workers, even those with college degrees, earn low salaries. It was indicated that "the average salary for a woman with a bachelor's degree who works full time is about the same as that of a man who is a high school drop out."[3]

---

[1]"Math Mystique: Fear of Figuring," Time Magazine (March 14, 1977), p. 36.

[2]"Recruiting Women for Traditionally Male Careers: Programs and Resources for Getting Women Into the Men's World," Project on the Status and Education of Women (October, 1977), p. 1.

[3]Ibid.

Historically, educational institutions have not provided the impetus to encourage women to enter the courses of study which provide the background and skills to enter the careers of science, law, medicine, engineering and other mathematics related fields. In 1970, about 30 percent of the male professionals were employed in the above mentioned careers, compared to only 2 percent of women professionals.[1]

This particular study gets at the question, how can we modify the teaching of mathematics so that girls and young women are encouraged to take mathematics and how can they be shown that mathematics is a useful and necessary tool which provides entry into many careers?

At the suggestion of the National Institute of Education, a proposal was developed at the University of Oklahoma Southwest Center for Human Relations Studies. This proposal was designed to deal with the problem of female math anxiety and avoidance. The proposal, authored by this researcher, was funded by the U.S. Office of Education under the Women's Educational Equity Act Program and was named MATHCO.

---

[1]Sarah Splaver, Non-Traditional Careers for Women. Julian Messner, a Division of Simon & Schuster, Inc., New York, N.Y.

Statement of the Problem

The problem was to determine the effectiveness of MATHCO materials, when taught under certain conditions by middle school and junior high mathematics teachers, in changing attitudes of middle school boys and girls as to the usefulness of math in selected careers. The study also assessed attitudes regarding the suitability of selected careers for both women and men.

Hypotheses to be Tested

HO_1 There is no significant difference between the attitudes of seventh grade male and female students regarding mathematics careers.

HO_2 There is no significant difference in attitudes of seventh grade students about mathematics and careers before using MATHCO materials and after using MATHCO materials.

HO_3 The difference, if any, for MATHCO Questionnaire scores between females and males on the pre-test is not significantly different from the difference, if any, between females and males on the post-test.

HO_4 There is no correlation between teachers' rating of students' ability in mathematics and students' self-rating on the mathematics and careers personal interest inventory.

HO_5 There is no correlation between teachers' rating of students' ability in mathematics and students' pre-post training difference scores on the MATHCO Questionnaire.

Delimitations of the Study

This study did not assess the actual math skill achievement of the students. MATHCO was developed to be used as a supplement to the middle school math program. It was not designed to teach mathematics skills, but to enhance by an interdisciplinary approach, those skills already learned. The teachers' knowledge of fine arts, science, social science, career education, language arts, and practical arts are variables which were not measured in this study. As in the assessment of overall effectiveness of all curricular materials, the skill, enthusiasm, and willingness to become deeply involved with students as individuals had a significant effect on the findings of this study. The teachers, therefore, who were involved in this study were selected by their school systems because they seemed to possess these qualities and were regarded as effective mathematics teachers.

The scope of this study did not consider the variables of race, family background, personality, or overall school ability.

Definition of Terms

MATHCO

An interdisciplinary mathematics careers curriculum model program for middle and junior high school. The model consists of six modules which include a pre-post test, an audiovisual motivational presentation which precedes each module, career wall charts, student and teacher activity sheets, student work sheets, fact sheets, and an In-Service Guide for educators.

Interdisciplinary Math Curriculum Program

The interdisciplinary approach to mathematics involves the use of mathematics in six other areas. These areas include social sciences, practical arts, fine arts, language arts, science, and careers. The students are engaged in learning activities which include the actual use of mathematics in other disciplines. (For example, the students make a music computer and discover how to spell chords, identify sharps and flats, and perform other skills by using math skills. In the area of language arts, students discover patterns and sequences in poetry, sentence structure, and make mathematical formulas to match same.)

Math Anxiety

Concern or solicitude respecting anything treating of quantity or magnitude which disturbs the mind or keeps it in a state of painful uneasiness.[1] A fear of mathematics based on a projected fear of inadequacy which often is related to a contemplated negative experience with mathematics. Mathophobia is another term for math anxiety.

Math Avoidance

Difficulties with mathematics or a dislike of mathematics, consequently resulting in an avoidance of study of the discipline. This is common among high school and college students, both male and female.

Middle School

Middle school is characterized by an age group of eleven years through thirteen and grades six through eight. The middle school philosophy embodies the concept of exploration, choices, rapid growth, extreme sensitivity and the onset of puberty for the pre-adolescent.

---

[1] Webster's Unabridged Dictionary.

Pre-Adolescent

The age period between childhood and adolescence. Pre-adolescents are often extremely sensitive, self-conscious, and vulnerable at this stage of their development.

Sex Stereotyping

The tendency of society to assign certain traits, behaviors, and characteristics to one of the sexes based upon inconclusive and non-scientific assumptions and conclusions.

Socialization

Socialization is an evolving process which begins at birth. It is characterized as a mode of behavior based upon societal values and mores, which affects one's aspirations, attitudes, beliefs, stereotypes, and patterns of behavior.

Science Careers

The careers included in this study which require skills acquired in high school mathematics and science courses include:

Science and technology careers including: Theoretical Mathematicians, Actuaries, Statisticians, Environmental Scientists, Life Scientists, Physical Scientists, Engineers, and Computer Programmer Analysts.

Business Careers

The careers included in this study which require skills acquired in high school mathematics and science courses include:

Accountants, Sales Engineers, Insurance Brokers, Advertising Researchers, Managers, Executives, Production Managers, and Corporate Executives.

Design and Procedure of the Study

The study was designed to determine the effectiveness on seventh grade students of MATHCO. The pre-post testing method of investigation was used before and after the participating mathematics classrooms used MATHCO for a three-week period.

The initial step in the study was to review the available literature related to the problem under investigation. A careful and detailed examination was made of research and other studies which dealt with the performance and achievement of women and girls in mathematics.

The population consisted of 389 seventh grade students from six Oklahoma school districts.

The instrument was constructed in the form of a questionnaire. The audiovisual component of this instrument was prepared by the University of Oklahoma College of Education Instructional Services Center with supervision from the writer.

Before development of the final form of the questionnaire, it was submitted to a panel of national educators, selected because of their knowledge in mathematics, curriculum development, and career education. This panel was asked to evaluate each of the items on the questionnaire and to suggest modification of the items. This procedure served to establish content validity of the questionnaire.

Statistical Treatment

By use of 1) 2 X 2 analysis of variance with repeated measures and 2) triserial correlation, the hypotheses of this study were tested. In order to arrive at logical and just conclusions, the following operations were statistically completed:

A. The MATHCO Questionnaire scores of females were compared with the MATHCO Questionnaire scores of males.

B. The pre-test MATHCO Questionnaire scores were compared with the post-test MATHCO Questionnaire scores.

C. The difference in MATHCO Questionnaire pre-test scores, if any, between males and females was compared with the difference in MATHCO Questionnaire post-test scores, if any, between males and females.

D. The gain scores of each school were correlated with the teachers' ranking of the students of high, middle, and low achievement.

E. The scores on the Pupil Personal Inventory evaluation were correlated with the teacher's ratings of student ability.

The study also examined the statistical significance of the difference in the attitudes between the sexes and between and among the schools before and after using the MATHCO materials by examining the means and standard deviations of the difference in the pre-test score and the post-test score of the MATHCO Questionnaire.

By use of triserial correlation, the difference in the pre-test and post-test scores was compared to the teachers' ranking of the students in one of three groups, high, middle, and low.

The above method was also used to compare the teachers' ranking of students and the Pupil Personal Inventory scores.

Organization of the Study

The organization of the study follows: A study of the pertinent research and literature related to the problem is presented in Chapter II. Chapter III contains a detailed description of the procedure of the study. The presentation and analysis of data is described in Chapter IV. Chapter V provides a summary of the study, as well as findings, conclusions, and recommendations, based upon the analysis and interpretation of the data.

For the purpose of this investigation, the review of selected studies revolved around three specific questions:

(1) What are some of the identifiable behaviors and practices in American education which promote sexism?

(2) Are there differences between the sexes in mathematics performance and achievement?

(3) Is there a correlation between the study of mathematics in high school and the career aspirations of young women?

The studies reviewed in each of the general areas were viewed as directly related to the problem of this investigation and underscored the need for all educators to examine their present educational policies, practices, and philosophies regarding mathematics education for women and girls.

CHAPTER II

REVIEW OF SELECTED STUDIES

This study was primarily concerned with determining the effectiveness of MATHCO interdisciplinary curriculum materials in changing attitudes of middle school boys and girls as to the usefulness of mathematics and its relationship to careers for women.

What Are Some Of The Identifiable Behaviors and Practices In American Education Which Promote Sexism?

"School children do not need to be taught the differential status of men and women--they learn it simply by attending school."[1]

The school is a microcosm of society itself. Many educational philosophers and historians agree that schools have perpetuated existing social and economic inequalities. Levy stated "Schools may not make a difference in the sense that they do not dramatically improve the life chances of the poor, of minority groups or of women, but they do make a difference in that they remain an effective instrument of social control. Schools, after all, were not created to

---

[1]Betty Levy, "Do Teachers Sell Girls Short? Sexism in the Elementary School," Special Feature on the Schools and Sex-Role Stereotyping. Reprint from Today's Education, NEA Journal.

change society, but to maintain it and thus help keep existing dominant groups dominant."[1]

Various ideas related to the above stated philosophy have been discussed, dissected, researched, and analyzed by educators/humanitarians and students for decades. Most critics of American education, however, have failed to examine the role schools play in perpetuating traditional sex role behavior which has been labeled as stifling and counterproductive to girls. The message to girls is to be obedient, accepting, dependent, and "ladylike." For boys, the schools send out the sometimes conflicting messages of so-called masculine traits of aggressiveness, achievement, independence, and activity, while at the same time admonishing them that good pupils are passive, quiet, 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."[2]

Good, Sikes, and Brophy, in a study designed to study the effects of teacher sex and student sex on classroom interaction concluded that:

---

[1] Ibid.

[2] Ibid.

> 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.[1]

The study by Good, Sikes and Brophy in which behavior of male and female teachers toward male and female students was studied, was conducted in sixteen junior high classrooms during ten instructional hours. The Brophy-Good Dyadic Coding System was used in this study. This system yields a variety of measurements of the quantity and quality of teacher-student interaction, separately recorded for each student in the class. An interesting aspect of the study was that there were no formally stated hypotheses "in view of the absence of comparison data and the availability of many competing theories about teacher behavior, some of which would predict different outcomes."[2]

Two examples of diametrically opposing theories were Biddle's role theory and Heider's balance theory. Biddle suggested that since teachers' training and principals' expectations are quite similar insofar as teachers' roles are concerned that male and female teachers should "behave

---

[1]Thomas L. Good, Jere E. Brophy, and Thomas L. Sikes, "Effects of Teacher Sex and Student Sex on Classroom Interaction," Journal of Educational Psychology, 1973, Vol. 65, No. 1, pp. 74-87.

[2]*Ibid*.

similarly in similar situations."[1] Heider's contrasting theory predicted that the male teacher would accept minor aggression more so than would the female teacher, "since males are more aggressive and presumably more comfortable with this behavior in others."[2] According to the authors, the intent of the study was to "provide purely empirical data, albeit data with important educational societal implications."[3] They felt that before the educational system could undergo the "expensive retooling" of the system to provide more male teachers in the classroom it seemed necessary to determine whether or not boys and girls were indeed treated differently by men and women teachers. Since it had been suggested that student achievement and subject matter typically affect the nature of teacher-student interaction in the classroom, these two variables were included as part of the study.

Data was collected in the seventh and eighth grade classrooms of four female and four male mathematics teachers and four female and four male social studies teachers. All teachers were white and most of the students were white, urban middle-to-upper-middle class students. Some of the

---

[1] Ibid.

[2] Ibid.

[3] Ibid.

[4] Ibid.

results of the study were not expected by the researchers. Although the variables of sex-of-teacher and sex-of-student were considered more important, the most potent variable that emerged from the study was that of 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 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 more often failed to provide feedback. When students misbehaved, social studies teachers were more likely merely to warn students, while mathematics teachers were likely to criticize them more intensively.[1]

These subject matter differences tended to emphasize some widely held stereotypes of these two subjects. Social studies classes were believed to be more open and relaxed than were classes in mathematics. Also, it was felt by many observers, that mathematics teachers, especially on the senior high level, tended to treat the overall subject of mathematics as mystical, highly intellectually oriented, and within the realm of understanding of only the gifted or near gifted student. Mathematics was also viewed as male-oriented. Sadly, many junior high mathematics teachers quite often are allowed

---

[1] *Ibid.*

to teach mathematics although they were not mathematics majors in college and they do not feel comfortable teaching mathematics. This uneasiness is perceived by their students.

Although teacher sex was a much less potent classifying variable than was the subject matter variable in the Brophy study, 13 main effects for teacher sex reached significance.

The variable of student sex proved to be potent with the main effects reaching significance for 20 variables and approaching significance for five variables.

In eight out of ten significant interactions among subject matter, student sex, and student achievement level, a definite pattern was established. Boys at all achievement levels were more active in mathematics classes than girls of corresponding achievement levels. Boys received more of all types of interactions (with teachers) than girls. "The boys initiated more questions and contacts with teachers, called out more answers, and guessed more frequently than girls."[1] The study suggested that teachers provided more opportunities for boys to respond. "Boys received more direct questions, open questions, self-reference questions, procedure, process, and product questions."[2] The study noted that boys, as a group, received both more positive and more negative effects

---

[1] Ibid.

