FACTORS INFLUENCING THE MATHEMATICS-RELATED ATTAINMENT OF A NATIONAL SAMPLE OF HISPANIC, BLACK, AND WHITE WOMEN

by

Susan J. Schaflander Rothschild

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APPROVED:

Marilyn Lichtman, Chair

Maxine Enderlein

Ronald McKeen

Jimmie Fortune

Larry Weber

Samuel Peng

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Blacksburg, Virginia

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I dedicate my dissertation to with the hope that by the time he makes educational and occupational decisions, girls, too, will have the same opportunities that he does.

TABLE OF CONTENTS

CHAPTER

CHAPTER

CHAPTER

LIST OF FIGURES

FIGURES

LIST OF TABLES

TABLES

TABLES

CHAPTER 1

Introduction

For the most part, women are still employed in traditionally female occupations which require little or no mathematics training (Oppenheimer, 1975; Reynolds, 1980). Data from the Bureau of Labor Statistics (1979) indicate that 67 percent of women are employed in the occupational categories of nursing, sales, secretarial, and teaching. The presence and seeming acceptance of confined, low-status occupations for women may represent an enormous loss of economic and intellectual potential for the individual woman and for society as a whole.

One basic pattern seems to emerge: women have not adequately studied mathematics in high school, which too frequently results in their inability to concentrate in college fields of study that are mathematics-related. Thus, when these women seek jobs, they may not be able to enter the many occupational fields which require background in mathematics. This, in turn, is one reason that women, who represent more than fifty percent of the labor force, earn only three-fifths as much as men (Norwood & Waldman, 1979).

Looking at the situation in reverse, one factor which accounts for this salary differential is the type of job held by women: occupations which most need mathematics training are those with the least sex differentiation in pay (Boswell, 1979; National Science Foundation, 1978). Therefore, from an educational perspective, it is imperative to focus on and investigate why women are not receiving the necessary mathematics training.

Sells' (1973) research was the impetus for further studies funded by the National Science Foundation and the National Institute of Education. She reported that 92 percent of the first year Berkeley college women could not meet the requirements to pursue advanced fields of study requiring mathematics, thus denying them access to occupational categories such as mathematicians, engineers, physical and biological scientists, dentists, and architects. Sells concluded that the number of high school mathematics courses taken was the "critical filter" for women in preventing them from achieving their educational potential.

In conjunction with funding studies, the National Science Foundation lobbied Senator Kennedy to introduce a bill, S-568 into the second session of the ninety-sixth Congress. The purpose of S-568 was "to promote the full use of human resources in science and technology through a comprehensive program to maximize the potential contribution and advancement of women in scientific, professional, and technical careers" (U.S. Congress, 1979). Title II of this bill, cited as the Women in Science and Technology

Equal Opportunity Act, lists among its findings that "women have long been denied equal educational and employment opportunities in scientific and technical fields, ... [and that] minority women have yet to achieve measurable participation in science" (U.S. Congress, 1979). On December 12, 1980, Bill S-568 was passed and became Public Law 96-516. Part B of this act is entitled Women, Minorities, Science, and Technology, or the Science and Technology Equal Opportunities Act (U.S. Congress, 1980).

High school mathematics participation is one factor affecting women's college mathematics training; psychological and social factors may also be influential. Most studies, however, neither emphasize the interrelationships of a wide array of variables nor select a sample to specifically include minorities. Thus, a framework to relate those variables--a model of mathematics-related attainment applied to minority women--is needed for the development and further understanding of this complex social, educational, and economic dilemma.

Background Of The Model

The proposed model in this study is derived from the status attainment model originated by Blau and Duncan (1967). Their model, devised for white males only, included the father's occupation and education and the son's educational attainment and first job as predictors of the son's occupational status. Sewell and Hauser (1975) and their associates extended this model (the "Wisconsin model") for males and females by including variables measuring ability and significant others' influence. In addition, the Wisconsin researchers used a variety of measures to indicate status: educational attainment, occupation, and/or income. Alexander and Eckland (1974) added curriculum track, educational expectations, and more complete socioeconomic status measures to their models of educational status attainment.

Falk and Cosby (1975) suggested modifying the Wisconsin model by including the additional independent variables of marriage and fertility plans so as to explain more variance for women's educational status. Lichtman, Rothschild, and Peng (in press), Thomas, Alexander, and Eckland (1977), and Wolfle and Lichtman (1980) elaborated further by considering an educational status attainment model for racial subgroups of women.

Peng and Jaffe (1979), Steel and Wise (1979), and Wise (1979) varied the status attainment model to an even greater degree by using dependent variables which were not traditionally status variables: entry into male-dominated college majors, twelfth grade mathematics achievement, and mathematics level of occupation at age 29, respectively.

It is this latest adaptation of the original Blau and Duncan status attainment model which is the basis for the mathematics-related attainment model.

Purpose of the Study

This study examined the effects of various background, high school, and socio-psychological factors on Hispanic, black and white women's attainment in mathematics-related fields by estimating a model of mathematics-related attainment. The variables considered in the model (Figure 1) were: socioeconomic status (SES), high school experience, high school achievement, psychological self-concept, significant others' perceived college influence (SOPCI), high school educational and occupational expectations, next to last college mathematics-related experience, sex-role orientation, family status, and latest college mathematics-related attainment. This mathematics-related attainment model is limited to Hispanic, black, and white college women who declared a college major for at least two years between 1972 and 1976. The data are provided by the National Longitudinal Study of the High School Class of 1972 (NLS), a longitudinal nationwide survey which follows the progress of high school students to adulthood. By testing a model for different ethnic groups of women, the processes by which

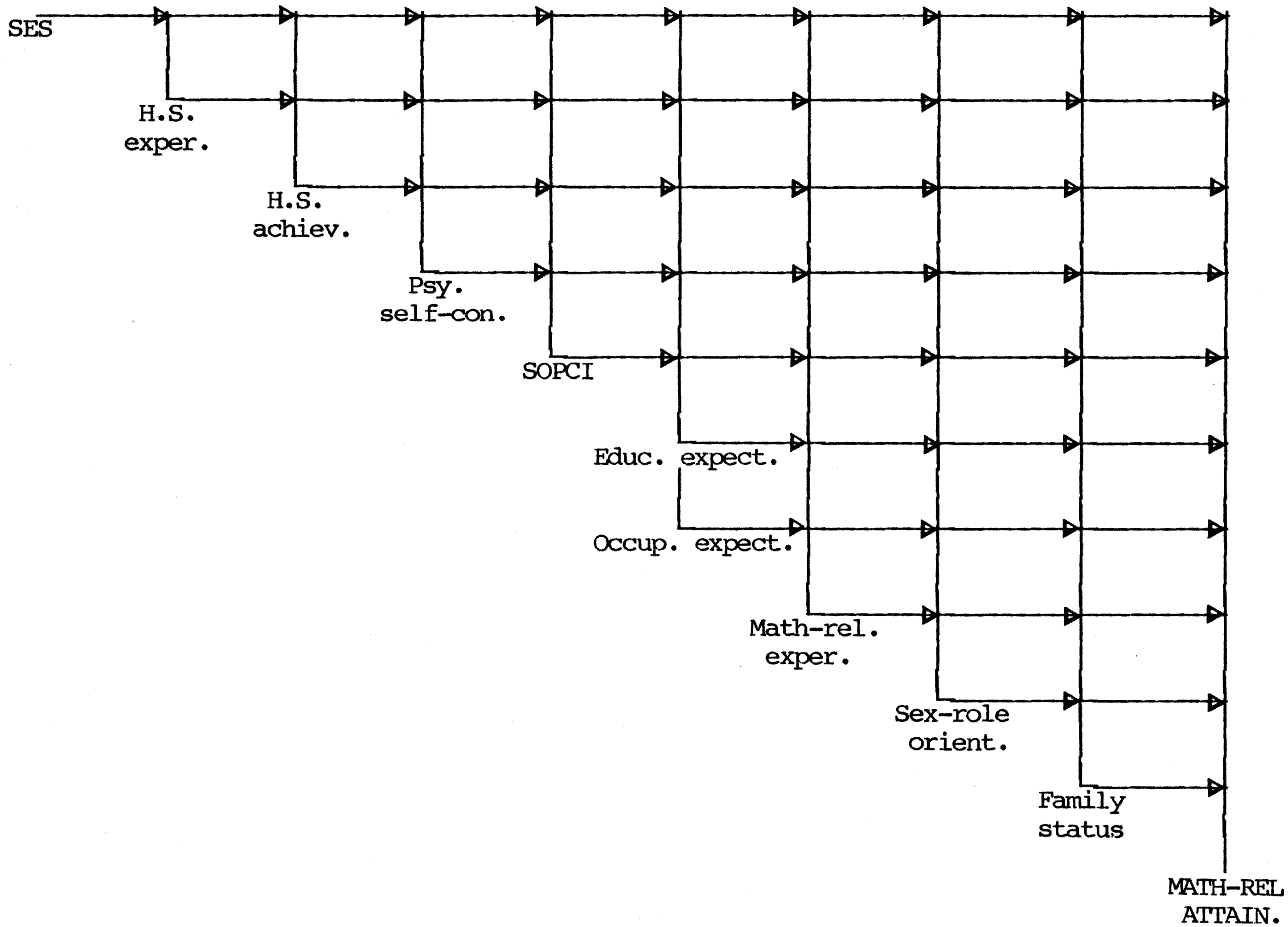

Figure 1

Path Model for Mathematics-related Attainment of Selected Groups of Women these women pursue mathematics-related educational attainments may be studied.

The objectives of this study were:

1. to provide descriptive profiles of the 1976 mathematics-related educational attainment of Hispanic, black, and white women;

2. to test a predictive model of mathematics-related educational attainment for these three groups of women by determining which variables in the model make a statistically significant and meaningful contribution to the mathematics-related attainment of each group of women; and

3. to compare the model for the three groups of women.

Limitations of the Study

This study is a secondary analysis, a method widely used with survey data and defined as "the extraction of knowledge on topics other than those which were the focus of the original surveys" (Hyman, 1972, p. 1). One of the benefits of a secondary analysis is to increase scientific knowledge of a problem with minimal cost. This economic benefit, however, also provides the major limitation of the study: because the data are already collected, the researcher has no control over error nor the instruments utilized to gather the information.