[2] Ibid.

from the teachers. It was noted that when teachers did give feedback towards girls, it was more likely to be positive.[1]

The study showed that student achievement level influenced the quality and quantity of classroom interaction. High achievers were much more likely to receive teacher feedback about their responses than were low achievers, who more frequently received no teacher response to their answers.

> This difference in teacher treatment was especially noticeable when students gave right answers, although even after wrong responses low achievers more often received no feedback from the teachers. In addition, low achievers were much less likely to receive teacher feedback informing them that their answer was incorrect (simple negation as opposed to criticism). In general, teachers provided low achievers with less feedback about their academic performance.[2]

The quality of life as determined by teacher-student relationship in the 16 classrooms involved in the study was much higher for the high achieving boys than for the high achieving girls or the low achieving boys and girls. The high achieving boys far surpassed all of their classmates in the frequency and quality of contacts shared with the teacher.

The study provided no evidence that teachers favor students of their own sex. Teachers, male and female, as a group treated high achieving students more favorably than

---

[1] Ibid.

[2] Ibid.

low achieving students and highly achieving males received the most favorable teacher treatment.

Many references were made to the negative ways in which low achieving males were treated. The need for practices capable of changing the behavior of both male and female teachers toward low achievers was emphasized. Low achieving girls were found to be passive and ignored. It was suggested that perhaps teachers were allowing student behavior and role expectations to shape teacher behavior.

Further research studies suggested by the authors included research centering on teaching low achieving boys to maintain eye-contact with the teacher instead of looking at the floor, etc., and teaching low achieving girls to raise their hands and seek out the teacher more often "to see if systematic changes in student behavior bring about desirable changes in teacher behavior."[1]

Research conducted by Stein of Pennsylvania State University indicated that childrens' sex-role standards for six achievement areas, including mathematics, mechanical, athletics, reading, artistic, and social skills, were related to their values, expectations, and standards of performance in these areas.[2]

---

[1] Ibid.

[2] Aletha Huston Stein, "The Effects of Sex-Role Standards for Achievement and Sex-Role Preferences on Three Determinants of Achievement Motivation," Developmental Psychology, 1971, Vol. 4, No. 2, pp. 219-231.

Stein's data indicated that:

> For both sexes, the areas which received predominantly masculine ratings, athletics, mechanical, and mathematics were all significantly different from reading, artistic and social skills which were given predominantly feminine ratings.[1]

Girls age 11 and age 14, rated art more important than mechanical subjects. The other four areas were not significantly different for girls in sixth grade (age 11), but 14 year-old girls in ninth grade placed greater importance on the "feminine" areas social skills and reading, than on mathematics and athletics.[2]

Are There Differences Between the Sexes In Mathematics Performance And Achievement?

In a longitudinal study conducted in Princeton, New Jersey, which began in 1961 at grade five and ended with grade eleven in 1967, the results indicated that "at grade five there were no differences in achievement but thereafter the boys pulled ahead. Parallel differences, however, emerged in the percentage perceiving mathematics as interesting and as likely to be helpful in earning a living."[3]

---

[1] *Ibid*.

[2] *Ibid*.

[3] Tosta W. Berglund and Thomas L. Hilton, "Sex Differences in Mathematical Achievement: A Longitudinal Study," *Journal of Educational Research*, Vol. 67, No. 5 (January 1974).

Macoby stated that sex differences in mathematics achievement were probably due to the following practices:

> Members of each sex are encouraged in, and become interested in and proficient at, the kinds of tasks that are most relevant to the roles they fill currently or are expected to fill in the future. According to this view, boys in high school forge ahead in mathematics because they and their parents and teachers know they may become engineers or scientists; while the girls know they are unlikely to need mathematics in the occupation they will take up when they leave school.[1]

Hilton and Berglund reached the following conclusions from a study reported in 1967:

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

The most interesting finding, according to the authors, was "that all the obtained differences between males and

---

[1]Elenore E. Macoby, The Development of Sex Differences, (Stanford: Stanford University Press, 1966).

females were generally negligible at the grade seven level but increased with age."[1]

Researchers seemed to reach consensus on the congruence of mathematics achievement and interest and perceived usefulness by both boys and girls. Berglund and Hilton reported "that the growing differences in math achievement between the males and females does, as predicted, take place in concert with increasing differences in interest. As the boys' interest in science increases relative to the girls', their achievement in mathematics increases relative to that of the girls." Their data indicated a difference between the boys and the girls in the percentage who perceived mathematics as useful in earning a living.[2]

Aiken, in an attempt to interpret the above congruence, pointed out the importance of learner attitudes:

> 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. This dynamic interaction between attitudes and behavior has received a great deal of attention in the recent socio-psychological literature.[3]

---

[1]Gosta W. Berglund and Thomas L. Hilton, "Sex Differences in Mathematical Achievement: A Longitudinal Study," Journal of Educational Research, Vol. 67, No. 5, (January 1967).

[2]Ibid.

[3]Lewis R. Aiken, Jr., "Attitudes Towards Mathematics," Review of Educational Research, Vol. 40, No. 1, (February 1970), pp. 551-596.

In other words, greater achievement is the result of an increase in interest and greater interest results from greater achievement. The exact nature of the relationship doesn't lend itself to investigation of a scientific nature, the problem being that interaction between interest and achievement is probably instantaneous. Hilton suggested that:

> One word of positive feedback from a respected teacher, guidance counselor, or peer, and the student is immediately more interested in mathematics and, as a consequence, immediately able in performing mathematically.[1]

The International Association for Evaluation of Educational Achievement, in an effort to further the understanding of the nature of the differences between the sexes in educational achievement in the areas of mathematics and science, collected data in 1964 and 1970 from several countries. Keeves considered ten of those countries in his studies regarding sex differences in mathematics and science. Keeves reported striking similarities in disparities of social expectation for girls and boys in Australia, Belgium, England, the Federal Republic of Germany, Finland, Japan, Netherlands, Scotland, Sweden, and the United States. (It was interesting to note that the demands for participation of those excluded from educational institutions led to research to measure the

---

[1]Gosta W. Berglund and Thomas L. Hilton, "Sex Differences in Mathematical Achievement: A Longitudinal Study," Journal of Educational Research, Vol. 67, No. 5, (January 1967).

ability of those seeking entrance; the research was conducted by those ranked among the "includeds.")[1]

Keeves also reported that toward the end of the nineteenth century the formation of the feminist movement led to demands for increased participation by women for matriculation at universities. "This demand," stated Keeves, "was supported by research into the question of whether women's general intelligence was or was not equal to men's. The research showed the existence of only small differences."[2]

The evidence from the ten countries showed that the study of mathematics at the pre-university level and the study of science during the first year at the university were largely male activities.

> There are however, marked differences in these respects between the ten countries included in this inquiry. This suggests that this predilection of male students to study mathematics and science arises not from inherited differences, but from environmental and cultural factors.
>
> Whatever the origins of the sex differences in participation rates reported above, it is clear that figures like these suggest disparities in educational opportunities.
>
> Higher education provides the gateway to professional life, and these inequalities between the sexes in opportunities for a professional career, particularly in fields

---

[1] John Keeves, "Differences between the Sexes in Mathematics and Science Courses," Australian Council for Educational Research.

[2] _Ibid_.

> where a knowledge of mathematics and science provides a foundation.
>
> While legal restrictions do not, in general, exist to prevent girls from taking part in any forms of education beyond the compulsory age limit, there would seem to be a variety of pressures at work. Insofar 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.[1]

Keeves postulated that sex differences in achievement and attitude in the area of mathematics and science were attributable to differences in role expectations of the community and other individuals or groups.[2]

Very conducted research designed to study individual differences in males' and females' ability to perform mathematical operations. He first sought to define mathematics and then to identify those competencies which are essential for performing mathematical operations. Although several mathematicians identified different competencies needed, there was one proficiency agreed on by all of them--the area of reasoning abilities. Very alluded to a number of these abilities, including reasoning with numbers and the more abstract ability to find and evaluate relationships. His

---

[1] Ibid.

[2] Ibid.

definition of mathematical ability was described in terms of the "basic processes involved, with specific references to the results of research in the area."[1]

Mathematical ability, as defined by Very, is a "construct composed of a number of separate but interrelated factors. Each factor has not yet been clearly isolated, but the area in general would include the ability to discover, manipulate, and evaluate relationships. Judging, estimating, inducing and deducing the mechanics of these relationships are essential processes."[2]

Thirty tests were used in the study of the 30 variables employed, only 17 showed a statistically significant difference with respect to sex. Of these 17 variables, females excelled males in six tests. This means that of the total of 30 variables, 19 of them failed to show that males were superior to females in mathematical ability. Very underscored the implications of most research done in the area of male and female differences in mathematics achievements and abilities in the introduction to his study: "In this society," he stated, "greater pressures are placed on

---

[1]Philip S. Very, "Differential Factor Structors in Mathematical Ability," Genetic Psychology Monographs, 1967, pp. 75, 169-207.

[2]Ibid.

the male than the female to take mathematics courses, to excel in them, and to pursue fields employing mathematical techniques."[1]

Minuchin, in a study designed to study sex differences in elementary schools, reported that boys and girls of the more traditional school behaved differently from children in the most modern school. In a problem-solving task, the boys in the former school dominated the problem-solving, while the girls in the latter school were actively involved in the problem-solving activity--on an equal basis with the boys.[2]

Minuchin declared:

> The specific ways in which sex differences vary among children from the different schools of our study, however, may be less important than the fact that they do vary, for this suggests that the schools have an influential impact on the course of development whether they are aware of it or not.[3]

She challenged educators to accept patterns of difference and offer channels for their expression, to help shape important identifications without stereotyping, and to provide broad horizons a supportive atmosphere and a wide range of learning possibilities from which each child--

---

[1] Ibid.

[2] Patricia P. Minuchin, "Sex Differences in Children: Research Findings in an Educational Context," The National Elementary Principal, Vol. XLVI, No. 2, (November 1966).

[3] Ibid.

boy or girl--can select and develop a personal life style to be integrated with a committed sex identity and a resolved social sex role.[1]

In a project supported by the National Science Foundation, Drs. Elizabeth Fennema and Julia Sherman conducted research which is viewed as highly significant in the area of sex-related differences in mathematics achievement, spatial visualization, and affective factors. Prior to 1974, it was almost a universally accepted fact that males achieved better in mathematics than females. Some of the research indicated that this difference was based on underlying ability and at other times it was attributed to social climate which did not encourage girls to study or excel in mathematics. However, Fennema and Sherman discovered the neglect of most researchers to control "one of the most important variables, i.e., the previous study of mathematics."[2] This variable (the previous study of mathematics) was viewed important enough to lead to the new research conducted by Fennema and Sherman, stated as follows:

> The major purpose of this study was to gain new insight into the important area of sex-related differences in mathematics achievement when this variable is controlled. A second purpose was to collect information

---

[1] Ibid.

[2] Elizabeth Fennema and Julia Sherman, "Sex Related Differences in Mathematics Achievement, Spatial Visualization and Affective Factors," American Educational Research Journal, Vol. 14, No. 1, (Winter 1977), pp. 51-71

> about variables hypothesized to be associated with sex-related differences in mathematics achievement.[1]

The variables involved were both cognitive and affective. Mathematics achievement and spatial visualization were the cognitive variables. The eight affective variables for which data were gathered were attitude toward success in mathematics, stereotyping of mathematics as a male domain, perceived attitudes of mother, father and teacher toward one as a learner of mathematics, motivation in mathematics, confidence in learning mathematics, and usefulness of mathematics and three other variables; number of mathematics related courses taken, number of space-related courses taken and amount of time spent outside of school in mathematics related activities.

The major dependent variable studied was mathematics achievement, which was measured by the <u>Test of Academic Progress</u>.[2] The authors alluded to the importance of general ability and verbal ability in the learning of mathematics. Prior research had indicated that females excelled in verbal ability. Therefore, it was deemed essential for Sherman and Fennema to control both general and verbal ability when comparing mathematics learning of males and females. The Quick Word Test by Borgatte and Corsini was used to establish control

---

[1] <u>Ibid</u>.

[2] Scannell, 1972

in this area. Spatial visualization was the third cognitive variable studied. According to Macoby and Jacklin, the average score of a group of males is often higher on tests measuring spatial visualization than is the average score of a group of females.[1]

Fennema and Sherman, in earlier studies, had reported that spatial visualization is logically related to the content of mathematics. Therefore, it was deemed important by the authors that the empirical relationship between spatial visualization and mathematics achievement and the relationship between visualization and any sex-related differences in mathematics achievement be examined. The Space Relations Test of the Differential Aptitude Test was used to measure this variable.[2]

Differences between the sexes in mathematics achievement or in the selection of mathematics courses were hypothesized as correlated to affective variables. These variables were measured by the Attitude toward Success in Mathematics Scale and the Mathematics as a Male Domain Scale. Perceived attitudes of important others, i.e., parents, teachers, older siblings, etc. toward one as a learner of mathematics,

---

[1]Elizabeth Fennema and Julia Sherman, "Sex Related Differences in Mathematics Achievement, Spatial Visualization and Affective Factors," American Educational Research Journal, Vol. 14, No. 1, (Winter 1977), pp. 51-71.

[2]Bennett, Seashore and Ivesman, 1973.

confidence in learning mathematics, and usefulness of mathematics were measured.

The interdisciplinary uses of mathematics was approached in the study. Students were asked to identify all courses which had a mathematics prerequisite or which were identified as having a significant amount of mathematics content.

Spatial skill-related courses were identified. Students were asked to indicate their experience in taking courses in drafting, art, design, etc.

The subjects of the study were 644 male and 589 female 9-12 grade students enrolled in "on grade" mathematics courses. The students were white.

The analyses and results of the Fennema-Sherman study was markedly different from other research reviewed in this study. The causation factor accountable for this variance was the variable of "previous study of mathematics" which was controlled in the Fennema-Sherman research.

The groups compared in the study were similar in verbal and general ability. Although males always scored higher on mathematics achievement, in only two (out of four) schools was the difference significant.

> The difference between the sexes was about two test items at each grade level. Males

> tended to score higher on spatial visualization but the differences were significant at only two schools.[1]

In almost every comparison, males rated mathematics more of a domain than females did and this difference was significant in all four high schools. In each comparison but one, boys scored higher in mathematics confidence and these differences were found to be significant at three high schools. Mothers' attitudes and fathers' attitudes towards the female subjects as learners of mathematics were perceived negatively by the girls who also reported that mathematics was less useful than did the boys at three high schools.

The Sherman-Fennema findings suggested that the existing opinion that females have less aptitude for mathematics than males needs to be modified. In the study, when only students of similar mathematics 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. The evidence underscored the post-1974 belief that socio-cultural factors were highly important concomitants of sex-related differences in mathematics achievement and spatial visualization.

---

[1]Elizabeth Fennema, University of Wisconsin and Julia Sherman, Women's Research Institute of Wisconsin, "Sex Related Differences in Mathematics Achievement, Spatial Visualization and Affective Factors," American Educational Research Journal, Vol. 14, No. 1, (Winter, 1977), pp. 51-71.

The study found more sex-related differences in confidence about one's ability to achieve in mathematics than in the actual mathematics 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 when performing at a level equal or superior to males.[1]

The authors urged educators to offer more opportunities for girls and boys in junior high to perceive mathematics as useful and universal. Girls need more positive reinforcements, while in a setting with males, in their ability to achieve in mathematics.

Dr. Fennema noted "the question of whether or not there are sex-related differences in mathematics is more complicated than it first appears."[2] She noted that while it is true that there are many more males than females involved in the study of post high school mathematics and in adult occupations involving mathematics, it is unclear as to whether this "unequal representation of females and males in post-high school studying and using mathematics

---

[1] Ibid.

[2] Elizabeth Fennema, "Sex Related Differences in Mathematics Achievement: Myths, Realities and Related Factors," Department of Curriculum and Instruction, University of Wisconsin at Madison, (unpublished paper).

is due to females' less adequate learning of mathematics or to deliberate choice by females not to study mathematics."[1]

Fennema took to task the directors of the National Longitudinal Study of Mathematical Abilities (NLSMA). She cited inadequate reporting and interpretation of data by Wilson.

Wilson's study supported the belief that females do not achieve as well as males in mathematics. Fennema's criticism contended that the researcher failed to report "the size of the differences between the mean female and male performance scores and the educational significance of that difference."[2]

Although 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.[3]

the study failed to offer statistical data to substantiate causative factors.

---

[1]Elizabeth Fennema, "Sex Related Differences in Mathematics Achievement: Myths, Realities and Related Factors," Department of Curriculum and Instruction, University of Wisconsin at Madison, (unpublished paper).

[2]<u>Ibid</u>.

[3]J. W. Wilson, "Patterns of Mathematics Achievement in Grade 11: Z Population," National Longitudinal Study of Mathematical Abilities.

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'.[1]

The Fennema study examined in great depth several myths surrounding the question of sex differences in mathematical abilities and achievement. The "positive proof" which many researchers offer to support their beliefs in male superiority to females in mathematics reflects the same degree of questionable research reported on racial supremacy in overall intelligence. One such myth questioned by Fennema was a statement made by Wirtz, who contended "In 1960 the mathematical component means on SAT were 465 for women, 520 for men. Twelve years later, the average for women was virtually unchanged, but the average for men had dropped by 14 points to 506."[2] The SAT (Scholastic Aptitude Test) is a college entrance examination normally administered to high school seniors. It has a mathematics component and a verbal component. The mathematics, according to publishers of the tests, covers skills developed in grades one through nine.

---

[1]Elizabeth Fennema, "Sex Related Differences in Mathematics Achievement: Myths, Realities and Related Factors," Department of Curriculum and Instruction, University of Wisconsin at Madison, (unpublished paper).

[2]Wirtz, p. 16.

"One reason for the decline in scores," concluded Wirtz, "is that more women were taking the test in 1970 than in 1962 when scores were higher."[1] However, Fennema observed that the data do not confirm that women's scores dropped. Furthermore, Fennema maintained that although the mathematics skills required on SAT tests cover areas taught in grades one through nine, it is obvious that if boys continued their mathematics studies throughout high school in much larger numbers than did the girls, they (the boys) were using those mathematics skills, thus retaining them and scoring much higher than girls taking the tests who had perhaps not studied mathematics for the past year or two.

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

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

2. After elementary school years, differences do not always appear.

3. Starting at about the seventh grade, if differences 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 schools may not be as large in 1978 as they were in previous years.

---

[1] *Ibid.*

5. Conclusions reached about male superiority have often been gathered from old studies or 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 participated in less mathematics education. In reality, what was being compared were not females and males but students who had studied mathematics one to three years in high school with students who had studied mathematics two to four years in high school.[1]

It was conceded that there <u>are</u> sex related differences in the <u>studying</u> of mathematics. This phenomenon is explained by young women choosing not to enroll in higher mathematics courses in high school and college. It was felt that "electing not to study mathematics in high school beyond minimal or college requirements is the cause of many females' nonparticipation in mathematics related occupations."[2]

Fennema concluded 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."[3]

---

[1] Elizabeth Fennema, "Sex Related Differences in Mathematics Achievement: Myths, Realities and Related Factors," Department of Curriculum and Instruction, University of Wisconsin at Madison, (unpublished paper).

[2] <u>Ibid</u>.

[3] <u>Ibid</u>.

Is There A Correlation Between The Study Of Mathematics In High School and Career Aspirations Of Young Women?

The Presidential Task Force on Women's Rights and Responsibilities maintained:

> Discrimination in education is one of the most damaging injustices women suffer. It denies them equal education and equal employment opportunity, contributing to a second-class self-image.

"You have probably never considered training your daughter to be a witch, but perhaps you'd better give it a thought."[1]

This caustic statement appears as the lead sentence of a report published by an organization whose goal is to secure legal and economic rights for women by conducting educational and research projects in the area of sex discrimination. According to a study of school primers made by a women's group in Princeton, "witch" is one of only 26 adult occupations shown for women, while 147 jobs were identified for males. The male jobs varied from building contractor to explorer, from shoemaker to zookeeper. Women were portrayed in such characterizations as queen, cleaning woman, secretary, non-working mother (although U. S. Labor statistics

---

[1]"My Son The Astronaut, My Daughter The Witch," WEAL Educational and Legal Defense Fund, Washington, D. C.

project 90 percent of American women will at one time or another be in the labor force), witch, and teacher.

The Title IX Education Amendments of 1972 made discrimination on the basis of sex illegal in any school receiving federal funds, but school textbooks are not included under the act. The WEAL Fund maintains that the typical American school board is composed of 80 percent males, who for the most part are unaware of sex stereotyping. Many teachers, parents, and school age girls are also unaware of sex-role stereotyping. According to this report, by the time a girl has reached the twelfth grade, she has been inundated with textbooks which portray her as a passive onlooker, devoid of female role models in the areas of mathematics, science and American history. Examples of pioneer men "and their wives" lead researchers to ask the question--"What were the wives?"[1]

In their study of images in elementary texts completed in 1974, Lenore Weitzman and Diane Rizzo reported the following patterns of sex-role stereotyping:

> Women comprise 53% of the U. S. population but in textbook illustrations they are only 31% of the total; males appear in 69% of the total. These images show men in 150 occupational roles; by contrast, almost all women illustrated are housewives. Everything goes smoothly for the textbook housewives. The realities and difficulties of

---

[1] Ibid.

> managing a household are neither portrayed or discussed.[1]

In elementary school mathematics books, illustrations and verbal problems showed stereotyped roles for boys and girls. The study contended that girls baked pies and played with dolls, while boys built fences and played with trucks. Other researchers have observed that the tendency for parents and education to encourage boys to build, design, etc. has perhaps been a factor in the superiority of males in visual spatial ability.

A 1973 study of elementary texts in Michigan revealed the following sexist practices:

> <u>Absence of Female Reference Words</u>
>
> The pronoun "she" does not appear until the third book of the series studied. At that same stage, "girl," "her," and "woman" have not appeared at all although "boy," "man," and "him" have appeared.
>
> <u>Identity</u>
>
> Four of ten females to whom reference is made in the texts are mentioned in connection with their husbands.
>
> <u>Demeaning Content</u>
>
> Females young and old are portrayed as incompetent. Texts imply that girls' activities are less important than boys' and that women are more valuable for their appearance than their ability.

---

[1] <u>Ibid</u>.

[2] <u>Ibid</u>.

In a 1974 study in Lexington, Massachusetts, according to the WEAL Fund, it was found that a widely used algebra text for grades eight through ten contained numerous sex stereotypes and biases. Example: "Boys work, earn high grades, paint, push mowers; girls spend money and one is on a diet."

The report cited other examples of sexism which affect career aspirations by lack of sufficient and positive female role models. Not only were textbooks offensive, but so were other instructional materials, such as films, transparencies, recordings, workbooks, games, periodicals, posters, bulletin boards and library materials.[1]

Simmons cited standardized tests, as being culturally biased, adding credence to the "stereotypes that males do better in science and mathematics and females score higher in literature and the arts." These test results are then used to counsel young people into career choices and options which in many cases seriously limit the options for minorities and women. Dr. Simmons suggested several changes are needed in education to end "racial and sexual stereotypes:"[2]

1. Changes in attitudes toward work roles on the basis of race or sex.

---

[1] "Sex Discrimination in an Elementary Reading Program," Kalamazoo, Michigan Public Schools, Michigan Women's Commission, Lansing, Michigan.

[2] Althea T. L. Simmons, Address at the 1976 National Leadership Development Seminar for State Directors of Vocational Education, Tuesday, September 21, 1976, Arrowhead Lodge, Canadian, Oklahoma.

2. Textbook changes depicting minorities and females in nontraditional roles.

3. Teacher training institutions must provide a more realistic training program for teachers and counselors.

4. Affirmative steps must be taken to recruit more women into the professions and vocational education.

Dr. Simmons further stipulated that even the most prestigious universities' traditional discouragement of women from aspiring to professional goals limits the pool of women in the professions.

Dr. Fennema offered the following suggestion in her conclusion:

> There is nothing inherent which keeps females from learning mathematics at the same level as do males. Intervention programs can and must be designed and implemented within schools which will increase females' 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.[1]

Keeves postulated:

> There are clear differences between the sexes in participation in education and in the nature of those educational activities in which boys and girls excel. To the extent that these differences limit the career choices and options for employment available to men and women in later

---

[1]Elizabeth Fennema, "Sex-Related Differences in Mathematics Achievement: Myths, Realities, and Related Factors," Department of Curriculum and Instruction, University of Wisconsin at Madison (unpublished paper).

> years, it must be suggested that inequities exist, even if their mode of operation is more subtle and less readily understood than the more obvious inequalities of race, class, and region. If, as we are hypothesizing, these sex differences are associated with differences in roles expected by society for boys and girls, then it is necessary to question whether or not such differences are the results of tradition and perhaps prejudice.
>
> It would seem that insufficient thought has been given in recent years to the objectives of education in the areas, for example, of mathematics and science, and to whether the current patterns of sex roles in each society and the consequent imposed expectations are compatible with 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. Perhaps within the home, the school, and the peer group new patterns of child-rearing practices and socialization will gradually evolve.[1]

Sells maintained that the job market is dismal for untrained people. She contended that career opportunities are somewhat better for people with high school and college degrees and that the fields which will open up in the next ten or fifteen years are based on mathematics training. She observed that certain groups of students are less likely to take any more mathematics in high school than is required

---

[1]John Keeves, "Differences Between the Sexes in Mathematics and Science Courses," Australian Council for Educational Research.

for admission to most universities. These groups included women and non-Asian minority students.[1]

The four year mathematics sequence is required for admission to courses similar to "Mathematics 1A at Berkeley," which in turn is required for majoring in every subject area at the University of California except the traditionally female and hence lower paying, fields of humanities, social sciences and other related fields.

In a recent small pilot project at the University of California, Berkeley, Sells reported open-ended responses of several upper division social science division students to the question "In summary, what do you consider to be the most important factors which influenced your interest and aptitude for doing mathematics in high school?" The responses were placed in three categories: those who took advanced mathematics and did well in it, those students who took advanced mathematics and performed poorly in it, and those students who did not take advanced mathematics in high school.

In the first category, the students' answers reflected good grades and encouragement of teachers, enjoyment of mathematics, confidence in the ability to handle it (mathematics), self-motivation and parental support, competition among other students in advanced classes, high grades in

---

[1]Lucy Sells, "High School Mathematics As The Critical Filter In The Job Market."

mathematics, and enthusiasm of the mathematics teacher and his/her ability to communicate it to the students. Finally, "...it helped to have fellow students excited about their work."[1]

The above highly positive reactions from high achievers supported the observations of Martin B. Fink who postulated that there exists a definite relationship between self-concept and academic achievement. Fink stipulated, "...an adequate self-concept is related to high achievement and an inadequate self-concept is related to low achievement (under-achievement)."[2]

The second group in the Berkeley study provided the following typical response:

> 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 mathematics teacher called me stupid in front of the class once and this had a great negative effect on my opinion of my intelligence.[3]

Other low achievers felt that mathematics classes were predominantly male oriented, mathematics was taught by males who had low expectations for the girls, that they were

---

[1]Ibid.

[2]Martin B. Fink, "Self-Concept as it Relates to Under-achievement," California Journal of Educational Research, Vol. XIII, No. 2, (March 1962), pp. 57-61.