Although there are additional and/or substitute variables which could be utilized as measures of constructs in the model under consideration, they are not available in the data set. For example, although a "self-confidence in mathematics" attribute variable would be a preferable variable for the model, a surrogate variable, "self-concept," was used instead, with the understanding that it is simply an indicator. This same substitution was made by Steel and Wise (1979) in their women and mathematics study which also employed an existing data set.

Another delimiter of this study is the time element involved. Specifically, the last possible measurement of the dependent variable, mathematics-related attainment, was taken in 1976, just four years after high school graduation. Many women had not completed their college education by that time; thus, the measure of mathematics-related attainment as indicated by latest college field of study may be a premature one. More generally, the social context of the early seventies--the mandatory draft, the Vietnam war and the resultant labor market shifts, as well as the emergence of the peace and women's liberation movements--may, in some way, have an effect on responses, particularly in relation to career patterns.

All findings should be considered in light of these limitations.

Significance

The importance of this study is two-fold and is directed at two groups of people: researchers and policymakers.

First, for researchers, this study makes a contribution on a technical level: for field of study/college major variables, a classification scheme is used. Devised by Steel and Wise (1979), this technique places a career or college major into one of six levels, depending on the amount of mathematics knowledge needed. In this way, college majors and careers can be evaluated on the strength of their relationship to mathematics and can be transformed into interval level mathematics variables.

Additionally, the study helps fill a gap left by much of the research conducted on women and mathematics. Westervelt (1975), in her review of barriers to women's post-secondary education participation, and Zuckerman (1976), in her review of educational aspirations and career goals of women, found that despite a plethora of studies, research using national samples and a fuller complement of variables is needed if comprehensive results are to be obtained.

The data for the present study are based on a national probability sample of high school seniors who were subsequently surveyed one, two, and four years after high school graduation. Thus, conclusions are based on a current and nationally representative sample of women who attended high school and at least some college in the early seventies and who will be in the labor force in the eighties. In addition, this sample includes Hispanic (an aggregate of Mexican-Americans, Puerto Ricans, and Latin Americans) and black as well as majority white women. Researchers (Dillon & James, 1977; Fennema, 1980; Rowe, 1977) have suggested that future studies include ethnic groups and their relationship to scientific interests, but few studies have heeded this advice. Details of the major research are provided in Chapter 2, but a compilation of recent studies about women and mathematics, as well as various aspects covered in the study (Figure 2) reveals that not one of these studies is longitudinal in scope, generalizable in extent, and ethnic-race specific in subjects.

Secondly, this research is helpful in providing information needed to help promote social and economic equity. With the increasing numbers of women in the job market and the depressing economic situation of this country, additional research must continue to be directed at women and

Name of Recent Researchers	Year	Aspects Covered				
		Sex Differences	Women Only	Race Subgroups	Longi-tudinal	National Samples
Armstrong	1980		X			X
Boswell	1979		X			
Brush	1979		X		X	
Fennema &	1977,	X				
Sherman	1978	X	X			
Houston	1979	X		X		
Peng & Jaffe	1979	X			X	X
Stallings	1979		X			
Steel & Wise	1979	X			X	X
Wise	1979	X			X	X

Figure 2

Aspects Covered in Recent Mathematics Studies their involvement in mathematics training. It is essential that we understand which factors contribute to mathematics participation so that potentially successful intervention (particularly during the high school years) may be undertaken to increase the influx of ethnic majority and minority women into mathematics-related fields of study and work.

CHAPTER 2

Review of Related Literature

As more women enter the work force, the need for research to provide explanations as to why so few women enter fields requiring mathematics becomes particularly important. Little empirical research that could provide insight about the complex nature of this phenomenon has been done, although research focusing on narrow areas has been carried out.

Few studies have been completed linking sex, race, and mathematics. One study by Houston (1979) used a sample of 300 Anglos, blacks, and Chicanos. Her findings indicated that race (Anglo, black, and Chicano), not sex, was a significant source of variance in mathematics achievement. Gilmartin, McLaughlin, Wise, and Rossi (1976) conducted a longitudinal, large scale study on the processes influencing a high school student to pursue a science career. Using 1971 follow-up data from 1200 scientists and 22,500 non-scientists, all of whom participated in the 1960 Project TALENT survey, as well as 1975 data on 1142 California high school students, they concluded that black and Spanish surnamed students took fewer science and mathematics courses and exhibited lower ability in these areas.

On the contrary, using the large NLS data set to determine the factors involved in choosing college science majors, Dunteman, Wisenbaker, and Taylor (1979) concluded that in the selection of a freshman college science major, there were fewer race (black-white) than sex differences. Clark and Zapato (1980) surveyed the influences of significant others, educational expectations, and sex-role attitudes on the mathematics and science participation of 30 high achieving Mexican-American females. Their results were similar to those reflected in the literature about white women: the entry of Mexican-American women into mathematics and science fields was hindered by the lack of a supportive environment and poor counseling.

Many studies concerned with mathematics participation and achievement pay particular attention to the roles that math anxiety and spatial perception play. Math anxiety is frequently cited as an explanation for female's lack of mathematics and science course taking, while sex differences in mathematics achievement are often accounted for by the male supposed superiority in spatial visualization, although there are conflicting results about sex differences in spatial perception. These topics are beyond the scope of this study and will not be further discussed; some references are included in the bibliography (for example, see Fennema, 1975; Fennema & Sherman, 1977; Maccoby & Jacklin, 1974; Restak, 1979; Sherman, 1977;

Tobias, 1976; Tobias & Weissbrod, 1980).

Mathematics is the language of science (McGraw-Hill Encyclopedia of Science and Technology, 1971) and is considered to be a science discipline--ten percent of the members of the prestigious National Academy of Sciences are pure mathematicians (National Academy of Sciences, 1981). Therefore, studies involving science abilities and careers are included in this review of the pertinent literature. The remainder of the chapter is organized into two parts: the first section details the most important research on models of women and mathematics, while the second section delineates the important factors in mathematics (and science) achievement studies.

Research on Models of Women and Mathematics

Many studies of a cross-sectional nature have dealt with the identification of factors related to the participation and achievement of high school women in mathematics (Armstrong, 1980; Boswell, 1979; Brush, 1979; Stallings, 1979), while other longitudinal studies have been concerned with the post high school mathematics experiences of women and their relation to high school factors (Peng & Jaffe, 1979; Steel & Wise, 1979; Wise, 1979). The longitudinal studies, in particular, are important because they were useful for formulating the model for the present research.

Peng and Jaffe (1979), considering male-dominated fields (defined as biological sciences, business, engineering, physical sciences, and mathematics) as the dependent variable, used first follow-up information from the NLS data base. They found that the most important predictor of women's entry into male-dominated fields was the number of high school science courses taken. Also important were mathematics ability, the number of high school mathematics courses taken, and educational expectations. Family background variables related only indirectly to choice of college major through academic high school curriculum and educational plans.

Steel and Wise (1979), using 7500 men and women from the longitudinal Project TALENT data from 1960 and 1963, and Wise (1979), analyzing the data collected from 1974 on Project TALENT, extended and elaborated on the Peng-Jaffe model by constructing models for twelfth grade mathematics achievement and mathematics level of actual occupation at age 29, respectively. They found that women who entered mathematics-related careers had early mathematics career plans, high educational attainment, completion of a mathematics-related college major, and high mathematics achievement scores. Achievement scores were predicted, in turn, by the number of high school mathematics courses taken which itself was a function of ninth grade mathematics abilities, educational expectations, and interest in mathematics. Self-concept was positively related to high school mathematics participation, while counselor influence negatively affected this participation. The number of science courses, father's occupation and education, and the academic high school curriculum were also related to mathematics participation.

These three studies were important precursors of the present research. They offered valuable information that was considered and incorporated into the model.

Research on Relevant Factors

In the past ten years, a multitude of studies relating to mathematics has been published. At first, the studies focused on mathematics participation; later, they were broadened to include other factors. Rather than discuss each study individually, the research surrounding each relevant factor is synthesized.

Mathematics Participation and Achievement

Research on mathematics participation was initially related to the high school mathematics preparation of college students. Sells (1973, 1976, 1978) and Ernest (1976), who replicated Sells' study, looked at University of California freshmen and their high school backgrounds and found mathematics participation of women to be much less than that of men, thus hindering female mathematics-related college prospects. Similarly, Dunteman et al. (1979) found that the high school science preparation for females and for blacks needed to be improved in order for them to consider majoring in science in college. Additionally, results from both Peng and Jaffe (1979) and Steel and Wise (1979) indicated that mathematics participation was an important predictor of women's mathematics achievement.

The research on mathematics achievement dealt primarily with sex differences. Maccoby and Jacklin (1974), in their comprehensive literature review of sex differences, concluded that there are few mathematics differences between the sexes through the middle school years. However, by the time high school students are seniors, males performed better than females, particularly at the high cognitive (problem solving) mathematics levels. This was clearly substantiated by Wilson (1972) in his report of the 1962-1967 National Longitudinal Study of Mathematical Ability (NLSMA) data; by Hilton and Berglund (1974) in their nationwide study using ETS data following 1961 fifth graders through the eleventh grade; by Aiken (1976) in his update of his 1970 review on factors affecting mathematics achievement; by both the first

(1972-73) and second (1977-78) National Assessment of Educational Progress (NAEP) mathematics assessments (Education Commission of the States, 1979); and most recently by Benbow and Stanley (1981) in their study of gifted seventh and eighth grade males and females.

In order to study sex differences in mathematics achievement, two Wisconsin researchers (Fennema & Sherman, 1977, 1978; Sherman & Fennema, 1977) collected data in 1975 on 1200 predominantly white ninth through twelfth graders in four high schools in Madison. In 1976, they surveyed about 1100 students in grades six through eight from the nine feeder schools to these high schools. In their remarks, Fennema and Sherman cautioned that the observed sex differences in mathematics achievement might be due to lower rates of mathematics participation by women since they found that females in the lower half of the achievement curve did not continue to study mathematics as often as did the males. But, data from two 1978 national surveys, the Women and Mathematics project, and the NAEP second mathematics assessment (Armstrong, 1980), seem to refute the explanation that for women, low mathematics achievement results from low mathematics participation. The NAEP study found that males outperform females in problem solving at every level of participation, while the Women and Mathematics study concurred--except at the highest mathematics participation levels of pre-calculus and calculus.