[3]Lucy Sells, "High School Mathematics As The Critical Filter In The Job Market."

perceived as "stupid" by their mathematics teachers and also experienced low expectations from 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 mathematics. This was not a sexist orientation, but very influential. Have since found out that I have a very strong natural bent for mathematics. I grew up feeling that I was not inclined toward mathematics--feeling that other academic areas were more interesting--that I wouldn't have much use for a lot of mathematics--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.[1]

The above student's observations coincided 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.[2]

---

[1] *Ibid*.

[2] Elizabeth Fennema, "Sex-Related Differences in Mathematics Achievement: Myths, Realities and Related Factors," Department of Curriculum and Instruction, University of Wisconsin at Madison, (unpublished paper).

The third group of Berkeley students offered the following reasons for opting not to elect advanced mathematics 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."[1]

Socialization factors, fear of mathematics, lack of encouragement from family, perceptions of mathematics as a male subject, lack of female role models, and lack of knowledge of careers requiring mathematics and a perception of mathematics as being useless, were responses which were prevalent in the Berkeley study. These were women classified as upper division, who had met Berkeley's stringent admission requirements. As one 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

---

[1] Lucy Sells, "High School Mathematics As The Critical Filter In The Job Market."

> pressure for females. Females were not covertly discouraged, but very infrequently encouraged to study mathematics in high school.

Summary

The review of selected studies revolved around three specific questions:

1. What are some of the identifiable behaviors and practices in American education which promote sexism?

2. Are there differences between the sexes in mathematics performance and achievement?

3. Is there a correlation between the study of mathematics in high school and career aspirations of young women?

In response to the first question, the research reported in this study gave a strong indication that there were several identifiable behaviors and practices in American education which promote sexism. Textbook language, patterns of teacher interaction with male and female students which favor high achieving males, predominantly male school board membership, and failure to encourage young women to pursue elective mathematics courses in high school were identified as a few of many obstacles to educational equity in American education.

Although research studies have been contradictory regarding sex differences in mathematical performance and achievement, the studies by Fennema indicated that females achieve at the same level as males when the variable of years of mathematics study is controlled. Almost all prior studies had failed to control this variable.

In response to the third question, it was concluded that there exists a direct correlation between the study of mathematics in high school and young women's career aspirations, achievement and acquisition.

In conclusion, reference is made to the statement: "If human potentialities are to be realized, society must be concerned not only with theoretical and philosophical concepts of human rights...irrespective of biological and cultural differences, each individual, male or female, must be treated with 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 or talents.[1]

If the above objective cannot be achieved through our educational system, then every parent, teacher, and administrator must answer the question: Where can our young women and men pursue their hopes, their dreams and their future?

---

[1] Phi Delta Kappa Teacher Education Commission on Education and Human Rights, Bloomington, Indiana, 1975.

CHAPTER III

PROCEDURE OF THE STUDY

This study was designed to determine the effectiveness of MATHCO materials, when taught under certain conditions by middle school mathematics teachers, in changing attitudes of middle school boys and girls as to the usefulness of mathematics in selected careers, and to assess their attitudes as to whether certain selected careers were suitable for both women and men. It was felt that this study also would enhance the awareness of educators, parents, and men and women in general regarding the interdisciplinary nature of mathematics, of the usefulness of mathematics in everyday life, and of the necessity for encouraging girls and young women to develop mathematics skills so that they will be prepared to enter many careers for which they have not prepared themselves adequately in the past.

The study was conducted in six Oklahoma middle schools in six Oklahoma school districts. These districts were chosen because of several factors. These factors were diversity of ethnicity, socio-economic strata, teaching experience of selected mathematics teachers, size of school population and no prior experience in the use of interdisciplinary mathematics curricular materials. Although the above variables were not considered as separate entities in the analysis of the data, the results of the experiment do represent the diversity which it was felt was necessary for the perceived target audience of this study.

The Population

The study was conducted with 389 seventh grade students. Seventh graders were chosen because previous studies inferred that at the age of twelve (the average age of seventh grade students), girls' interest in mathematics plummets.

Each of the six school systems was asked to select a teacher who possessed certain qualities which included skill, enthusiasm, willingness to become deeply involved with students as individuals, and who were regarded as highly effective mathematics teachers. The students who participated in the study were the seventh graders who were taught by these selected teachers. The statistical data presented includes treatment of the scores of all seventh grade students who participated in the study.

TABLE I

POPULATION COMPOSITION - DESCRIPTION

School	Demographic Description	Female	Male
A	Middle school, large school district. Female principal, predominantly white, median-income community.	47	49
B	Junior-senior high school, independent school district. Suburban neighborhood school, predominantly black middle-income community.	44	34
C	Middle school, neighborhood middle-class university town community. Urban setting. Predominantly white, middle-class community.	32	25
D	Junior-senior high school, independent school district on perimeter of large city school district. Predominantly black low-income neighborhood.	16	10
E	Junior-senior high school, independent school district, rural, predominantly Native American low-income farming community.	20	12
F	Middle school, large urban school district. Pupils are "bussed" in from all over the city. Pupils are racially and economically diversified from high to low-income families.	49	51

The Instrument

The literature pertaining to attitudes regarding mathematics and mathematics related careers failed to reveal an adequate instrument designed to determine the effectiveness of curriculum materials pertinent to the objectives of MATHCO. (See Appendix C.) Therefore, it became necessary to develop such a tool.

The MATHCO National Review Board participated in the development of the instrument from the projects' initial inception in October, 1977. Content validity was provided by this panel of educators skilled in mathematics education and counseling. (See Appendix A.)

The MATHCO Questionnaire was developed in order to ascertain the students' attitudes about the perceived usefulness of mathematics as a necessary tool in their present and future endeavors. It was felt that students' attitudes about career accessibility might have a direct correlation to their attitudes about whether or not mathematics was a "necessary" subject. The questionnaire was divided into four sections and was presented as a slide audio-tape component. The first section presented several vignettes of persons applying for jobs, persons working on jobs, etc. The students were asked if mathematics was being used or whether the male or the female should be hired for a particular job. Example: One illustration portrayed a woman approaching a building which had two signs displayed which read as follows: "School principals apply at the door on the right. School teachers apply at the door on the left." The question which the students were asked was, "To which door should this person go to apply for a job?"

The second part of the questionnaire or test listed and illustrated 35 careers and the respondents were asked to check one of three columns: male, female, or both, indicating who was most capable of filling each career.

Part three illustrated the same above mentioned (35) careers and the students responded either yes or no to the question, "Is mathematics used or needed in this career?"

Part four contained five blank spaces in which respondents were asked to list five careers in which they were interested or which they would like to pursue in the future. The total possible score was 125 points.

A student could score 125 points by listing five careers as a possible future career, by projecting all careers in the questionnaire as suitable for both men and women, and by responding positively to the question, "Is mathematics used or needed in this career?"

Before taking the MATHCO Questionnaire, each student responded to five questions on the Pupil Personal Inventory. The questions on the survey dealt with each student's perception of his/her own ability and interest in mathematics. The final question dealt with the extent to which the student would seek or avoid a career which used mathematics. The total possible score on the inventory was 25 points.

The questions were scored on a continuum. The higher points were given for pupils' high self-rating of mathematical ability and the degree to which each respondent would seek a career which used mathematical skills.

Each teacher was asked to give the researcher a list containing the names of each class member participating in the study. The students on the list were placed into three categories indicating either high, middle or low mathematics achievement for each participating student.

Procedure of the Study

In June, 1977, a preliminary visit to the school districts was made by the researcher for the purpose of explaining and clarifying the objectives of the study. These visits were followed by a formal agreement with the schools indicating their willingness to participate in the study.

In September, 1977, a meeting was held at the University of Oklahoma with two representatives from each of the six school systems. These representatives included, from each school district, the selected mathematics teacher who would participate in the study and one other district representative. The non-teaching representatives included one school superintendent who was a former mathematics teacher, two school principals, and three mathematics consultants. At this meeting the study was explained in detail and questions were asked and discussed. Since the MATHCO study involved not only the administering of a questionnaire, but in addition three weeks of teaching MATHCO materials to their students, the six district representatives needed assurances that appropriate mathematics skills would be covered and that their students would not suffer as a result of the exclusive use of MATHCO materials for the three week period. To report that the representatives were skeptical initially would be an understatement. However, they were assured that the curriculum developers had been carefully chosen and that the project staff would be in close contact with them throughout the developmental stages of the materials.

Before the materials were administered in the classrooms, the selected teachers and district representatives returned to the University of Oklahoma in March, 1978, to preview the instrument and receive instructions on its proper administration to their students. The group approved the instrument and the identified units for the study.

On April 7, 1978 the Pupil Personal Inventory was administered, and the following Monday, April 10, the MATHCO Questionnaire was administered. The next 15 days of class were devoted to teaching the MATHCO interdisciplinary materials. On the sixteenth class day the students took the MATHCO Questionnaire for post-testing.

As a basis for judging the effectiveness of the teaching materials used in the project, the students and teachers evaluated each lesson which was taught. Each teacher evaluated the MATHCO Questionnaire on a form designed by the MATHCO staff. After the three-week period, the third meeting was held with the six mathematics teachers to discuss their experiences with the MATHCO Questionnaire and curriculum materials.

Statistical Procedure

In an effort to test the hypotheses stated in Chapter I, it was necessary to test 1) the sex main effect to determine if the mean dependent measure (MATHCO Questionnaire Score) for males and females differed; 2) the testing main effect to determine if the mean dependent measure for the Pre-Test differed from that for the Post-Test; and 3) the interaction of sex and testing effect to determine the difference, if any, between male and female MATHCO scores on the Pre-Test was significantly different from the difference, if any, between male and female on the Post-Test.

The above hypotheses were submitted to a 2 X 2 analysis of variance with repeated measures at the .01 level of confidence.

The remaining two hypotheses involved the computation of the correlation between the trichotomized teacher rating of students with the Pupil Personal Inventory scores and the Pre-Post Questionnaire difference scores. The Jaspen[1]

---

[1]Jaspen, Naten, 1946. Serial Correlation. Psychometrika 11, 23-30.

and Jenkins[2] procedures for triserial correlation were used for computing the above statistical data.

[2]Jenkins, W. L., 1956, "Triserial 4 - A Neglected Statistic," Journal of Applied Psychology, Vol. 40, pp. 63-64.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

INTRODUCTION

This study was designed to determine the effectiveness on middle school students of MATHCO: A Program to Enhance Young Women's Understanding of Interdisciplinary Uses of Math in Career Choices. The major purpose of this chapter is to present, analyze and interpret the data derived from the instruments used in the study.

Utilizing the procedures designed in Chapters I and III, data on students' attitudes were derived from six middle schools and junior high schools in Oklahoma. These data were analyzed to test the following hypotheses:

HO_1 There is no significant difference between the attitudes of seventh grade male and female students regarding mathematics and mathematics careers.

HO_2 There is no significant difference in attitudes of seventh grade students about mathematics and careers before using MATHCO materials and after using MATHCO materials.

HO_3 The difference, if any, for MATHCO Questionnaire scores between females and males on the pre-test is not significantly different from the difference, if any, between females and males on the post-test.

HO_4 There is no correlation between teachers' rating of students' ability in mathematics and students' self-rating on the mathematics and careers personal interest inventory.

HO_5 There is no correlation between teachers' rating of students' ability in mathematics and students' pre-post training difference scores on the MATHCO Questionnaire.

Statistical data and its analysis were reported in condensed form utilizing tables. Their primary purpose was to provide clarification of statistical evidence.

Summarization of Data Analysis

The MATHCO Questionnaire data were submitted to a 2 X 2 ANOVA with repeated measures on one independent variable, testing (pre vs. post).[1] The second independent variable was sex (male vs. female). This statistical design allowed the testing of three specific hypotheses for the above paradigm:

1. The sex main effect: which holds that the mean dependent measure (MATHCO Questionnaire score) for males does not differ from that for females.

2. The testing main effect: which holds that the mean dependent measure for the pre-test does not differ from that for the post-test.

3. The interaction of sex and testing effect: which holds that the difference, if any, between male and female MATHCO Questionnaire scores on the pre-test is not different from the difference, if any, between males and females on the MATHCO post-test.

---

[1]Bruning, James L.; Kintz, B. L., "Two Factor Mixed Design: Repeated Measures on One Factor." Computational Handbook of Statistics (second edition), pp. 55-61.

Tables II through VIII summarize for each of the six schools (A through F) the means and standard deviations for the 2 X 2 designs. Each table also includes the summary for the analysis of variance on these data. Below each table appear conclusions from the analyses of MATHCO Questionnaire data contributed by seventh grade students from each of the participating schools. These data are relative to HO_1, HO_2, and HO_3.

TABLE II
MEAN SCORES AND STANDARD DEVIATIONS
MATHCO QUESTIONNAIRE DATA
SCHOOL A

Sex	Number		Pre	Post
Male	49	$\bar{X}$	73.73	83.94
		SD	13.13	16.97
Female	47	$\bar{X}$	83.81	107.19
		SD	20.73	18.44

ANALYSIS OF VARIANCE

Source	SS	DF	MS	F
Sex (S)	13322.10	1	13322.10	26.29*
error between	499.08	94	499.08	-
Testing (T)	13316.70	1	13316.70	118.07*
S x T	2083.30	1	2083.30	18.47*
error within	10601.50	94	112.78	-

*$p < .01$

School A

This school is a large, predominantly white, median income middle school in a predominantly white community. The principal is female, has a strong mathematics background and the school was the first school to send a letter of commitment to the project.

The mean female scores were greater than male scores (at $p < .01$). The mean post-test scores were greater than the pre-test scores ($p < .01$). Although female scores were initially greater than male scores, females had a greater pre to post-test increase than did males ($p < .01$).