The effect of high school mathematics and science preparation on mathematics and science achievement for women alone and for women in comparison with men, then, is still uncertain. There is enough research, however, to warrant further study of the effects of both high school participation and achievement on attainment.

Socioeconomic Status

Since the days of Blau and Duncan (1967), a measure of socioeconomic status (SES) has been used in virtually every model involving educational attainment. In addition, Dunteman et al. (1979), Peng and Jaffe (1979), Steel and Wise (1979), and Wise (1979) all used some measure of socioeconomic status in their models predicting mathematics/science attainment.

The extent of the effect of SES on mathematics-related attainment is not completely clear. Peng and Jaffe (1979) found this factor only indirectly related to college major choice. However, Gilmartin et al. (1976), in their large scale study of high school students and science careers, concluded that women's career plans were strongly related to parental education level. This finding closely paralleled a similar one made by Erlick and LeBold in 1975. After analyzing responses from a nationwide poll of tenth through twelfth grade high school students, Erlick and LeBold determined that SES was correlated positively with scientific ability. Brush (1979) studied sixth through eleventh graders in order to trace the development of the decision of women to or not to continue in mathematics. She found that no background variables were important in the middle school years, but that in high school, SES was an important predictor of the number of mathematics courses taken.

Self-concept

Sherman and Fennema (1977) discovered that the "self-concept as a learner of mathematics" dimension was related to intent to take further mathematics classes which was related to mathematics achievement. They also reported that the mathematics confidence of males was significantly higher than that of females in both the middle and high school years (Fennema & Sherman, 1977, 1978). Ernest (1976) supported these findings by reporting that in the younger grades, both males and females believed that their own sex was better in mathematics. By the older grades, however, both sexes perceived that the males were superior in mathematics--even if the females were getting better mathematics grades (Fennema, 1975; Levine, 1976). The lower mathematics self-concept of women may be related to what Fennema and Sherman call the "mathematics stereotyped as male domain" factor which correlates significantly more with mathematics achievement for females than for males (Fennema & Sherman, 1977; Fox, 1977).

Two longitudinal studies also reported the importance of self-concept. Steel and Wise (1979) found that women's self-concept was significantly related to their mathematics participation, while Kaminski, Erickson, Ross, and Bradfield (1976), after surveying over 500 eighth through twelfth graders, discovered self-concept to be an important intervening variable between parental expectations and women's participation in high school mathematics classes.

Significant Others' Perceived Influence

This section discusses the relationship of significant others--parents, teachers/counselors, and peers--and their perceived influence on mathematics and science participation and goals.

Fennema and Sherman (1977, 1978) found that although there were no sex differences in the middle school grades, by the high school years, parents had a less positive attitude toward females learning mathematics. In addition, Parsons (1979) reported that parents thought that daughters had to try harder to do well in mathematics and that it was more difficult and less important for them. Fox (1975) found that this sex difference in parental treatment was true even when the females were mathematically gifted.

In a study identifying factors promoting high mathematics enrollment and achievement of students in eleven Northern California high schools, Stallings (1979) concluded that the influences of both the mother and father were perhaps the most important factors in their daughter's continuance with mathematics studies. Erlick and LeBold (1975) also found that parental encouragement was influential in high school student's attitudes toward science careers.

Considering each parent individually, Armstrong (1980) reported that only the father's educational expectations for his daughter were important for her mathematics course taking, while in three studies of women mathematicians (Helson, 1971; Luchins, 1976; and Osen, 1974), a common thread was the positive attitude of their fathers toward the continuation of their mathematics studies. Other researchers reported that the mother was the important significant other. Boswell (1979), studying the cultural, social, and psychological antecedents of mathematics participation, surveyed Denver Public School students in grades three through twelve. She found that mother's attitude toward mathematics correlated significantly with the daughter's and that the influence of the mother was affecting female mathematics behavior. Clark and Zapato (1980), too, found that women reported more consistent support for doing well in mathematics and science from their mothers than from their fathers.

Mostly negative teacher attitudes toward females studying mathematics were reported by Ernest (1976), as were teacher and counselor expectations for females (Ernest, 1976; Levine, 1976). Casserly (1975) and Fox (1975) found, however, that the advanced placement mathematics females whom they studied had some helpful, enthusiastic mathematics teachers. Luchins (1976) also reported that female teachers encouraged some women mathematicians--although in general the mathematicians felt that they had received differential treatment via lower expectations and less attention paid to them. Similarly, Casserly (1975, 1979) and Luchins (1976) learned that counselors, perhaps projecting their own mathematics anxieties, discouraged (or tried to discourage) females from taking advanced mathematics classes. Goldman and Hewitt (1976), after reviewing the mathematics SAT scores and college majors of 1973-1974 undergraduates at four University of California campuses, concluded that females were not encouraged by their high school counselors to take mathematics. Concurring, McLure and Piel (1978), in an NSF study of over 1000 high ability college-bound girls, reported that teachers did not encourage scientific interest in girls.

In terms of mathematics course taking, Armstrong (1980) found that for women, teacher encouragement was one of the two most important predictors of the decision to continue in mathematics studies. On the contrary, Stallings (1979) found that neither teacher nor counselor influence was important in mathematics participation. The reason for this discrepancy is not known; the results that Armstrong presented, based on nationwide data, however, also contradict findings in other areas.

There has not been a great deal of research reported about peers' attitudes toward one's learning mathematics, although Fox (1977), using the Johns Hopkins mathematically precocious study data, suggested that female students with strong mathematics ability achieved less in mathematics than males because of peer pressure, and Casserly (1975), who also studied high ability mathematics female students, mentioned that other girlfriends were helpful to the female mathematics student in dealing with the disapproval of males. Horner's "avoidance of success" construct for high achieving women (Horner, 1972) was affirmed by Sherman (1979) who found that female fourth year mathematics Wisconsin high school students felt less mathematically successful than those taking only two or three years of mathematics! Other studies (Armstrong, 1980; Casserly, 1975; Stallings, 1979) revealed that peer influence was not nearly as important as that of the parents.

The research indicates that significant others' attitudes toward mathematics appears to affect the decision to pursue mathematics. There is, however, no clear agreement as to the magnitude and direction of the influence that parents, teachers/counselors, and peers exert.

Educational and Occupational Expectations

Little information has been published on the association between the expectations and mathematics-related attainment of women. However, the Erlick and LeBold (1975) study found that the reason high school students did not pursue science careers was related to their lowered educational and occupational expectations; Gilmartin et al. (1976) corroborated this finding for Spanish surnamed females. Other related findings--by Peng and Jaffe (1979) and Wise (1979)--were that a woman's educational and occupational expectations, respectively, were important predictors of her entry into mathematical/scientific college majors and careers.

Sex-role Orientation

Safilios-Rothschild (1979), in her extensive review and critique of the literature relating to sex-role socialization and sex discrimination, concluded that there was a high correlation between a woman's sex-role ideology and her choice of nonstereotypical occupations, while Rossi (1965a), using census data and studying 1961 women college graduates, determined that women who did not select engineering, medical, or science careers were those women who accepted the traditional sex-role stereotype.

In smaller scaled studies, Hawley (1972), who surveyed 146 San Diego State college students, found that women who chose mathematics or science had liberal sex-role ideologies, and Fitzpatrick (1978), in a small study of 43 bright tenth grade Texas females, reported a positive correlation between the more liberal orientation of sex-role attitudes and mathematics achievement for women. Additionally, Sherman (1979), after following up and interviewing 200 Wisconsin high school students from the original Fennema-Sherman sample, determined that sex-role stereotyping was detrimental to females in developing mathematics skills.

There seems to be general agreement, in both large and small studies, that a more liberal sex-role orientation is associated with non-feminine (read: mathematics-related) occupations. However, no model of mathematics-related attainment has used this variable.

Marriage and Children

Several studies revealed that women were concerned that having a career and a family were incompatible. Bielby (1978), in a longitudinal study of white women who were college seniors in 1961, found that marital and familial roles, as well as negative attitudes toward them, contributed to lower career involvement. More specifically, Erlick and LeBold (1975) indicated from their analysis of high school students in grades 10-12 that women planning science careers were more likely to be married later in life; Rossi (1965b) showed that women who were professional scientists were less likely to be married. Family responsibilities have also been cited (Astin & Myint, 1971; McLure & Piel, 1978; and Smith, 1976) as the greatest barrier to women seeking scientific careers. In addition, Steel and Wise (1979) reported that the number of children women expected to have was significantly and negatively related to their mathematics achievement.

Little clear-cut evidence exists as to which factors play the most important roles in women's mathematics-related attainments. Even less information is available as to how these variables affect different ethnic groups of women. It appears, however, that socioeconomic status, high school and college experiences, psychological attributes, significant others' perceived influence, educational and occupational expectations, sex-role orientation, and family status are factors which are worthy of further examination.

In this chapter, information on studies linking sex, race, and mathematics; on models relating to mathematics and science attainment; and on the interrelationships of mathematics participation and achievement, socioeconomic status, self-concept, significant others' perceived influence, expectations, sex-role orientation, and family status was presented. Appropriate measures of these variables, in the context of a model of mathematics-related attainment for ethnic subgroups of academic women, are provided in the next chapter.

CHAPTER 3

Methodology

The Data Base

The data for this study are a sample drawn from the National Longitudinal Study of the High School Class of 1972 (NLS). This survey, sponsored by the National Center for Education Statistics (NCES), and conducted by the Educational Testing Service and the Research Triangle Institute, is a deeply stratified two-stage national probability sample of 22,652 seniors from 1,318 public and private schools in the 50 states and the District of Columbia (Levinsohn, Henderson, Riccobono, & Moore, 1978). The students were sampled with equal probabilities within schools, but to increase the representation of minorities, schools located in low-income areas and those with a high proportion of minority group enrollment were sampled at approximately twice the sampling rate for other schools.

This panel study is designed to provide data on the development of the educational, vocational, and personal aspects of the lives of adolescents as they make the transition from high school and possibly post-secondary school into the adult world.

In the spring of 1972, the base year, subjects completed responses to a 104-item student questionnaire concerning their family background, high school experiences, educational and occupational expectations, and personal attitudes. Each student also completed a 69-minute Test Book. The test battery, consisting of six tests and measuring both verbal and non-verbal ability, included one subtest providing a measure of basic mathematics competence. Additional baseline information was gathered from the 11-part student School Record Information Form.

In the three follow-up surveys, further information was obtained about the respondents' educational and occupational careers, their expectations, and attitudes. Collection of data for each survey consumed more than six months time. The first follow-up survey began in October 1973 and was completed in April 1974; the second follow-up began in October 1974 and ended in April 1975; the third follow-up started in October 1976 and ended in May 1977. Response rates of 94.2 percent, 94.7 percent, and 92.1 percent, respectively, were obtained (King & Thorne, 1979). The effective overall response rate for the four survey instruments was almost 85 percent (Eckland & Alexander, 1980).

Sample

Although the NLS data base contains over 22,000 respondents, 5969 of them did not complete the base year questionnaire and unfortunately had to be discarded since crucial base year information was unavailable. Respondents from the remaining 16,683 cases were further excluded unless they were women and of Hispanic (Mexican-American, Puerto Rican, Latin American), black, or white ethnicity. This left 7929 cases--351 Hispanic, 1193 black, and 6385 white women. These cases were then examined to determine if there were non-missing values for mathematics-related attainment (the most recent college major) and mathematics-related experience (the second most recent college major), two of the most important variables in the model. If these conditions were met, the cases were included in the sample.

The remaining 3607 women are a very select group: an average of 146 Hispanic, 543 black, and 2918 white women who responded to the 1972 base year survey instrument and subsequently enrolled in college and declared a college major at least twice. This sample approximates the nationwide estimates that 45% of high school students attend college (Eiden & Grant, 1979); that blacks are nearly as likely as whites to attend college (Suter, 1980); that Hispanics are less likely than whites to attend college (Brown, Rosen, Hill, & Olivas, 1980); and that white females are slightly less than half of the white college population, black women are more than half of black college students, and Hispanic women are less than half of the Hispanic students who attend college (Dearman & Plisko, 1980).

Variable Measurement

This section presents descriptions of the variables specified in the model. Included in the descriptions are operational definitions, as well as information about statistical procedures employed in creating the variables and decision-making processes involved in handling missing data and coding.

Socioeconomic Status

The socioeconomic status (SES) variable is an aggregate based on an equally weighted linear combination of five base year instrument variables: father's and mother's education, father's occupation, parent's income, and household items. The SES scores were divided into quartiles and the upper quartile was coded 3, the middle two = 2, and the lower quartile = 1 (Levinsohn, Henderson, Riccobono, & Moore, 1978, p. 75).

Initially, separate SES measures of father's and mother's education and occupation, as well as number of siblings, were introduced into the model and correlated with the other variables. No variable showed any stronger association than did the SES composite measure. Researchers of status attainment based on the Wisconsin data of 1957 high school men and women followed up in 1964 (Hauser, 1973; Sewell & Shah, 1968), used an aggregated SES measure of father's and mother's education, father's occupation, and family income. Hauser (1973) explicitly discussed the aggregation and disaggregation of the SES measure, finding that disaggregation did not cause a loss of information. Several NLS data analyses involving race and sex effects (Page & Grandon, 1979; Thomas, Alexander, & Eckland, 1977) also utilized the SES composite score.

High School Experience

This variable is a weighted linear combination of three high school variables: the number of semesters of mathematics taken in high school, the number of semesters of science taken in high school, and the student's high school curriculum (dichotomized as academic or not academic). The information for these three variables comes from the base year School Record Information Form.

The weights or factor scores used to create this new variable result from applying factor analytic techniques. Using all the 7929 NLS Hispanic, black, and white women, a principal axis factor analysis was performed, yielding one factor.

Factor analysis is a method often used in data reduction (Kerlinger & Pedhazur, 1973; Kim, 1975). Considering the intercorrelations among a larger set of variables--in this particular case, number of semesters of high school mathematics, number of semesters of high school science, and the high school curriculum--a smaller number of variables is created. If there is only one factor, as in this case, the best linear combination of these variables is formulated. This linear combination is "best" in that it explains as much as possible of the variance in the original scores. Further information can be obtained by referring to the SAS manual (1979) and Appendix A, which includes the computer program and output. As with all researcher-created factor analytic composite scores in this study, a non-missing value for this indicator variable was computed for each case in which there was at least one non-missing component; if there were two or fewer non-missing components, the means substitution procedure (Cohen & Cohen, 1975) was employed.

High School Achievement

High school achievement is also a weighted linear combination of three variables. The first variable, mathematics ability, is the scaled mathematics score from the Test Battery subtest. The second variable is the student's percentile class rank. This variable is on the master file and was estimated from the School Record Information Form (see Levinsohn, Henderson, Riccobono, &

Moore, 1978, pp. 83-85). The third variable is an academic self-concept measure, based on the response to the base year question "Whatever your plans, do you think you have the ability to complete college?" Responses ranged from "definitely not" to "yes, definitely."

Principal axis factor analysis using these three variables resulted in one distinct factor (see Appendix A for more details) labeled high school achievement. The mathematics ability score, based on a subtest from the Test Battery, correlates highly with the composite ability score; these ability tests, since they were taken in the twelfth grade, can arguably be considered academic achievement scores (Green, 1974). Percentile class rank is clearly an academic achievement score. The third variable, named academic self-concept by Allen (1977) as well, is highly related to the high school academic achievement of females.

Psychological Self-concept

One variable, a composite on the master file, is included in this category: the 1972 self-concept measure. The composite was derived, on the basis of alpha factor analysis, from four base year instrument items with five-point Likert scale responses ranging from "strongly disagree" to "strongly agree." The four items composing the self-concept measure are: (1) "I take a positive attitude toward myself." (2) "I feel I am a person of worth, on an equal plane with others." (3) "I am able to do things as well as most other people." (4) "On the whole, I'm satisfied with myself." These four items, originating from Rosenberg's eleven-item self-concept scale, have a reasonably high measure of internal consistency (coefficient alpha = .66) (NCES, 1977).

As noted by Steel and Wise (1979), a mathematics self-concept variable is more desirable than a general self-concept measure. However, in their case as in this case, only the latter was available. It is anticipated that this self-concept measure will be as acceptable a surrogate measure as it was for Steel and Wise (1979) and Kaminski et al. (1976).

Significant Others' Perceived College Influence (SOPCI)

This composite variable is a weighted linear combination of three influence variables, one each for parents, teachers/counselors, and peers.

The parental perceived college influence variable involves two base year questionnaire responses to: "As far as you know, how much schooling do your father and mother (or guardian) want you to get?" The variable is coded "3" if it is reported that both parents wanted the respondent to pursue at least a two year college academic program, or if one parent was reported to want that and there was no report for the other parent. The variable is coded "2" if one parent wanted college and the other did not, and it is coded "1" if neither parent wanted at least a two year college academic program for their child.

The teacher/counselor perceived college influence variable is a dichotomy, coded "1" for influence if the response to the base year question: "Have your teachers or counselors ever tried to influence your plans after high school?" was "encouraged me to go to college."

The dichotomous perceived peer college influence variable reflects the respondent's response to the base year question: "What do most of your close friends plan to do next year?" If the answer is: "go to college," it is considered to be a measure of peer influence and was accordingly coded "1."

There are vast differences in the literature as to the importance of one or all of these significant others' influence variables as well as to how the measure is handled. Hauser (1973), in his reanalysis of the Wisconsin attainment model, suggested assigning different weights to the three influence variables if an acceptable composite significant others variable were used. Thus, these three variables were factor analyzed using the principal axis method; one factor emerged (see Appendix A).

It should be noted that this significant others' perceived college influence variable is important in terms of general attainment. However, a more specific "influence on mathematics studies" would have been preferred for this study; as this was not possible, SOPCI is used as a surrogate measure.

Expectations

There are two distinct variables in this category: educational expectations and occupational expectations. Although it might have been preferable to have measured these two variables in the ninth grade and then related them to the resultant high school and college experiences, this was not possible.

The educational expectations variable is the respondent's base year response to the question asking "the highest level of education you plan to attain." Answers range from 1 = less than high school graduation to 6 = go to a graduate or professional school after college.

The variable measuring expected occupation is derived from a base year questionnaire item asking the respondents to indicate "the best description of the kind of work you'd like to do." The occupational categories were then recoded as 2 = professional work, 1 = non-professional work, and 0 = otherwise.

Mathematics-related Experience

The variable in this category is based on the next to *last* college field of study that the respondent has declared. In other words, if one respondent declared a college major for 1972, 1973 and 1976, the college major under discussion would be 1973; if another respondent answered field of studies questions for 1974 and 1976, 1974's declaration would be included in this variable.

The response to the next to last college field of study is then recoded into six mathematics level categories using a classification scheme devised by Steel and Wise (1979). This scheme involves placing a career or college major into one of six categories, depending on the amount of mathematics knowledge required. The classifications are:

Level 6 (requires graduate level mathematics)--mathematician;

Level 5 (generally requires advanced college mathematics)--engineer, physical scientist, architect, pilot;

Level 4 (generally requires introductory college mathematics)--pharmicist, dentist, physician, biological scientist;

Level 3 (requires college and may require some statistics)--forester, lawyer, college professor, engineering aide,

Level 3 (con't)	medical/dental technician, accountant, high school teacher, elementary teacher, sociologist/psychologist, political scientist/economist, businessman, librarian, clergyman, writer, social worker;
Level 2	(generally requires some high school level mathematics)--nurse, salesperson, policeman/fireman, armed forces entlisted man, artist/entertainer, farmer, skilled worker, structural worker;
Level 1	(generally requires little or no mathematics)-- secretary/office worker, barber/beautician.

Sex-role Orientation

The one variable in this category is a sex-role orientation measure. This composite is derived from third follow-up items selected from 19 items used by other national studies and the National Center for the Study of Politics at Ann Arbor (Peng & Jaffe, 1980). Responses to nine of the items ranged from "agree strongly" to "disagree strongly." The nine items summed to comprise this variable are: (1) "It is usually better for everyone involved if the man is the achiever outside the home and the woman takes care of the home and family." (2) "Young men should be encouraged to take jobs that are usually filled by women (nursing, secretarial work, etc.)." (3) "Most women are just not interested in having big and important jobs." (4) "Many qualified women can't get good jobs; men with the same skills have much less trouble." (5) "Most women are happiest when they are making a home and caring for children." (6) "High school counselors should urge young women to train for jobs which are now held mainly by men." (7) "It is more important for a wife to help her husband than to have a career herself." (8) "Schools teach women to want the less important jobs." (9) "Men should be given first chance at most jobs because they have the primary responsibility for providing for a family."