TABLE III
MEAN SCORES AND STANDARD DEVIATIONS
MATHCO QUESTIONNAIRE DATA
SCHOOL B

Sex	Number		Pre	Post
Male	34	$\bar{X}$	73.35	93.94
		SD	13.83	21.33
Female	44	$\bar{X}$	79.61	100.04
		SD	19.51	19.45

ANALYSIS OF VARIANCE

Source	SS	DF	MS	F
Sex (S)	1466.20	1	1466.20	2.60
error between	42874.50	76	564.14	-
Testing (T)	16389.80	1	16389.80	112.28*
S x T	.23	1	.23	.002
error within	11093.50	76	145.98	-

*p <.01

School B

This is a junior-senior high school which is located within walking distance of the National Cowboy Hall of Fame, a large planetarium, golf course, and Interstate Highway 35. The students are predominantly black and they live in a suburban predominantly black middle class neighborhood. The new superintendent-elect of this independent school is black.

There was no difference between male and female scores (at $p < .01$). The mean post-test scores were greater than pre-test scores. ($p < .01$). There was no interaction between sex and testing.

TABLE IV
MEAN SCORES AND STANDARD DEVIATIONS
MATHCO QUESTIONNAIRE DATA
SCHOOL C

Sex	Number		Pre	Post
Male	25	$\bar{X}$	74.44	80.32
		SD	14.77	19.69
Female	32	$\bar{X}$	80.47	89.03
		SD	16.25	17.87

ANALYSIS OF VARIANCE

Source	SS	DF	MS	F
Sex (S)	1524.68	1	1524.68	2.95
error between	28424.30	55	516.81	-
Testing (T)	1554.75	1	1554.75	20.34*
S x T	50.50	1	50.50	.66
error within	4204.16	55	76.44	-

*$p < .01$

School C

This is a middle school whose pupils live in the surrounding neighborhood. The neighborhood is predominantly white, middle-class and is located in a medium sized suburb which revolves around a large university.

There was no difference between male and female scores (at $p < .01$). The mean post-test scores were greater than the pre-test scores ($p < .01$). There was no interaction on female-male rate of gain.

TABLE V
MEAN SCORES AND STANDARD DEVIATIONS
MATHCO QUESTIONNAIRE DATA
SCHOOL D

Sex	Number		Pre	Post
Male	10	$\bar{X}$	70.30	72.20
		SD	18.74	20.07
Female	16	$\bar{X}$	74.12	82.44
		SD	15.12	19.45

ANALYSIS OF VARIANCE

Source	SS	DF	MS	F
Sex (S)	608.47	1	608.47	1.01
error between	14461.20	24	602.55	-
Testing (T)	444.31	1	444.31	7.48*
S x T	126.52	1	126.52	2.13
error within	1426.17	24	59.42	-

*$p < .05$

School D

This is a junior-senior high school, independent school district. Logistically, it is located on the perimeter of a large metropolitan school district. The students are representative of different races and are for the most part lower income students. Their neighborhood includes a highly populated public housing project which has been the subject of numerous outbreaks of violence.

There was no difference between male and female scores (at $p < .05$). The mean post-test scores were greater than pre-test scores (at $p < .05$). There was no interaction between sex and testing.

TABLE VI
MEAN SCORES AND STANDARD DEVIATIONS
MATHCO QUESTIONNAIRE DATA
SCHOOL E

Sex	Number		Pre	Post
Male	12	$\overline{X}$	67.42	68.25
		SD	7.99	12.59
Female	20	$\overline{X}$	85.55	88.20
		SD	17.98	17.30

ANALYSIS OF VARIANCE

Source	SS	DF	MS	F
Sex (S)	5438.78	1	5438.78	12.72*
error between	12823.20	30	427.44	-
Testing (T)	62.02	1	62.02	1.28
S x T	12.38	1	12.38	.26
error within	1450.11	30	48.34	-

*$p < .01$

School E

This school is a junior-senior high school, independent school district. The setting is rural, and farming is the chief means of income for the families in this school community. The population of the school is predominantly Native American. The other students are white American. The economic level is lower income.

The mean female scores were greater than male scores (at $p < .01$). Pre-test scores did not differ from post-test scores. There was no interaction between males and females.

TABLE VII
MEAN SCORES AND STANDARD DEVIATIONS
MATHCO QUESTIONNAIRE DATA
SCHOOL F

Sex	Number		Pre	Post
Male	51	$\bar{X}$	77.02	81.26
		SD	18.38	21.52
Female	49	$\bar{X}$	79.06	91.98
		SD	19.63	19.02

ANALYSIS OF VARIANCE

Source	SS	DF	MS	F
Sex (S)	2014.92	1	2014.92	2.88
error between	67907.00	97	700.07	-
Testing (T)	3606.19	1	3606.19	48.55*
S x T	931.92	1	931.92	12.55*
error within	7205.40	97	74.28	-

*$p < .01$

<u>School F</u>

This school is a middle school in a large metropolitan city. The pupils are "bussed" in from all over the city. The racial and socio-economic strata are diversified. The students represent all income and social levels from very high income to very low income families. The principal is black and very progressive. The school is relatively new and campus style. The school is located in a high-income neighborhood.

There was no difference between male and female scores (at $p < .01$). The mean post-test scores were greater than pre-test scores. Although mean female scores did not differ from males scores on the pre-test, their mean increase on the post-test was greater than the mean increase for males ($p < .01$).

Table VIII represents a summarization of data for the combined population formed by pooling seventh grade students from the six school systems. An inspection of the pattern of the four means for each of the six school systems showed essentially the same pattern. The male pre-test results were the smallest of the four means. The female pre-test results were the next smallest mean scores. The male post-test increase over the pre-test was generally larger than the female pre-test mean, and finally, the female post-test was the largest mean score. The pooling of this pattern is represented below for the combined data. Figure I represents a graphic presentation of the above data.

TABLE VIII
COMBINED SAMPLE OF SEVENTH GRADE STUDENTS
FROM THE SIX SCHOOLS

Sex	Number		Pre	Post
Male	181	$\overline{X}$	74.14	83.01
		SD	15.20	20.47
Female	208	$\overline{X}$	80.71	95.57
		SD	18.93	20.09

ANALYSIS OF VARIANCE

Source	SS	DF	MS	F
Sex (S)	17717.20	1	17717.20	29.79*
error between	230172.00	387	594.76	-
Testing (T)	28332.90	1	28332.90	245.62*
S x T	1741.31	1	1741.31	15.10*
error within	44641.30	387	115.35	-

*$p < .01$

Figure 1 presents a graphic presentation of statistical data from Table VIII.

MATHCO QUESTIONNAIRE
PRE - POST MEAN SCORES
COMBINED SCHOOLS

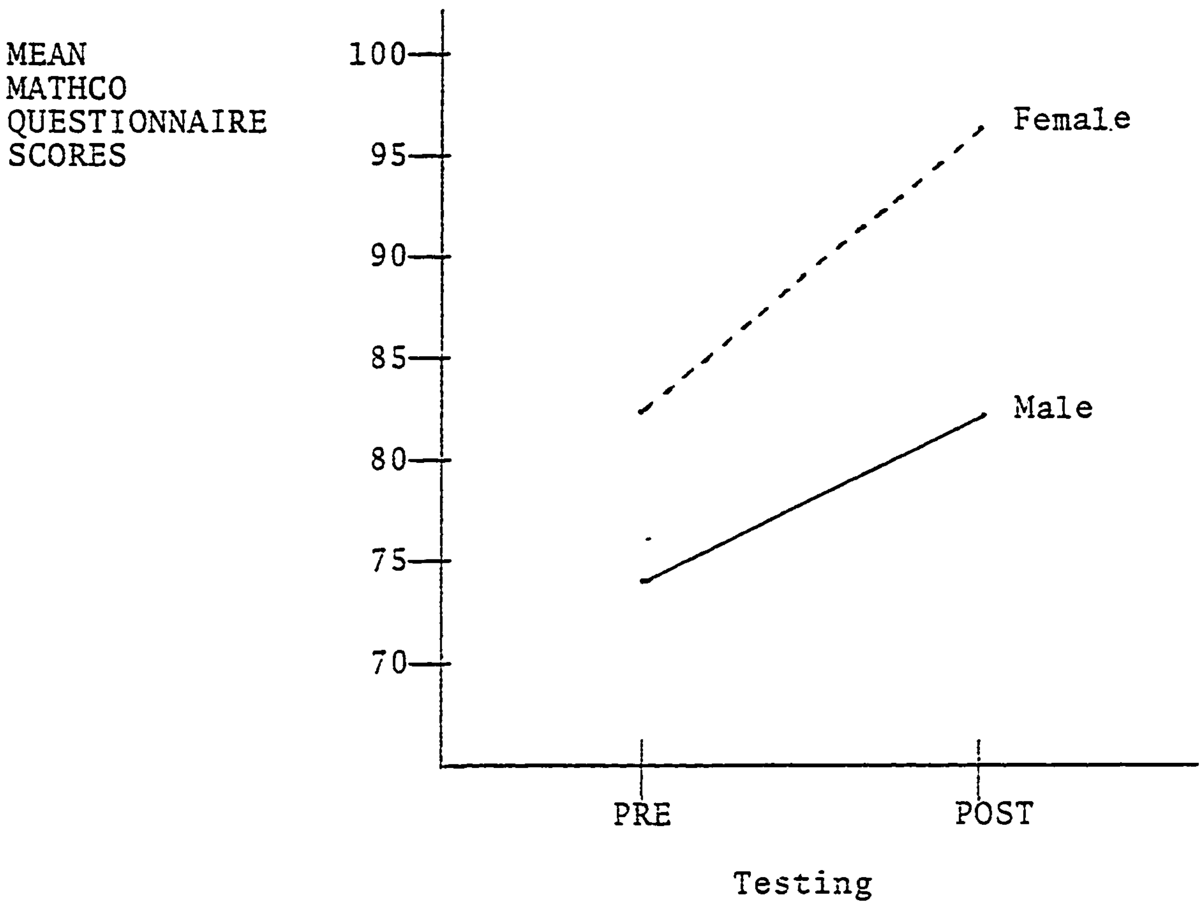

figure 1.

Jaspen reported a procedure for estimating the correlation between two variables where one variable is distributed along a continuous scale and the other is reduced to three discrete categories or otherwise stated are trichotomized.[1] This statistic seemed appropriate for computing the correlation between Personal Inventory Scores for students at each of the six cooperating schools and mathematics teacher ratings of each student as high, middle, or low mathematics performance. It was also decided that similar triserial correlations could be computed for these same groups using the same mathematics teacher ratings as the trichotomized variable and pre-post test MATHCO Questionnaire score differences as the distributed variable. Further, samples were pooled and triserial correlations were computed between the trichotomized teacher rating variable and each of the two distributed variables, Personal Inventory scores and MATHCO difference scores.

Table IX summarizes the triserial correlation between the trichotomized teacher rating variable (high, middle, and low) and Personal Inventory scores for seventh grade students in each of the six school systems. The mean and standard deviation for each of the trichotomized categories is also presented. For a positive correlation

---

[1]Nathan Jaspen, "Serial Correlation," Psychometrika 11, pp. 23-30. 1946.

to exist, the magnitude of the means must descend from the high group to the low group. Jenkins, in a 1956 article, provided the following formula for the standard error of a triserial correlation coefficient:

$$SE_{tri} = \frac{\sqrt{pg/y - r^2 - .5 + P}}{N}$$

With this formula the computed triserials were tested for significance differing from a zero correlation by utilizing the t statistic.[1]

The triserial correlation coefficients for School A (.689), School B (.548), and School F (.546) by application of this procedure were significantly different at the .05 level of confidence from a zero correlation. The triserial correlations for School C (.258), School D (.073) and School E (.351 and small n's) on the other hand, were not significant. It is important to note, however, that all six schools had positive correlations and, with the exception of the high-middle reversal for School D, the means descended from high to low for the other five schools.

---

[1]W. L. Jenkins, "Triserial r - A Neglected Statistic," *Journal of Applied Psychology*, pp. 40, 63-64. 1956.