Family Status

This variable is a linear combination of two third follow-up questionnaire dichotomous variables describing the respondent's October 1976 marital status (1 = married, 0 = otherwise) and whether there are children in the family (1 = at least one child, 0 = no children). Aneshensel and Rosen (1980), Broschart (1978), and Heatherington, Cox, and Cox (1979) indicated that there are additional stresses on unmarried women bringing up a child. Therefore, the family status variable is coded "0" if the respondent is neither married nor with children, "1" if the respondent is married but childless, "2" if the respondent is married with children, and "3" if the respondent is unmarried but has children.

Mathematics-related Attainment

This last variable is the dependent variable and is constructed similarly to the mathematics-related experience variable. This variable, depending on how far along the respondent is in completing an education, can range from a 1973 college major declaration (in which case the respondent would have declared a 1972 college major which would be the mathematics-related experience variable) to a 1976 graduate school field of study (in which case the respondent would have her last undergraduate college major as her mathematics-related experience variable).

It is well known that many students interrupt or delay their college attendance; this is particularly true for women who marry early and have children (Waite & Moore, 1978). The literature is conflicting as to how interrupted schooling affects eventual educational attainment level (Robertshaw & Wolfle, 1980). Since this research is concerned with women's mathematics-related attainment and experience as of 1976, there is every reason to include those women who were in college for two years, regardless of which two years. Therefore, the decision was made to allow the survey instrument from which mathematics-related attainment (based on the most recent college major) and mathematics-related experience (based on the second most recent college major) were obtained, to vary on a case by case basis for these two variables.

Data Analysis

To accomplish the objectives of this study, an NLS subfile, constructed as a Statistical Analysis System (SAS) data set, was developed from the master file. All analyses were performed using the subfile and the SAS computer packages (SAS, 1979). Two types of analyses were conducted: one of a descriptive and one of an analytic nature.

Descriptive Analysis

This analysis included weighted means and standard deviations. Weighted percentages and zero-order weighted correlations also were computed.

One purpose of this analysis was to provide group profiles with respect to SES, high school experience and achievement, attitudes, expectations, and mathematics-related participation in educational spheres, as well as to present the 1976 mathematics-related attainment of the

Hispanic, black, and white women. Another purpose was to determine, for each subgroup, the independent variables with the most significant relationships to the dependent variable.

Multivariate Analysis

Statistical computations of multiple linear regression coefficients were utilized for the multivariate analysis.

Path Analysis. Path analysis, or the causal analysis of structural equations, was used for model testing purposes. Path analysis, first used in the early 1920's by the geneticist Sewell Wright (Duncan, 1966), became more well known in the 1960's when Blau and Duncan's (1967) use of path analysis techniques for assessing status attainment models assured its usage by sociologists for further attainment model research. Users of longitudinal data, after conceptualizing a model, have also found path analysis useful. Anderson and Evans (1974) were one of the first to publish a paper whose specific purpose was to demonstrate the application of the procedure of causal modeling to educational research theory. Recent issue of the American Educational Research Journal, Harvard Educational Review, and Review of Educational Research indicate that path analysis has subsequently been well accepted by educational researchers. The major advantage of path analysis is not to determine causality, but rather to be able to explicitly specify a priori and test an ordered structure of relationships, as well as consistently interpret the patterns of the interrelations.

Path analysis, from a statistical point of view, is simply that of multiple linear regression analysis; the requirements necessary for path analysis, therefore, encompass those for ordinary least squares (OLS) regression. The assumptions of path analysis compiled from a variety of sources (Asher, 1976; Blalock, 1968; Loether & McTavish, 1974; Schumm, Southerly & Figley, 1980) are:

1. the relationship among the variables is linear and additive;

2. the variables are interval level data although dichotomies are also permissable (Land, 1969);

3. for each independent variable, the dependent variable is normally distributed and has equal variance (homoscedasticity);

4. the residuals (error terms) are normally distributed with means of zero (to allow for F tests and to insure that the variable measurements are reliable) and are uncorrelated with each other or with independent variables in the same equation (so as to get unbiased and efficient estimates from OLS).

5. the model must be based on a priori theory, ordered temporally, and should be a closed system (namely, all major independent variables should be included so that unbiased estimates may be calculated).

As is stressed, the external specification of the model, that is, the correct causal ordering is most important (Duncan, 1966; Land, 1969; Schumm et al., 1980; Wolfle, 1980). In the mathematics-related attainment path model, the ordering of the variables was determined, whenever possible, by the time at which they were measured or to which they refer. When two or more variables were measured at the same point in time, judgments as to their order were made based on previous research. The remaining path analysis assumptions will not be dealt with further; most analyses of a similar nature (for example, use of path analytic models on NLS data by Dunteman et al., 1979; Falk & Falkowski, 1980; Peng & Jaffe, 1979; Thomas et al., 1977) do not consider the assumptions because regression analysis is so robust.

Interpretations of path analytic models utilize some terms which need to be defined. For example, the model depicted in Figure 1 is called a block recursive model. It is recursive because causality is unidirectional; it is block because in one class of variables (educational and occupational expectations), the two are parallel to each other (Wolfle, 1980). A variable is called exogenous if no explanation of its value is attributed to the model; the only exogenous variable in the mathematics-related attainment model is the SES variable. The non-exogenous independent variables as well as the dependent variable are termed endogenous variables because their values are explained by the model (Bridge, Judd, & Moock, 1979).

In discussing the decomposition of effects in path analysis, Alwin and Hauser (1975) define the total association between two variables as their zero-order correlation; this association is the sum of spurious effects, joint associations, and total effects. The total effects and their components, direct and indirect effects, are the only concerns in this path analysis. Considering only a section of the mathematics-related attainment model (see Figure 3), the total effect of mathematics-related experience (variable x_i) on mathematics-related attainment (variable x_j) is the amount of change in variable x_j which was induced by variable x_i, irrespective of how the change occurred. The direct effect of mathematics-related experience (variable x_i) on mathematics-related attainment (variable x_j) is statistically defined as the beta weight or standardized partial regression coefficient, p_{ji}, of variable x_i on variable x_j, holding all the other variables in the model constant. It is the unmediated effect of variable x_i on variable x_j. The <u>indirect effect</u> of variable x_i on variable x_j would be that part of the total effect which is mediated by intervening variables.

In the model in Figure 3, there are two <u>intervening</u> or <u>mediating variables</u> between mathematics-related experience and mathematics-related attainment--sex-role orientation (variable x_c) and family status (variable x_d). Thus, the indirect effect of variable x_i on variable x_j is the sum of the effects of variable x_i on variable x_j mediated through variable x_c, of variable x_i on variable x_j through variable x_d, and of variable x_i on variable x_j through variables x_c and x_d. These effects are calculated respectively, as $p_{ci} * p_{jc}$, $p_{di} * p_{jd}$, $p_{ci} * p_{dc} * p_{jd}$.

These defined terms are needed to provide interpretations of the results obtained from the <u>basic theorem of path analysis</u> as stated by Duncan (1966):

$$r_{ji} = \sum_k p_{jk} * r_{ki}$$

where i indexes the causal variable of interest, x_i;

j indexes the affected variable x_j which is to the right of x_i in the model;

and k is an index which runs over all variables in the model from which paths lead directly to x_j.

The expansion of this summation yields an equation whose left-hand term, r_{ji}, is the total association between

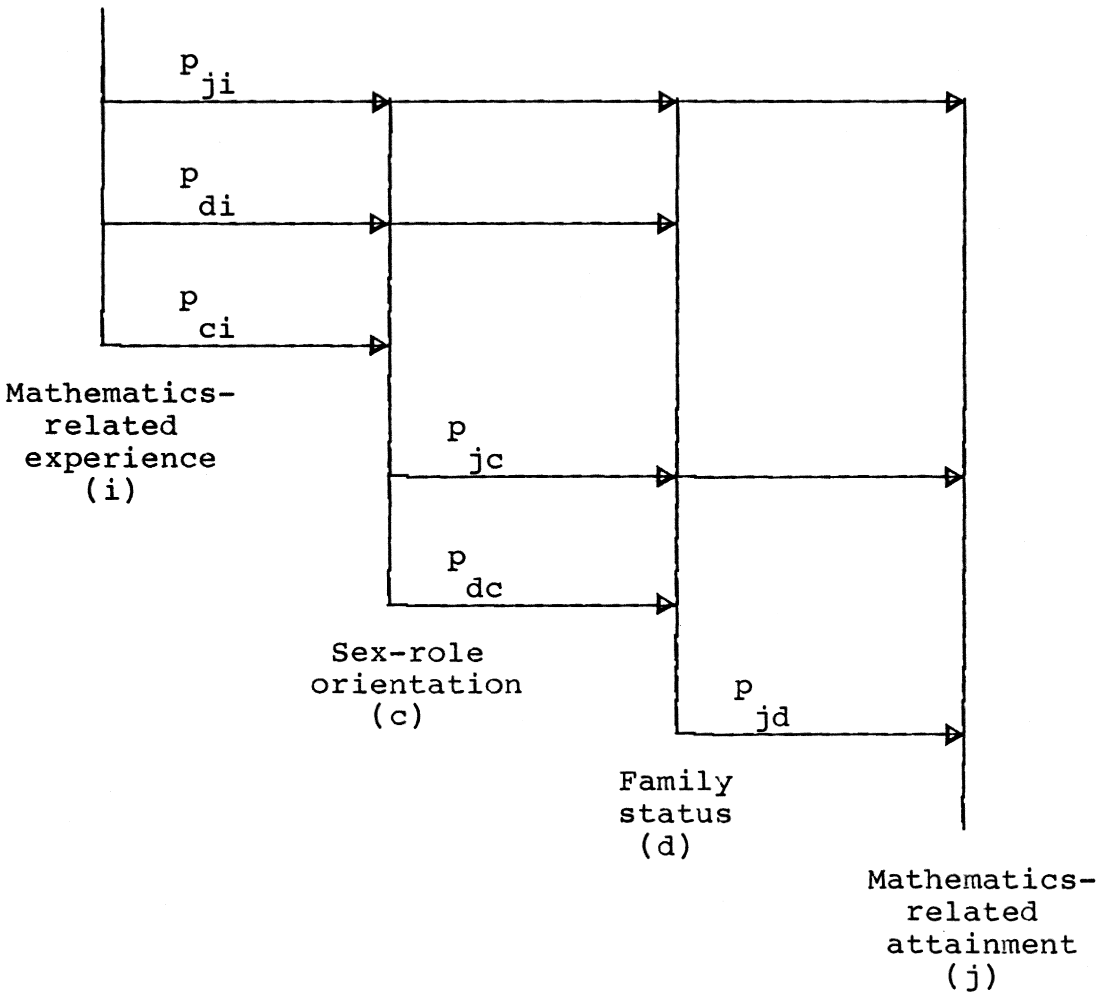

Figure 3

Incomplete Path Model for
Explaining Direct and Indirect Effects

x_j and x_i, and whose right hand side is composed of p_{ji}, the direct effect; several path products, each of which is an indirect effect; and several other path and correlation coefficients which represent spurious effects/joint associations. (See Alwin and Hauser, 1975; Duncan, 1966; Wolfle, 1980 for examples of the expanded summations.)