TABLE IX
TRISERIAL CORRELATIONS BETWEEN PERSONAL INVENTORY SCORES AND THE CATEGORIES OF TEACHER RATING FOR SEVENTH GRADE STUDENTS IN SIX SEPARATE SCHOOLS

School		Teacher Rating Categories		
		High	Middle	Low
A	N	37	28	31
	Mean	20.73	18.29	15.52
	SD	2.06	3.21	3.34
r_{tri} = .689*				
B	N	27	29	22
	Mean	20.85	19.03	17.27
	SD	1.90	2.71	3.01
r_{tri} = .548*				
C	N	17	23	17
	Mean	15.53	15.48	14.18
	SD	1.66	1.97	2.88
r_{tri} = .258				
D	N	11	14	7
	Mean	16.91	17.00	16.57
	SD	3.08	3.82	2.57
r_{tri} = .073				
E	N	4	11	11
	Mean	18.25	16.36	14.00
	SD	4.11	2.84	3.46
r_{tri} = .351				
F	N	31	34	35
	Mean	19.16	18.18	15.31
	SD	3.00	2.11	3.26
r_{tri} = .546*				

*$p < .01$

TRISERIAL CORRELATION BETWEEN PERSONAL INVENTORY SCORES
AND THE THREE CATEGORIES OF TEACHER RATINGS
FOR SEVENTH GRADE STUDENTS - COMBINED SIX SCHOOLS

		High	Middle	Low
Six Schools Combined	N	127	139	123
	Mean	19.27	17.67	15.51

r_{tri} - .465*

*p < .01

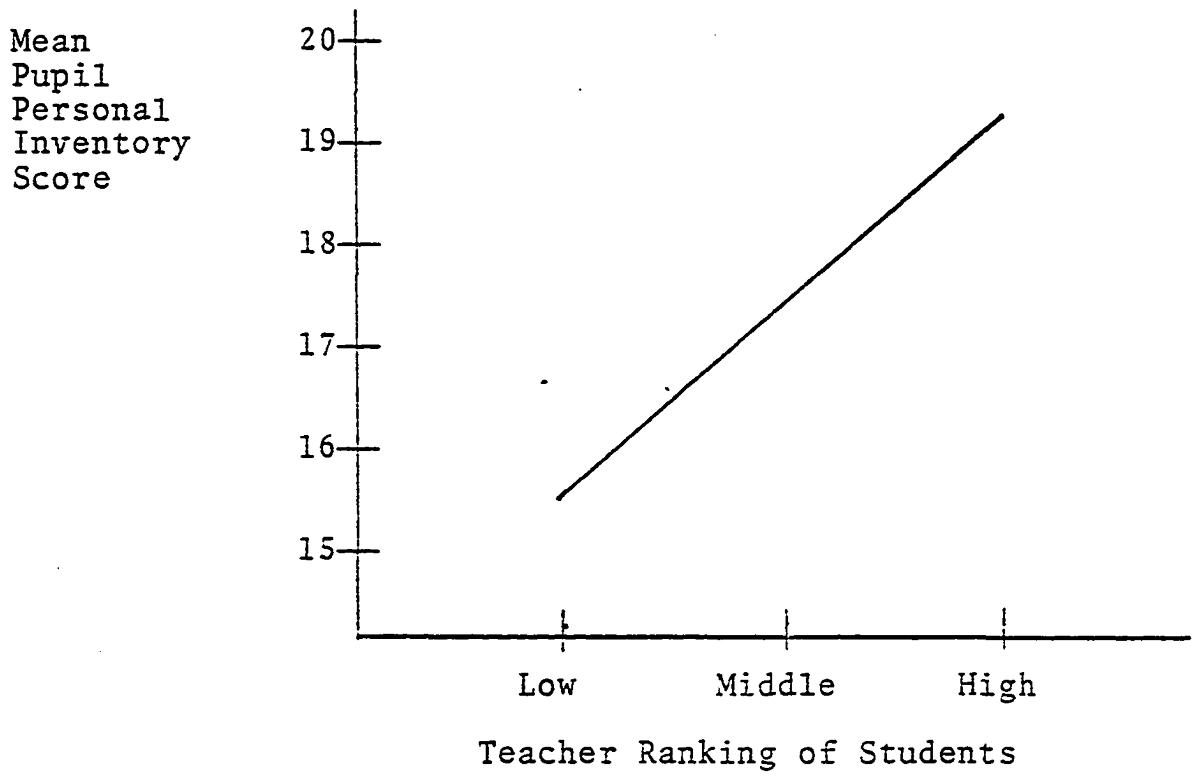

figure 2.

Figure 2 summarizes the triserial correlation for the combined samples (N = 389), which yielded a moderate, positive correlation of .465 which was statistically significant at the .01 level. The Means descended from High to Low with values of 19.27, 17.67, and 15.15, respectively.

Table X summarizes the Mean Pre - Post difference scores on the MATHCO Questionnaire for the trichotomy formed by dividing students into high, middle, and low mathematics aptitude groups based on teacher evaluations. These means and standard deviations are presented for seventh grade students from each of the six school systems, along with the computed triserial correlation coefficient for each. Only two of the triserial correlation coefficients reached statistical significance at the .05 level: School E (.552) and School F (-.341). It should be noted that the triserial correlation for School F was a negative correlation. Specifically, this indicates that for School F, the Low Group had the largest Mean Pre - Post test change, followed by the Middle, and trailed by the High Group; the triserial correlation coefficient for the combined six school population of 389 seventh grade students yielded a nonsignificant .095.

TABLE X
TRISERIAL CORRELATIONS BETWEEN PRE - POST DIFFERENCE SCORES ON THE MATHCO QUESTIONNAIRE AND THREE CATEGORIES OF TEACHER RATINGS FOR SEVENTH GRADE STUDENTS IN SIX SEPARATE SCHOOL SYSTEMS

School		Teacher Rating Categories		
		High	Middle	Low
A	N	37	28	31
	Mean	16.11	17.89	15.87
	SD	13.59	19.75	16.50
$r_{tri} = .003$				
B	N	27	29	22
	Mean	24.78	17.41	16.68
	SD	16.24	20.13	15.36
$r_{tri} = .210$				
C	N	17	23	17
	Mean	9.35	10.39	1.71
	SD	13.56	13.31	7.90
$r_{tri} = .264$				
D	N	11	14	7
	Mean	3.45	1.86	-0.14
	SD	11.84	9.91	5.67
$r_{tri} = .178$				
E	N	4	11	11
	Mean	13.25	9.18	-0.18
	SD	10.72	11.30	8.61
$r_{tri} = .552$*				
F	N	31	34	35
	Mean	6.23	8.94	10.40
	SD	12.86	11.26	14.30
$r_{tri} = -.341$ *				

*$p < .05$

Table XI displays the triserial correlation coefficient for the combined six school population of 389 seventh grade students which yielded a nonsignificant .095.

TABLE XI
TRISERIAL CORRELATION COEFFICIENT
COMBINED SIX SCHOOL POPULATION

Six Schools Combined		High	Middle	Low
	N	127	139	123
	Mean	13.45	12.06	10.15
r_{tri} = .095				

Pursuant to the findings, it was necessary to respond to the hypotheses in the following manner:

HO_1 There is no significant difference between the attitudes of seventh grade male and female students regarding mathematics and mathematics careers.
Rejected.

HO_2 There is no significant difference in attitudes of seventh grade students about mathematics and careers before using MATHCO materials and after using MATHCO materials.
Rejected.

HO_3 The difference, if any, for MATHCO Questionnaire scores between females and males on the pre-test is not significantly different from the difference, if any, between females and males on the post-test.
Rejected.

HO_4 There is no correlation between teachers' rating of students' ability in mathematics and students' self-rating on the mathematics and careers personal interest inventory.
Rejected.

HO_5 There is no correlation between teachers' rating of students' ability in mathematics and students' pre-post training difference scores on the MATHCO Questionnaire. Accepted.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The problem of this study was to determine the effectiveness of MATHCO materials, when taught under certain conditions by middle and junior high school mathematics teachers, in changing attitudes of middle and junior high school boys and girls as to the usefulness of mathematics in selected careers. The study also assessed attitudes regarding the suitability of selected careers for both women and men.

MATHCO is an interdisciplinary mathematics careers curriculum model program for middle and junior high school. The model consists of six modules which include activities focusing on the relationship of mathematics and social sciences, practical arts, fine arts, language arts, science, and careers.

The study was designed to test the following hypotheses:

HO_1 There is no significant difference between the attitudes of seventh grade male and female students regarding mathematics and mathematics careers.

HO_2 There is no significant difference in attitudes of seventh grade students about mathematics and careers before using MATHCO materials and after using MATHCO materials.

HO_3 The difference, if any, for MATHCO Questionnaire scores between females and males on the pre-test is not significantly different from the difference, if any, between females and males on the post-test.

HO_4 There is no correlation between teachers' rating of students' abilities in mathematics and students' self-rating on the mathematics and careers personal interest inventory.

HO_5 There is no correlation between teachers' rating of students' ability in mathematics and students' pre-post training difference scores on the MATHCO Questionnaire.

In order to test these hypotheses, the following procedures were used in this study.

A review of the related literature described in Chapter II revealed the nature of previous research done in sex-related differences in attitudes, achievement, educational practices and career aspirations and preference in the area of mathematics and answered in large part the following questions: 1) What are some of the identifiable behaviors and practices in American education which promote sexism?, 2) Are there differences between the sexes in mathematics performance and achievement?, and 3) Is there a correlation between the study of mathematics in high school and the career aspirations, achievement, and acquisition of young women? The review of literature pinpointed the need for intervention programs in mathematics and career education at the middle school level.

The MATHCO Questionnaire was designed and administered to seventh grade students for the purpose of testing the effectiveness of MATHCO instructional materials in altering the attitudes of students regarding 1) the usefulness of mathematics in selected careers, and 2) the suitability of selected careers for both women and men.

The population of the study included seventh grade students from six Oklahoma middle and junior high schools located in six different school districts who were administered the MATHCO Pre-Post Questionnaire. Of the 389 students, 54 percent were female and 46 percent were male.

School	Sex	
	Female	Male
A	47	49
B	44	34
C	32	25
D	16	10
E	20	12
F	49	51
Total	208	181

The pupil personal interest inventory was administered to the students in all six schools on April 7, 1978. The MATHCO Questionnaire was administered to the same students on April 10, 1978.

For the ensuing three weeks they studied MATHCO materials, which included interdisciplinary mathematics/careers activities. On April 31, 1978, the students were administered the MATHCO Questionnaire for post-testing. (See Appendix B.)

Findings

The two-way analysis of variance with repeated measures on one independent variable, testing, pre vs. post, and the second independent variable which was sex, allowed the testing of the first three hypotheses. The data indicated that mean female scores were greater than male scores at the .01 level. The mean post-test scores were greater than the pre-test scores and the rate of gain for females was greater than that of males.

The triserial correlation between teacher ranking of students in three categories of high, middle, or low and Pupil Personal Inventory indicated a moderate, positive correlation of .465 which was statistically significant at the .001 level. The means descended from high to low with values of 19.27, 17.67, and 15.51 respectively (out of a possible raw score of 25).

The triserial correlation between mean pre-post test difference scores on the MATHCO Questionnaire for the trichotomy formed by dividing students into high, medium, and low mathematics aptitude groups based on teacher evaluations yielded a nonsignificant .095.

On the basis of the information revealed in the statistical analysis, the following hypotheses were, therefore, rejected:

HO_1 There is no significant difference between the attitudes of seventh grade male and female students regarding mathematics and mathematics careers.

HO_2 There is no significant difference in attitudes of seventh grade students about mathematics and careers before using MATHCO materials and after using MATHCO materials.

HO_3 The difference, if any, for MATHCO Questionnaire scores between females and males on the pre-test is not significantly different from the difference, if any, between females and males on the post-test.

HO_4 There is no correlation between teachers' rating of students' ability in mathematics and students' self-rating on the mathematics and careers Personal Interest Inventory.

The following hypothesis was accepted:

HO_5 There is no correlation between teachers' rating of students' ability in mathematics and students' ability in mathematics and students' pre-post training difference scores on the MATHCO Questionnaire.

Other Findings

It was also found that seventh grade students had little knowledge about careers which require mathematics skills. These students tended to perceive mathematics as the study of numbers and the working of problems within the boundaries of the mathematics classroom. The interdisciplinary nature of mathematics and its practical applicability to everyday life seemed to be almost unknown by seventh grade students.

It was found that males and females who live in black suburban, middle class communities tended to have similar attitudes about mathematics and careers.

Although females (to a greater extent than males) in the study tended to accept the premise that women can enter most careers which have heretofore been traditionally male, the black males from the middle class, suburban neighborhood accepted this premise to a greater extent than did all other males in the study.

It was found that males in the rural and low income neighborhoods experienced less change in attitude than all other males in the study. Males in the rural, predominantly Native American school achieved the lowest pre-test score, 67.42, and the lowest gain score, 68.25, of all six schools. However, the girls in this school had a pre-test score of 85.55, which was the highest pre-test score of the six schools. This school is located in a rural community.

It was found that Native American rural seventh grade girls tended to see mathematics and mathematics careers as useful for women to a much greater extent than did Native American rural seventh grade boys, perhaps because of Indian cultural attitudes regarding the traditional roles of women.

It was found from written student evaluations of MATHCO materials that male and female students did enjoy experimenting with innovative, interdisciplinary mathematics materials, that they enjoyed audiovisual motivational presentations, and that they liked the opportunity to use materials which reflect everyday life, i.e., writing checks, computing bowling scores, building and using a hygrometer, studying the electoral college, designing their dream houses, computing long distance telephone rates and planning an automobile trip.

Conclusions

It was concluded that the historical discrimination toward women in mathematics related careers was probably the major cause for the differing perceptions of boys and girls toward entry in these careers.

Because black males from suburban middle-class communities have suffered historically from job and career discrimination because of race, these males tended to identify with sex discrimination at a rate equal to their female counterparts. The conclusion was therefore reached that black males and females from middle-class backgrounds should both receive special encouragement to enter careers which have been traditionally reserved for white males.

It was concluded that many vocational or career counseling programs are not effective in junior high or middle schools where such counseling could be most effective in encouraging girls to become familiar with new career opportunities for women. In the schools whose students belong to cultural or socio-economic groups where mathematics related careers have traditionally been denied to or avoided by males as well as females, the need for counseling in these careers is obviously greater.

It was concluded that some mathematics teachers and administrators welcomed the opportunity to test new innovative mathematics materials and that they were concerned about ways to reduce school practices which are discriminatory regarding sex.

It was concluded that regardless of mathematics ability, seventh grade students' attitudes about mathematics and careers can be changed by innovative, interdisciplinary curriculum materials, and that public school systems and universities can cooperatively develop materials and teaching procedures which are designed to enhance understanding regarding career opportunities for women in mathematics related fields.

It was concluded that counselors, parents and educators in those schools whose students are from rural, low socio-economic, or racial minority homes, should perceive the problem of mathematics avoidance as a male and female problem. Young men from these designated groups need the same level of concentrated mathematics related career counseling as do the young women.

It was concluded that present efforts in mathematics teaching probably do not include any significant effort to achieve the objectives of the MATHCO program.