When partial regression coefficients are calculated for each path in the model, they are standardized so that each beta weight, β, in the model may be compared to the others. For example, if a structural equation model had $\beta_1 = .3$ and $\beta_2 = .6$, it would be said that the second variable contributed twice as much as the first variable to the variance of mathematics-related attainment, all other variables held constant. Additionally, $\beta_1 = .3$ could be interpreted as follows: holding the other variables in the model constant, a one unit change in β_1 would induce a .3 unit change in the dependent variable.

Unstandardized partial regression coefficients, b, often called metric coefficients, are also useful. The equation relating the two types of coefficients is $\beta_{yx} = b_{yx}*(s_x/s_y)$. The b's are utilized when comparisons of the mathematics-related attainment model are made among the Hispanic, black, and white subgroups. For example, if $b_1 = .04$ for Hispanic women and $b_1 = .12$ for blacks, the effect of b_1 is three times as strong for blacks as for

Hispanics.

Potential Data Analysis Problems

Although the effective overall NLS response rate was almost 85 percent (Eckland & Alexander, 1980), there still was the problem of instrument and item non-response. The instrument non-response difficulty was rectified by using appropriate weights. The item non-response aspect, however, presented difficulties (see Levinsohn & McAdams, 1978) in the multivariate analysis. This was mitigated by using the pairwise, rather than listwise, deletion method for calculating correlation matrices and performing regression analyses. (See Kim and Curry, 1977; Wolfle and Lichtman, 1980, for support for this method.)

The other problem involving the multivariate analysis was that of multicollinearity, that is, intercorrelations among the independent variables. Asher (1976) indicated that multicollinearity is more likely a problem with aggregate rather than with individual survey data--especially surveys with large sample sizes. Since random measurement error is present, the correlation coefficients are attenuated which makes the problem of collinearity less likely.

This chapter provided information on the NLS data base, the sample, the variables, and the data analyses. The next chapter reveals the results of the analyses.

CHAPTER 4

Results

This section details the results of the data analysis conducted using the NLS subfile. The descriptive analyses presented provide a report of the 1976 mathematics-related attainment of the Hispanic, black, and white women who declared a college field of study at least twice between 1972 and 1976, as well as profiles of these three groups of women. The multivariate analyses provide information about the theoretical model for the three groups of women, show the relative influence of the variables in the model, and allow for a comparison among the three subgroups. For the descriptive study, means and percentages of response across subgroups are contrasted without concern for statistical significance. The statistical significance will be dealt with in the multivariate analyses, due to the confounding relationships of sample size and variables.

Descriptive Results

Mathematics-related Attainment

One of the most visible differences among the three groups of women is their 1976 mathematics-related attainment. Defining "highly mathematics-related" fields of study as those fields of study with a mathematics level of 4, 5, or 6--that is, fields of study requiring at least college mathematics--14.7% of the whites, 11.7% of the Hispanics, and 8.1% of the blacks had college majors in that category (see Tables 1 and 2). Of those who received a bachelor's degree, the percentage for white women was one-half that of Hispanics (12.8% and 25.1%, respectively) in the highly mathematics-related category, with black women nearly equalling that of the Hispanic women (22.3%). In terms of graduate school majors, 60.9% of the Hispanics expected to be in a highly mathematics-related field of study, while equal percentages of blacks and whites (25.1% and 25.3%, respectively) expected to be in that category.

For the black and white women, between two-thirds and three-fifths of the responses to the mathematics level of the 1976 college major, of the 1976 bachelor's degree field of study, and of the 1976 expected graduate school field of study fell into the category "requiring some college and perhaps some statistics." Hispanics followed the same pattern in responding to the mathematics level of the college major and bachelor's degree. For the mathematics level of the expected graduate school field of study, however, only two-fifths of the Hispanics fell in that category, while nearly the same proportion fell in the next higher category "requires introductory college mathematics."

It is, however, interesting to note that in the

Table 1

Weighted Percentages for Women in Highly Mathematics-related Field of Study Variables

College Major Variable	Groups of Women					
	Hispanic		Black		White	
	%	n	%	n	%	n
Expected college, 1972	7.4	93	16.5	308	11.7	2421
1972	8.2	146	13.3	418	11.7	2504
1973	9.1	119	11.9	434	10.7	2445
1974	8.7	92	12.3	340	11.9	2117
1975	12.5	70	12.4	324	12.4	1849
1976	11.7	61	8.1	231	14.7	1105
B.A., 1976	25.1	12	22.3	105	12.8	973
Expected grad. school, 1976	60.9	9	25.1	38	25.3	296

Note. n's are unweighted total sample sizes for each indicated year; highly mathematics-related field of study variables are defined as fields of study requiring at least college mathematics (mathematics levels 4, 5, 6).

Table 2

Weighted Percentages of Women's Field of Study Mathematics Level

Math. Level	Groups of Women								
	Hispanic[a]			Black[b]			White[c]		
	M76	MBA	MGR	M76	MBA	MGR	M76	MBA	MGR
1	5.3	---	---	2.8	---	---	3.1	---	---
2	20.8	---	---	15.1	7.3	6.0	17.4	10.1	9.3
3	62.2	74.9	39.1	74.1	70.4	68.9	64.8	77.2	65.4
4	10.4	25.1	39.4	7.1	16.0	22.3	10.7	8.8	19.7
5	1.3	---	21.5	0.6	4.6	2.8	3.7	2.3	4.2
6	---	---	---	0.4	1.7	---	0.3	1.7	1.4

Note. Percentages may not total one hundred due to rounding. Level 1 requires little or no mathematics, level 2 generally requires some high school level mathematics, level 3 requires some college and may require some statistics, level 4 generally requires introductory college mathematics, level 5 generally requires advanced college mathematics, level 6 requires graduate level mathematics. M76 = 1976 college field of study, MBA = 1976 field of study of B.A. degree, MGR = expected graduate school field of study.

[a]Hispanic sample sizes for M76, MBA, and MGR are 61, 12, and 9, respectively.

[b]Black sample sizes for M76, MBA, and MGR are 231, 105, and 38, respectively.

[c]White sample sizes for M76, MBA, and MGR are 1105, 873, and 296, respectively.

years through 1974, blacks had the largest proportion of women declaring highly mathematics-related fields of study, with whites next and Hispanics last; in 1975, all three groups reported similar percentages; and in 1976, the order switched with the blacks placing last in the proportion of highly mathematics-related fields of study for their 1976 college major and expected graduate school major.

Profiles

An illustrative way to envision a picture of the three groups of women is to look at their frequency distribution and mean scores for key factors.

SES. Tables 3 and 4 show a noteworthy discrepancy between the groups of women and their socioeconomic status (SES) quartiles; on the average both Hispanics and blacks fell in the middle of the first quartile with over 50% of both groups in the low SES range. White women were, on the average, in the middle SES range, with at least half of them in the middle two quartiles.

High School Experience and Achievement. The high school experience of the three groups of women is somewhat dissimilar. The composite variable means indicated that, given a range from 0 to 8.07, whites scored highest (3.39) followed by blacks (3.04) and then Hispanics (2.86). This

Table 3

Weighted Means and Standard Deviations of Selected Variables of Interest

Variables	Groups of Women								
	Hispanic			Black			White		
	$\overline{X}$	sd	n	$\overline{X}$	sd	n	$\overline{X}$	sd	n
SES	1.54	.06	146	1.55	.06	542	2.29	.04	2916
H.S. exper.[a]	2.86	.12	146	3.04	.11	543	3.39	.09	2913
Semes. math.	3.70	.16	145	3.99	.16	519	4.25	.13	2812
Semes. sci.	3.31	.14	143	3.54	.16	521	3.95	.13	2814
H.S. achv.[a]	43.62	1.07	146	41.07	1.08	543	51.58	.82	2918
Math. abil.	44.96	.75	135	43.62	.77	502	55.01	.56	2792
Perc. class rank	60.74	2.35	127	55.44	2.50	470	69.55	1.66	2750
Acad. self-con.	4.34	.07	146	4.35	.07	540	4.51	.05	2912
Psy. self-con.	3.92	.05	146	3.97	.06	539	3.95	.05	2913
Sex-role	2.84	.03	124	2.80	.03	492	2.83	.03	2757
SOPCI[a]	1.50	.03	146	1.49	.04	542	1.63	.03	2918
Math-rel. attain.	2.66	.08	146	2.81	.08	543	2.82	.06	2918

Note. Means and standard deviations are weighted; sample size is unweighted.

[a]Composite score.

Table 4

Weighted Percentages of Family Background and High School Experience Variables

Variables	Categories	Groups of Women: Hispanic	Black	White
SES[a]	Low	55.1	54.1	10.4
	Middle	33.3	36.9	50.1
	High	9.5	9.0	39.6
H.S. math. prep.[b]	None	3.5	0.6	1.8
	1 yr.	36.0	31.6	23.6
	2 yrs.	34.6	36.9	37.0
	3 yrs.	18.6	24.4	31.8
	4 yrs. or more	7.2	6.5	5.8
H.S. science prep.[c]	None	1.5	2.2	1.2
	1 yr.	46.4	39.5	31.3
	2 yrs.	35.9	37.3	38.6
	3 yrs.	13.1	17.4	23.4
	4 yrs. or more	3.2	3.5	5.4
H.S. acad. curric.[d]	No	53.2	56.7	25.2
	Yes	46.8	43.3	74.8

Note. Percentages may not total one hundred due to rounding.

[a]Sample sizes for Hispanics, blacks, and whites are 146, 542, and 2916 respectively.

[b]Sample sizes for Hispanics, blacks, and whites are 145, 519, and 2812, respectively.

[c]Sample sizes for Hispanics, blacks, and whites are 143, 521, and 2814, respectively.

[d]Sample sizes for Hispanics, blacks, and whites are 142, 530, and 2888, respectively.

rank ordering was reinforced by looking at the frequencies of the three variables which comprise the high school experience composite. White women clearly were more often in an academic curriculum (74.8% versus 46.8% for Hispanics and 43.3% for blacks), and took more mathematics and science classes than black women who, in turn, took more of the same than Hispanic women (Tables 3 and 4).

The high school achievement composite means showed that the whites still were first, but that Hispanics were second, followed by blacks. The means, based on scores ranging from 14.26 to 68.89, were 51.58, 43.62, and 41.07, respectively. The results from the means of the variables forming this composite verified this ordering. White women still remained first in their mathematics ability score, percentile class rank, and academic self-concept, with means of 55.01, 69.55, and 4.51 respectively; Hispanics followed next with 44.96 and 60.74, and 4.34 as their mean mathematics ability scores, percentile class rank, and academic self-concept, respectively; and black women were third with respective scores of 43.62, 55.44, and 4.35 (Table 3).

Socio-psychological Attributes. Hispanic, black, and white women were similar in their mean scores measuring their psychological self-concepts and sex-role orientations. On a continuum from 1 to 5, the self-concept mean scores were 3.92, 3.97, and 3.95, respectively; the sex-role orientations mean scores, ranging from 1.33 to 4, were 2.84, 2.80, and 2.83, respectively (Tables 3 and 4).

<u>SOPCI</u>. The composite significant others' perceived college influence (SOPCI) variable had values ranging from .40 to 1.87. The mean scores ranked the white women (1.63) first, followed by the almost equal scores of Hispanics (1.50) and blacks (1.49). The percentages for the separate influence variables clarified the ordering of the groups. All three groups of women reportedly perceived that their parents, teachers/counselors, and peers influenced their decisions to go to college, with proportions ranging from two-thirds to more than four-fifths. Teacher/counselor influences for the three groups were nearly equal, although blacks perceived slightly more influence. Whites, however, felt considerably more influenced by parents and peers (88.4% and 82.8%, respectively) than blacks (77.4% and 66.2%, respectively) and Hispanics (79% and 68.7%, respectively) who perceived themselves similarly influenced by these two groups of significant others (Tables 3 and 5).

<u>Expectations</u>. In terms of expectations (see Table 6), there were not many differences: almost all of the women expected to work, although three-fourths of the women

Table 5

Weighted Percentages of Significant Others' Perceived College Influence Variables

Perceived College Influence Variables	Categories	Groups of Women Hispanic	Black	White
Parental[a]	None	11.2	12.2	8.6
	Some	9.8	10.4	3.1
	A great deal	79.0	77.4	88.4
Teacher/ counselor[b]	No	24.9	20.6	22.8
	Yes	75.1	79.4	77.2
Peer[c]	No	31.3	33.8	17.2
	Yes	68.7	66.2	82.8

Note. Percentages may not total one hundred due to rounding.

[a]Sample sizes for Hispanics, blacks, and whites are 104, 333, and 2497, respectively.

[b]Sample sizes for Hispanics, blacks, and whites are 146, 535, and 2910, respectively.

[c]Sample sizes for Hispanics, blacks, and whites are 141, 529, and 2874, respectively.

Table 6

Weighted Percentages of Educational
and Occupational Expectations Variables

		Groups of Women		
Variables	Categories	Hispanic	Black	White
Educ. expec.[a]	Not H.S. grad.	1.2	1.2	0.4
	Graduate H.S.	2.9	4.7	2.3
	Voc/tech school	11.5	13.8	8.9
	Junior college	19.9	10.1	14.9
	Four yr. college	51.1	46.9	59.5
	Graduate school	13.4	23.3	14.0
Occup. expec.[b]	Professional work	54.6	58.7	73.6
	Other work	43.8	39.4	24.6
	Otherwise	1.6	2.0	1.9

Note. Percentages may not total one hundred due to rounding.

[a]Sample sizes for Hispanics, blacks, and whites are 96, 339, and 2538, respectively.

[b]Sample sizes for Hispanics, blacks, and whites are 111, 343, and 2616, respectively.

expected to be professionals and only slightly more than half of the black and Hispanic women held that expectation. At least four-fifths of all the women expected to attend some college, with from two-thirds (Hispanics) to seven-tenths (blacks) to three-fourths (whites) expecting to at least attend a four year college; black women, however, had the highest expectations for attending graduate school--nearly double the proportion of Hispanics and whites who expected to.

Family Status. Table 7 shows percentages for family status variables. Of the three groups of women, white women were the most often not married (67.4%), without children (92.2%), and not married without children (65.8%). Blacks had the greatest number of children (1.3% had at least 3 children) and had them most frequently (28.8%); additionally, they were the most likely to have children and not be married (17.6%). Hispanics were most likely to be married (35%) and to be married with children (12.1%).

Correlations

In order to determine which factors have important associations with mathematics-related attainment, weighted pairwise deletion correlation matrices were generated (see Tables 8-10) for Hispanic, black, and white women who at

Table 7

Weighted Percentages of Family Status Variables

Variables	Categories	Groups of Women		
		Hispanic	Black	White
Family status[a]	No mar. & no child.	62.5	60.3	65.8
	Mar. & no child.	23.2	10.9	26.4
	Mar. & child.	12.1	11.3	6.6
	No mar. & child.	2.2	17.6	1.2
Marital status[b]	Single, plans	12.9	14.1	11.8
	Single, no plans	48.3	59.5	53.1
	Divorced, widowed	3.8	4.3	2.5
	Married	35.0	22.1	32.5
Children[c]	None	85.7	71.2	92.2
	One	13.2	21.7	7.0
	Two	1.1	5.8	0.8
	Three or more	----	1.3	0.0

Note. Percentages may not total one hundred due to rounding.

[a]Sample sizes for Hispanics, blacks, and whites are 146, 505, and 2744, respectively.

[b]Sample sizes for Hispanics, blacks, and whites are 132, 509, and 2789, respectively.

[c]Sample sizes for Hispanics, blacks, and whites are 131, 507, and 2758, respectively.

ic Women

April 11, 1985

									: MATHEXPR	SEXROL	FAMLY
MATHAT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.63426 0.0001 146	0.14609 0.1054 124	-0.10540 0.2309 131
SES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.20447 0.0133 146	-0.05365 0.5540 124	-0.09664 0.2722 131
HSEXPE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.29261 0.0003 146	0.16745 0.0630 124	-0.03402 0.6996 131
HSACH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.24833 0.0025 146	0.27860 0.0017 124	-0.00919 0.9170 131
PSYSC7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.07789 0.3501 146	-0.05485 0.5451 124	-0.22817 0.0088 131
SOPCI	[illegible] 0.0101 146	[illegible] 0.0406 146	[illegible] 0.0035 146	[illegible] 0.0001 146	[illegible] 0.0497 146	[illegible] 0.0000 146	[illegible] 0.0001 96	[illegible] 0.0624 111	0.21148 0.0104 146	0.09634 0.2872 124	-0.09344 0.2884 131
EDEXPEC	0.51110 0.0001 96	0.15471 0.1323 96	0.53126 0.0001 96	0.47327 0.0001 96	0.07804 0.4498 96	0.45146 0.0001 96	1.00000 0.0000 96	0.52164 0.0001 85	0.57093 0.0001 96	0.46372 0.0001 81	-0.03913 0.7238 84
OCCEXPEC	0.34524 0.0002 111	0.13928 0.1449 111	0.38409 0.0001 111	0.37858 0.0001 111	0.00730 0.9394 111	0.17744 0.0624 111	0.52164 0.0001 85	1.00000 0.0000 111	0.37263 0.0001 111	0.33069 0.0012 93	-0.08665 0.4012 96
MATHEXPR	0.63426 0.0001 146	0.20447 0.0133 146	0.29261 0.0003 146	0.24833 0.0025 146	0.07789 0.3501 146	0.21148 0.0104 146	0.57093 0.0001 96	0.37263 0.0001 111	1.00000 0.0000 146	0.29239 0.0010 124	-0.12608 0.1513 131
SEXROL	0.14609 0.1054 124	-0.05365 0.5540 124	0.16745 0.0630 124	0.27860 0.0017 124	-0.05485 0.5451 124	0.09634 0.2872 124	0.46372 0.0001 81	0.33069 0.0012 93	0.29239 0.0010 124	1.00000 0.0000 124	-0.12688 0.1620 123
FAMLY	-0.10540 0.2309 131	-0.09664 0.2722 131	-0.03402 0.6996 131	-0.00919 0.9170 131	-0.22817 0.0088 131	-0.09344 0.2884 131	-0.03913 0.7238 84	-0.08665 0.4012 96	-0.12608 0.1513 131	-0.12688 0.1620 123	1.00000 0.0000 131

Note. First line is coefficient, second is significance level, and third is sample size.