Recommendations

Historically, the middle school philosophy has included the concept of exploration. According to Bibens, the middle school curriculum should include exhaustive opportunities for the students to explore various academic and career areas.[1] Bibens further stipulated that the

[1]Robert F. Bibens, Professor of Education, University of Oklahoma. Workshop Presentation, 1978.

interdisciplinary nature of <u>all</u> subject offerings should be developed and presented to middle school students.

The recommendations which follow are not restricted to this study, but are related to the exploratory nature of the middle school, including the interdisciplinary nature of mathematics, career education and the educational equity of young women and young men.

1. It is recommended that middle school educators reduce the practice of presenting subject matter to students in isolated compartments. Students need to discover that all subjects are interdisciplinary, thus increasing the students' appreciation of the "out of the classroom" usefulness of knowledge gained in school.

2. It is recommended that middle school mathematics teachers help students to correlate everyday problem-solving in the classroom with problem-solving in related careers.

3. It is recommended that mathematics educators examine textbooks, audiovisual entities, and other teaching materials for sex-biased and culturally-biased language, illustrations, and exclusions.

4. It is recommended that mathematics educators examine their classroom behavior regarding high achievers, low achievers, males and females.

5. It is recommended that mathematics educators purposely structure positive self-concept activities in the classrooms.

6. It is recommended that teachers, counselors, and parents examine their own attitudes regarding the ability of women and girls to achieve in mathematics.

7. It is recommended that counseling programs be strengthened in middle and junior high schools so that students will be able to elect high school programming more suited to their needs and abilities.

8. It is recommended that a longitudinal study be conducted in five years to determine the percentages of seventh graders in this study who elected more years of mathematics in high school.

9. It is recommended that future research studies involving the subject of sex-related differences in mathematics achievement include population samples which represent the diverse racial and socio-economic groups in this country.

10. Finally, it is recommended that special materials similar to those used in "MATHCO" be used by teachers in the developing learning experiences for students in mathematics classes offered in the high school.

BIBLIOGRAPHY

Books

Brownoski, J. "Mathematics." In The Quality of Education, edited by D. Thompson and J. Reeves. London: Muller, 1947.

Bruning, James L.; Kintz, B. L. "Two Factor Mixed Design: Repeated Measures on One Factor." Computational Handbook of Statistics (second edition) 55-61.

Callahan, J. G.; Glennon, V. J. Elementary School Mathematics: A Guide to Current Research. Washington, D. C.: Association for Supervision and Curriculum Development, 1975.

Festinger, L., and others. Conflict, Decision and Dissonance. Stanford University Press: Stanford, 1964.

Flanagan, J. C.; Davis, F. B.; Daily, J. T.; Shaycroft, M. F.; Orr, D. B.; Goldberg, I.; and Mayman, C. A. The American High School Student. University of Pittsburgh: Pittsburgh, 1964.

Fox, L. H. "Sex Differences in Mathematical Precocity: Bridging the Gap." In Intellectual Talent: Research and Development, edited by D. P. Keating. Baltimore: Johns Hopkins University, 1976.

French, J. W. The Description of Aptitude and Achievement Factors in Terms of Rotated Factors. Chicago: University of Chicago Press, 1951.

Ghiselli, Edwin E. Theory of Psychological Measurement. McGraw-Hill: New York, 1964.

Harman, H. Modern Factor Analysis. Chicago: Chicago University Press, 1962.

Husen, Torsten, ed. International Study of Achievement in Mathematics: A Comparison of Twelve Countries. Wiley: New York, 1967.

Kagan, J. "Acquisition and Significance of Sex Typing and Sex Role Identity." In Review of Child Development Research, edited by M. L. Hoffman and L. Hoffman. New York: Russell Sage Foundation, 1964.

Macoby, Elenore E. The Development of Sex Differences. Stanford: Stanford University Press, 1966.

Macoby, E. E. and Jacklin, C. N. The Psychology of Sex Differences. Stanford: Stanford University Press, 1974.

Minuchin, D. D. "Sex-Role Concepts and Sex Typing in Childhood as a Function of School and Home Environments." In Social Development and Personality, edited by G. C. Thompson. New York: John Wiley and Sons, Inc., 1971.

Smith, I. M. Spatial Ability. San Diego: Knapp, 1964.

Splaver, Sarah. Non-Traditional Careers for Women. Julian Messner (division of Simon and Shuster, Inc.): New York, New York.

Tyler, Leona E. The Psychology of Human Differences (third edition). Appleton-Century-Crofts: New York, 1965.

Werdelin, I. The Geometrical Ability and Space Factor in Boys and Girls. Lund, Sweden: University of Lund, 1971.

Witkin, H. A.; Dyk, R. B.; Faterson, H. F.; Henna, F.; Goodenough, D. R.; Karp, S. A. Psychological Differentiation: Studies of Development. Wiley: New York, 1962.

Periodicals

Aiken, L. R. "Ability and Creativity in Math." Review of Educational Research. Vol. 43, 1973, pp. 405-432.

___________. "Attitudes Towards Mathematics." Review of Educational Research. Vol. 40 (No. 1), pp. 551-596. (February 1970).

___________. "Intellectual Variables and Mathematics Achievement: Directions for Research." Journal of School Psychology. Vol. 9, pp. 201-209. 1971.

Alpert, R.; Stellwagen, G.; Becker, D. "Psychological Factors in Mathematics Education." School Mathematics Study Group Newsletter. (No. 15), pp. 17-24. 1963.

Anderson, Scarvia B.; Maier, Milton H. "34,000 Pupils and How they Grow." Journal of Teacher Education. 14: 212-216, (June 1963).

Bachman, A. M. "The Relationship Between a Seventh-Grade Pupil's Academic Self-Concept and Achievement in Mathematics." Journal for Research in Mathematics Education. Vol. 1, pp. 173-179. 1970.

Berglund, G. W.; Hilton, Thomas L. "Sex Differences in Mathematical Achievement: A Longitudinal Study." Journal of Educational Research. Vol. 67, (No. 5). (January 1967).

Bobbe, C. N. "Sex-Role Preference and Academic Achievement" (Doctoral Dissertation, Yeshiva University, 1971). Dissertation Abstracts International. Vol. 32B, pp. 1818-1819. 1971.

Brookover, W. W.; Thomas, S. "Self Concept of Ability and School Achievement." Sociology of Education. Vol. 37 (No. 3), pp. 271-279. 1964.

Carey, Gloria L. "Sex Differences in Problem-Solving Performance as a Function of Attitude Differences." Journal of Abnormal and Social Psychology. 56: (No. 2) 256-260. (March 1958).

Clark, M. P. "Changes in Primary Mental Abilities with Age." Arch. Psychology. No. 291, p. 30. 1944.

Coleman, R. H. "An Analysis of Certain Components of Mathematical Abilities and an Attempt to Predict Mathematical Achievement in a Specific Situation." Dissertation Abstracts. Vol. 16, p. 2062. 1956.

Crandall, V. J.; Katkovsky, W.; Preston, A. "Motivational and Ability Determinants of Young Children's Intellectual Achievement Behaviors." Child Development. Vol. 33, pp. 643-661. 1962.

Crosswhite, F. J. "Correlates of Attitudes Toward Mathematics." (NLSMA Report No. 20. Abstracted by L. R. Aiken.) Investigations in Mathematics Education. Vol. 5, pp. 126-139. 1974.

Doppelt, J. E. "The Organization of Mental Abilities in the Age Range 13-17." Teacher's Coll. Contrib. Education. Vol. 962, pp. 1-86. 1950.

Droege, Robert C. "Sex Differences in Aptitude Maturation During High School." Journal of Counseling Psychology. 14: (No. 5) 407-411. (September 1967).

Fennema, E. "Mathematics Learning and the Sexes: A Review." Journal for Research in Mathematics Education. Vol. 5, pp. 126-139. 1974.

Fennema, E.; Sherman, J. A. "Sex-Related Differences in Mathematics Achievement, Spatial Visualization and Affective Factors." American Educational Research Journal. Vol. 14, (No. 1), pp. 15-71. 1977.

Fennema, E.; Sherman, J. "Sex-Related Differences in Mathematics Achievement and Related Factors: A Further Study." Journal for Research in Mathematics Education. Vol. 9 (No. 3), pp. 189-203. 1978.

Fillela, J. F. "Educational and Sex-Differences in the Organization of Abilities in Technical and Academic Students in Colombia, South America." Genetic Psychology Monographs. Vol. 61, pp. 115-163. 1960.

Fink, M. B. "Self-Concept as it Related to Academic Underachievement." California Journal of Educational Research. Vol. 13, pp. 57-61. 1969.

Flanagan, J. C. "Changes in School Levels of Achievement: Project TALENT Ten and Fifteen Year Retests." Educational Researcher. Vol. 5 (No. 8), pp. 9-12. 1967.

French, J. W. "The West Point Tryout of the Guidance Battery. (Research Bulletin 51-12) Princeton: Educational Testing Service, 1951. Psychological Review. Vol. 74, pp. 290-299. 1967.

Fruchter, B. "Measurement of Spatial Abilities: History and Background." Educational and Psychological Measurement. Vol. 14, pp. 387-395. 1954.

Garrett, H. E. "A Developmental Theory of Intelligence." American Journal of Psychology. Vol. 1, pp. 372-378. 1946.

Good, T.; Brophy, J. E. "Questioned Equality for Grade One Boys and Girls." The Reading Teacher. Vol. 25, pp. 247-252. 1971.

Good, T.; Sikes, J. N.; Brophy, J. E. "Effects of Teacher Sex and Student Sex on Classroom Interaction." Journal of Educational Psychology. Vol. 65, pp. 74-87. 1973.

Guilford, J. P.; Green, R. F.; Christensen, P. R. " Factor Analytic Study of Reasoning Abilities. II." (Administration of Tests and Analysis of Results. Report No. 3, 1951. University of Southern California Psychology Laboratory.) Psychological Review. Vol. 74, pp. 290-299. 1967.

Guthrie, G. M. "Structure of Abilities in a Non-Western Culture." Journal of Educational Psychology. Vol. 54, pp. 90-103. 1963.

Hilton, T. L.; Berglund, G. W. "Sex-Differences in Mathematics Achievement - A Longitudinal Study." Journal of Educational Researcher. Vol. 67, pp. 231-237. 1974.

Hilton, T. L.; Myers, Albert E. "Personal Background, Experience and School Achievement: An Investigation of the Contribution of Questionnaire Data to Academic Production." Journal of Educational Measurement. Vol. 4, pp. 69-80. (Summer 1967).

Hilton, T. L.; Patrick, C. "Cross-Sectional Versus Longitudinal Data: An Empirical Comparison of Mean Differences in Academic Growth." Journal of Educational Measurement. Vol. 7 (No. 1), pp. 15-24.

Jaspen, Naten. "Serial Correlation." Psychometrika. pp. 23-30. 1946.

Jenkins, W. L. "Triserial 4 - A Neglected Statistic." Journal of Applied Psychology. Vol. 40, pp. 63-64. 1956.

Kaiser, H. R. "The Varimax Criterion for Analytic Rotation in Factor Analysis." Psychology. Vol. 23, pp. 187-200. 1958.

Keeves, J. P. "Differences Between the Sexes in Mathematics and Science Courses." International Review of Education. Vol. 19, pp. 47-63. 1973.

Leviton, H. "The Implications of the Relationship Between Self-Concept and Academic Achievement." Child Study Journal. Vol. 5, pp. 25-36. 1975.

Levy, Betty. "Do Teachers Sell Girls Short?" Special Feature on the Schools and Sex-Role Stereotyping. Reprint from Today's Education, NEA Journal.

Lindgren, Henry C.; Silva, Ina; Faraco, Italia; Da Rocha, Nadin S. "Attitudes Toward Problem-Solving as a Function of Success in Arithmetic in Brazilian Elementary Schools." Journal of Educational Research. Vol. 55 (No. 1), pp. 44-45. (September 1964).

"Math Mystique: Fear of Figuring." Time Magazine. (March 14, 1977). p. 36.

Milton, G. A. "The Effects of Sex-Role Identification Upon Problem-Solving Skill." Journal of Abnormal and Social Psychology. Vol. 55 (No. 2), pp. 208-212. (September 1957).

Minuchin. "Sex Differences in Children: Research Findings in an Educational Context." National Elementary Principal. Vol. XLVI (No. 2), (November 1966).

Murray, J. E. "An Analysis of Geometric Ability." Journal of Educational Psychology. Vol. 40 (1949), pp. 118-124.

Neale, D. C. "The Role of Attitudes in Learning Mathematics." Arithmetic Teacher. Vol. 16 (1969), pp. 631-640.

O'Brian, C. W. "Pupil Achievement, Attendance, and Attitudes, and the Relationship Between Teacher Perception, Teacher Sex, and Pupil Sex." (Doctoral Dissertation, University of Michigan, 1975) Dissertation Abstracts International. 36A (1975), p. 1222.

Primavera, L. H.; Simon, W. E.; Primavera, A. "The Relationship Between Self-Esteem and Academic Achievement: An Investigation of Sex Differences." Psychology in the Schools. Vol. 11 (1947), pp. 213-216.

Rowell, J. A. "Sex Differences in Achievement in Science and the Expectations of Teachers." The Australian Journal of Education. Vol. 15 (1971), pp. 16-29.

Sears, P. S.; Feldman, D. H. "Teacher Interaction with Boys and Girls." National Elementary Principal. Vol. 46 (No. 2), pp. 45-48. 1966.

Sells, Lucy W. "Mathematics - A Critical Filter." The Science Teacher. Vol. 45 (No. 2). (February 1978).

Sherman, J.; Fennema, E. "The Study of Mathematics Among High School Girls and Boys: Related Factors." American Educational Research Journal. Vol. 14 (No. 2), 1977.

Shinedling, M.; Pederson, D. M. "Effects of Sex of Teacher and Student on Children's Gain in Quantitative and Verbal Performance." The Journal of Psychology. Vol. 67 (1970), pp. 79-84.

Stein, A. H. "The Effects of Sex-Role Standards for Achievement and Sex-Role Preference on Three Determinants of Achievement Motivation." Developmental Psychology. Vol. 7 (1971), pp. 219-231.

Stein, A. H.; Smithells, J. "Age and Sex Differences in Children's Sex Role Standards About Achievement." Developmental Psychology. Vol. 4 (1971), pp. 252-259.

Thurston, L. L. "Primary Mental Ability." Psychometric Monographs. No. 1 (1938), pp. 1-121.

Very, P. S. "Differential Factor Structures in Mathematical Ability." Genetic Psychology Monographs. Vol. 75 (1967), pp. 169-207.

Weaver, J. F. "Seductive Shibboleths." The Arithmetic Teacher. Vol. 18 (1971), pp. 263-264.

White, R. W. "Motivation Reconsidered: The Concept of Motivation." Psychological Review. Vol. 66 (1959), pp. 297-333.

Unpublished Material

Fennema, E. "Sex-Related Differences in Mathematics Achievement: Myths, Realities and Related Factors." Department of Curriculum and Instruction, University of Wisconsin at Madison. (Unpublished paper).

Fennema, E.; Meyer, R. A. "Attitudes Toward Mathematics Held by Females Educated in Single Sex or Coed Schools." Manuscript in preparation, 1976.

Lim, H. "Geometry and the Spare Factors." Unpublished paper for the School Mathematics Study Group, (Summer, 1963.).

Other Sources

Casserly, P. L. An Assessment of Factors Affecting Female Participation in Advanced Placement Programs in Mathematics, Chemistry, and Physics. (Grant No. GY - 11325). Washington, D. C.: National Science Foundation.

Conway, J. K. "Perspectives on the History of Women's Education in the United States." In Perspectives on Female Education. Symposium presented to the annual meeting of the American Educational Research Association, New Orleans, 1973.

French, J. W. (ed). Manual for Kit of Selected Tests for Reference Aptitude and Achievement Factors. Princeton, N. J.: Educational Testing Service, 1954.

Glennon, V. J.; Callahan, L. G. A Guide to Current Research: Elementary School Mathematics. Washington, D. C.: Association for Supervision and Curriculum Development, 1968.

Guilford, J. P. Structure of Intelligent Model: Its Uses and Implications. Psychological Laboratory Report No. 24, University of Southern California, Los Angeles, California, 1960.

Hilton, Thomas L. "A Study of Intellectual Growth and Vocational Development." Final Report, Project No. 6-1830 (Grant No. 036-1-6-0618136-9650). United States Office of Education, March 1971.

Keeves, John. "Differences Between the Sexes in Mathematics and Science Courses." Australian Council for Educational Research.

"My Son the Astronaut, My Daughter the Witch." WEAL Educational and Legal Defense Fund, Washington, D. C.

Sells, S. "Mental Abilities and Personality Variables in Relation to Proficiency in Mathematics." In Research Problems in Mathematics Education. Reports from a Conference on Psychological Problems and Research Methods. Cooperative Research Monograph No. 3, United States Department of Health, Education and Welfare, Office of Education, United States Government Printing Office, 1966.

Phi Delta Kappa Teacher Education Commission on Education and Human Rights. Bloomington, Indiana. 1975.

"Sex Discrimination in an Elementary Reading Program." Kalamazoo, Michigan Public Schools, Michigan Women's Commission, Lansing, Michigan.

Simmons, Althea T. L. Address at the 1976 National Leadership Development Seminar for State Directors of Vocational Education, Tuesday, September 21, 1976, Arrowhead Lodge, Canadian, Oklahoma.

Suydam, M. N.; Riedsel, C. A. Interpretive Study of Research and Development in Elementary School Mathematics, Vol. I. Introduction and Summary: What Research Says. Final Report, Project No. 8-0586, Department of Health, Education and Welfare.

APPENDIXES

APPENDIX A

MATHCO PROJECT STAFF

NATIONAL REVIEW BOARD

SPECIAL CONSULTANTS

UNIVERSITY OF OKLAHOMA SPECIAL CONSULTANTS

PARTICIPATING MIDDLE SCHOOL MATHEMATICS TEACHERS

Project Staff

Ms. Carole Hall Hardeman
Project Director

Ms. Barbara T. Laquer
Program Specialist

Ms. Kristin Y. Carl
Editorial Assistant/Secretary

National Review Board

Dr. Rita Bornstein
Title IX Coordinator
Florida School Desegregation Consulting Center
University of Miami

Ms. Iris Bruce, Director
Division of Guidance and Counseling
Oklahoma State Department of Education

Ms. Connie Earhart, Assistant Director
Sex Desegregation Consulting Center
Kansas State University

Dr. Tom Gallaher, Director
Oklahoma Consortium/Teacher Corps Project
University of Oklahoma

Dr. Geneva Gay, Professor
Department of Education
Purdue University
West Lafayette, Indiana

Ms. Iola Hayden, Executive Director
Oklahomans for Indian Opportunity
Norman, Oklahoma

Mr. Robert M. Malinka, Project Director
Middle School Resource Center
Indianapolis, Indiana

Ms. Adeline Naiman, Director
Special Projects, Education Development Center
Newton, Massachusetts

Dr. Charles Rankin
Sex and Race Desegregation Consulting Center
Kansas State University

Dr. Marzell Smith, Associate Director
Florida School Desegregation Consulting Center
University of Miami

Ms. Florence M. Yoshiwara, Director
Japanese-American Curriculum Project, Inc.
San Mateo, California

Special Consultants

Ms. Vivian V. Coulter, Research and Curriculum Development Specialist

Mr. Gene Dillehay, Audio Producer, Producers Workshop

Dr. William A. Fredrickson, Statistics Consultant

Ms. Jenetta James, Research and Curriculum Developer

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

Ms. Linda W. Kramer, Research and Curriculum Developer

Ms. Jean Hubinger, Research and Curriculum Developer

Ms. Margaret Ann Smith, Media Consultant

Ms. Cheryl Sweetser, Research and Curriculum Developer

University of Oklahoma Special Advisors

Dr. Robert Bibens, Professor
College of Education

Dr. Donald J. Hall, Director
Southwest Center for Human Relations Studies

Dr. Glenn Snider
Regents Professor
College of Education

Participating Middle School Mathematics Teachers

Ms. Josephine Adamson	Ms. Diane M. Lewis
Ms. Edna E. Barnes	Mr. Orville Roper
Ms. Jennetta James	Ms. Carolyn Stuckey

YOUR NAME: ______________________ SEX: ______ AGE: ______

THE GRADE YOU ARE IN: ______ YOUR SCHOOL: ______________________

TODAY'S DATE: ______________________

Here are some questions asking how you feel about math. Check the choice that best describes the way you feel.

1. HOW WELL DO YOU LIKE MATH COMPARED WITH YOUR OTHER SUBJECTS?

_____ A. I LIKE IT BEST.

_____ B. I LIKE IT BETTER THAN MOST OF MY SUBJECTS.

_____ C. I LIKE IT AN AVERAGE AMOUNT.

_____ D. I LIKE IT LESS THAN MOST OF MY SUBJECTS.

_____ E. I REALLY HATE IT!

2. HOW ARE YOUR GRADES IN MATH?

_____ A. MOSTLY A'S.

_____ B. MOSTLY B'S.

_____ C. MOSTLY C'S.

_____ D. MOSTLY D'S.

_____ E. MOSTLY F'S.

3. IS IT HARD FOR YOU TO WORK MATH PROBLEMS?

_____ A. NO. IT'S EASY FOR ME.

_____ B. SOMETIMES. BUT I CAN USUALLY FIGURE THEM OUT.

_____ C. YES. I NEED A LOT OF HELP.

4. HOW MUCH MATH DO YOU PLAN TO TAKE IN HIGH SCHOOL?

_____ A. AS MUCH AS I CAN.

_____ B. AN EXTRA COURSE OR TWO.

_____ C. AS LITTLE AS POSSIBLE.

5. WOULD YOU AVOID CHOOSING A CAREER THAT REQUIRES MATH?

_____ A. NO. I WANT TO GET A JOB THAT USES MATH.

_____ B. IT WOULDN'T MAKE ANY DIFFERENCE TO ME WHETHER OR NOT I NEEDED TO USE MATH ON THE JOB.

_____ C. YES. I'D AVOID <u>ANY</u> JOB THAT USED MATH.

APPENDIX B

MATHCO PUPIL PERSONAL INTEREST INVENTORY

MATHCO PRE-POST QUESTIONNAIRE

YOUR NAME: ______________________ YOUR AGE: ______

SECTION OR HOUR OF THIS CLASS PERIOD: ______________________

TODAY'S DATE: ______________________ SEX: (please circle)
FEMALE MALE

PART 1

1. IN THIS PICTURE THERE ARE TWO PERSONS. WHICH PERSON IS THE NURSE?

____

____

2. HERE WE SEE A PERSON SITTING AT A DRAWING BOARD. WHAT IS THIS PERSON DESIGNING?

____

____

3. DOES THIS PERSON USE MATH IN THE WORK THAT IS BEING DONE?

____

____

4. DOES THIS BAND DIRECTOR USE MATH IN HIS JOB?

____

____

5. PICTURED HERE ARE THREE PERSONS WHO ARE IN THE CONSTRUCTION AND BUILDING OCCUPATIONS. HOW MANY OF THEM USE MATH IN THEIR WORK?

____

____

6. HERE IS A HELP WANTED SIGN INDICATING THAT POLICE OFFICERS ARE NEEDED. WHICH ONE OF THESE PERSONS SHOULD GET THE JOB?

____

____

7. HERE WE SEE A SCHOOL BUILDING WHERE SOMEONE INSIDE IS IN THE PROCESS OF INTERVIEWING PERSONS INTERESTED IN APPLYING FOR THE POSITION OF TEACHER OR FOR THE POSITION OF PRINCIPAL. WHICH JOB OR POSITION WILL THE PERSON IN THE PICTURE APPLY FOR?

8. THE SUPERVISOR AT THIS PLANT IS TALKING TO THE CLERK ABOUT A SHIPPING ORDER. WHO DO YOU THINK IS THE SUPERVISOR?

9. DO AUTO MECHANICS USE MATH IN THEIR WORK?

PART 2

Who do you think could do this job best? A woman, a man, or both?			
1. STOCKBROKER			
2. ARCHITECT			
3. NEWSPAPER REPORTER			
4. TELEVISION METEOROLOGIST			

Who do you think could do this job best? A woman, a man, or both?			
5. NEWSPAPER EDITOR			
6. BALLET DANCER			
7. ENVIRONMENTAL ANALYST			
8. ARTIST			
9. CHEF			
10. A PERSON WHO REPAIRS AIR CONDITIONERS AND FURNACES			
11. DOCTOR			
12. PLUMBER			
13. FARMER			
14. LABORATORY TECHNICIAN			
15. ORCHESTRA CONDUCTOR			

Who do you think could do this job best? A woman, a man, or both?			
16. Electrician			
17. Salesperson in a Department Store			
18. Paper Hanger			
19. Police Officer			
20. Fire Fighter			
21. Carpenter			
22. Brick Layer			
23. Guitar Player			
24. Airline Pilot			
25. Astronaut			
26. Clothing Designer			

Who do you think could do this job best? A woman, a man, or both?			
27. BANKER			
28. TRUCK DRIVER			
29. COLLEGE PROFESSOR			
30. SERVICE STATION ATTENDANT			
31. PARK RANGER			
32. VETERINARIAN			
33. PHOTOGRAPHER			
34. GROCERY STORE CHECKER			
35. NURSE			

PART 3

Is math used or needed in this career or occupation?	**YES**	**NO**
1. Stockbroker		
2. Architect		
3. Newspaper Reporter		
4. Television Meteorologist		
5. Newspaper Editor		
6. Ballet Dancer		
7. Environmental Analyst		
8. Artist		
9. Chef		
10. A Person Who Repairs Air Conditioners and Furnaces		
11. Doctor		

Is math used or needed in this career or occupation?	YES	NO
12. Plumber		
13. Farmer		
14. Laboratory Technician		
15. Orchestra Conductor		
16. Electrician		
17. Salesperson in a Department Store		
18. Paper Hanger		
19. Police Officer		
20. Fire Fighter		
21. Carpenter		
22. Bricklayer		

Is math used or needed in this career or occupation?	YES	NO
23. GUITAR PLAYER		
24. AIRLINE PILOT		
25. ASTRONAUT		
26. CLOTHING DESIGNER		
27. BANKER		
28. TRUCK DRIVER		
29. COLLEGE PROFESSOR		
30. SERVICE STATION ATTENDANT		
31. PARK RANGER		
32. VETERINARIAN		
33. PHOTOGRAPHER		

Is math used or needed in this career or occupation?	**YES**	**NO**
34. Grocery Store Checker		
35. Nurse		

PART 4

Have you ever thought about what you'd like to be when you are an adult? On the lines below, please list up to five careers that you are interested in. Remember, you can be anything you want to be...

____

____

____

____

____

THE END

APPENDIX C

MATHCO OBJECTIVES

The Objectives of MATHCO

1. To provide up-to-date, validated information on the universal and interdisciplinary nature of mathematics 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 provide role models of successful women in non-traditional mathematics-oriented careers;

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

5. To provide adaptable materials which are appropriate for use both by mathematics teachers and by teachers of other disciplines;

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

7. To provide current research-based information about careers which women have traditionally not been encouraged to enter and/or have been reluctant to enter;

8. To encourage young women to pursue the study of non-required mathematics courses in high school; and

9. To design materials which are appropriate for use nationwide and which can be easily disseminated at a low cost.