Table 9

Weighted Pairwise Deletion Correlation Matrix for Black Women

	MATHATT	SES	HSEXPER	HSACH	PSYSC72	SOPCI	EDEXPEC	OCCEXPEC	MATHEXPR	SEXROL	FAMLY
MATHATT	1.00000	0.06549	0.19364	0.23038	0.05659	0.18084	0.26720	0.09419	0.67404	0.04298	-0.24613
	0.0000	0.1278	0.0001	0.0001	0.1896	0.0001	0.0001	0.0815	0.0001	0.3414	0.0001
	543	542	543	543	539	542	339	343	543	492	505
SES	0.06549	1.00000	0.11976	0.03990	-0.00646	0.18110	0.22516	0.07902	0.03174	0.15000	-0.17801
	0.1278	0.0000	0.0052	0.3539	0.8811	0.0001	0.0001	0.1442	0.4609	0.0009	0.0001
	542	542	542	542	538	541	338	343	542	491	504
HSEXPER	0.19364	0.11976	1.00000	0.32569	0.01786	0.24092	0.25259	0.28703	0.26496	0.11283	-0.19631
	0.0001	0.0052	0.0000	0.0001	0.6791	0.0001	0.0001	0.0001	0.0001	0.0123	0.0001
	543	542	543	543	539	542	339	343	543	492	505
HSACH	0.23038	0.03990	0.32569	1.00000	0.02088	0.27747	0.34953	0.30218	0.26630	0.14534	-0.22307
	0.0001	0.3539	0.0001	0.0000	0.6286	0.0001	0.0001	0.0001	0.0001	0.0012	0.0001
	543	542	543	543	539	542	339	343	543	492	505
PSYSC72	0.05659	-0.00646	0.01786	0.02088	1.00000	0.04462	0.13635	0.04048	0.04137	-0.01208	-0.00998
	0.1896	0.8811	0.6791	0.6286	0.0000	0.3012	0.0122	0.4569	0.3377	0.7902	0.8237
	539	538	539	539	539	539	337	340	539	488	501
SOPCI	0.18084	0.18110	0.24092	0.27747	0.04462	1.00000	0.46592	0.20949	0.11649	0.14496	-0.16683
	0.0001	0.0001	0.0001	0.0001	0.3012	0.0000	0.0001	0.0001	0.0066	0.0013	0.0002
	542	541	542	542	539	542	339	343	542	491	504
EDEXPEC	0.26720	0.22516	0.25259	0.34953	0.13635	0.46592	1.00000	0.30409	0.19006	0.18601	-0.14218
	0.0001	0.0001	0.0001	0.0001	0.0122	0.0001	0.0000	0.0001	0.0004	0.0010	0.0110
	339	338	339	339	337	339	339	252	339	308	319
OCCEXPEC	0.09419	0.07902	0.28703	0.30218	0.04048	0.20949	0.30409	1.00000	0.12360	0.11262	-0.09193
	0.0815	0.1442	0.0001	0.0001	0.4569	0.0001	0.0001	0.0000	0.0221	0.0462	0.0996
	343	343	343	343	340	343	252	343	343	314	322
MATHEXPR	0.67404	0.03174	0.26496	0.26630	0.04137	0.11649	0.19006	0.12360	1.00000	0.09172	-0.18897
	0.0001	0.4609	0.0001	0.0001	0.3377	0.0066	0.0004	0.0221	0.0000	0.0420	0.0001
	543	542	543	543	539	542	339	343	543	492	505
SEXROL	0.04298	0.15000	0.11283	0.14534	-0.01208	0.14496	0.18601	0.11262	0.09172	1.00000	-0.07083
	0.3414	0.0009	0.0123	0.0012	0.7902	0.0013	0.0010	0.0462	0.0420	0.0000	0.1189
	492	491	492	492	488	491	308	314	492	492	486
FAMLY	-0.24613	-0.17801	-0.19631	-0.22307	-0.00998	-0.16683	-0.14218	-0.09193	-0.18897	-0.07083	1.00000
	0.0001	0.0001	0.0001	0.0001	0.8237	0.0002	0.0110	0.0996	0.0001	0.1189	0.0000
	505	504	505	505	501	504	319	322	505	486	505

Note. First line is coefficient, second is significance level, and third is sample size.

Table 10

Weighted Pairwise Deletion Correlation Matrix for White Women

	MATHATT	SES	HSEXPER	HSACH	PSYSC72	SOPCI	EDEXPEC	OCCEXPEC	MATHEXPR	SEXROL	FAMLY
MATHATT	1.00000	0.14433	0.23773	0.23652	0.04862	0.19740	0.27920	0.13836	0.71345	0.15864	-0.13594
	0.0000	0.0001	0.0001	0.0001	0.0087	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	2918	2916	2913	2918	2913	2918	2538	2616	2918	2757	2744
SES	0.14433	1.00000	0.08149	0.07666	0.07781	0.26613	0.23981	0.09416	0.17269	0.10989	-0.11662
	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	2916	2916	2911	2916	2911	2916	2538	2616	2916	2756	2743
HSEXPER	0.23773	0.08149	1.00000	0.34250	0.05083	0.24056	0.27418	0.23096	0.25858	0.09474	-0.08112
	0.0001	0.0001	0.0000	0.0001	0.0061	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	2913	2911	2913	2913	2908	2913	2533	2611	2913	2754	2741
HSACH	0.23652	0.07666	0.34250	1.00000	0.13029	0.32845	0.35516	0.20510	0.27935	0.12767	-0.10805
	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	2918	2916	2913	2918	2913	2918	2538	2616	2918	2757	2744
PSYSC72	0.04862	0.07781	0.05083	0.13029	1.00000	0.10498	0.12767	0.04790	0.06014	0.05326	-0.01029
	0.0087	0.0001	0.0061	0.0001	0.0000	0.0001	0.0001	0.0143	0.0012	0.0052	0.5903
	2913	2911	2908	2913	2913	2913	2534	2612	2913	2754	2741
SOPCI	0.19740	0.26613	0.24056	0.32845	0.10498	1.00000	0.52872	0.25704	0.25522	0.12280	-0.11820
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001
	2918	2916	2913	2918	2913	2918	2538	2616	2918	2757	2744
EDEXPEC	0.27920	0.23981	0.27418	0.35516	0.12767	0.52872	1.00000	0.36583	0.33706	0.20698	-0.16647
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001
	2538	2538	2533	2538	2534	2538	2538	2340	2538	2398	2389
OCCEXPEC	0.13836	0.09416	0.23096	0.20510	0.04790	0.25704	0.36583	1.00000	0.20543	0.13542	-0.08932
	0.0001	0.0001	0.0001	0.0001	0.0143	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001
	2616	2616	2611	2616	2612	2616	2340	2616	2616	2473	2458
MATHEXPR	0.71345	0.17269	0.25858	0.27935	0.06014	0.25522	0.33706	0.20543	1.00000	0.12947	-0.12998
	0.0001	0.0001	0.0001	0.0001	0.0012	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001
	2918	2916	2913	2918	2913	2918	2538	2616	2918	2757	2744
SEXROL	0.15864	0.10989	0.09474	0.12767	0.05326	C.12280	0.20698	0.13542	0.12947	1.00000	-0.16692
	0.0001	0.0001	0.0001	0.0001	0.0052	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001
	2757	2756	2754	2757	2754	2757	2398	2473	2757	2757	2703
FAMLY	-0.13594	-0.11662	-0.08112	-0.10805	-0.01029	-0.11820	-0.16647	-0.08932	-0.12998	-0.16692	1.00000
	0.0001	0.0001	0.0001	0.0001	0.5903	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000
	2744	2743	2741	2744	2741	2744	2389	2458	2744	2703	2744

Note. First line is coefficient, second is significance level, and third is sample size.

least twice declared a college major. Looking at the significance and magnitude of these correlations, two points can be made.

First, Hispanic women had 31 significant (at the .05 level) coefficients, blacks had 38; for the white group, 54--all but one--were significant. These results are not unexpected since statistical significance is in part a function of sample size and the white sample is almost twenty times that of the Hispanic and more than four times that of the black.

Secondly, the correlations, although statistically significant, seem low. Because these women are a highly select group--regardless of their ethnicity--the correlations will be attenuated and coefficients of a magnitude of at least .2 are considered associations worth mentioning. Hispanics had 26 correlations of .2 or greater, while blacks had 19, and whites 23.

Dependent Variable. Comparing the associations between the dependent variable, mathematics-related attainment, and the other independent variables, it is immediately noticeable that for all three groups, the dependent variable significantly correlates most highly with the same variable--mathematics-related experience (.63 for Hispanics, .67 for blacks, and .71 for whites). For all women, too, there are similar, although more moderate, associations between the dependent variable and educational expectations (.51 for Hispanics, .27 for blacks, and .28 for whites) and high school achievement (.23 for Hispanics and blacks, and .24 for whites).

For white women, all of the independent variables correlated significantly with the dependent variable, but only five showed a magnitude greater than .2: high school experience and achievement, SOPCI, educational expectations, and mathematics-related experience. For Hispanic women, correlation with six independent variables were statistically significant: high school experience and achievement, SOPCI, educational and occupational expectations, and mathematics-related experience. For black women, four independent variables were significantly related to the dependent variable: high school achievement, educational expectations, mathematics-related experience, and family status. Of interest is the family status variable for blacks which correlated significantly and negatively (-.25) with mathematics-related attainment. In other words, having a family is an impediment to the mathematics-related attainment of black women.

Independent Variables. Viewing each group of women with regard to the interrelationships of the independent variables, a few distinct associations can be discerned.

For Hispanic women, most interesting is the association between sex-role orientation and educational expectations (.46), occupational expectation (.33), mathematics-related experience (.29), and high school achievement (.28).

The striking factor for black women is the consistently significant negative correlations between the family status variable and several of the independent variables: -.18 with SES, -.20 with high school experience, -.17 with significant others' perceived college influence, -.14 with educational expectations, and -.19 with mathematics-related experience. Stated another way, the more likely black women are to have children without marriage, the lower their SES, their high school experience score, their SOPCI score, their educational expectations, and their mathematics-related experience.

Most intercorrelations between the independent variables are significant for white women. The exception is the non-significant association between psychological self-concept and family status.

In sum, for all three groups of women, the correlation matrices indicate a few significant correlations between independent variables and several significant relationships between the dependent and independent variables. This augurs well for the next step which uses the correlation matrices to derive the path coefficients needed to test the mathematics-related attainment models and to assess the direct and indirect effects of the independent variables.

Multivariate Results

There are several important ideas to keep in mind when the results of a path analysis are disclosed. First of all, it is desirable to know how much of the variance is explained (R^2) in the theoretical model. It is also valuable to know the number, magnitude, and direction of the significant paths, so that the direct, indirect, and total effects of each independent variable on the dependent variable can be assessed (Tewari, 1979). It will be helpful to recall, first, that a direct effect is measured by the path coefficient between the independent variable and the dependent variable. Secondly, the measure of an indirect effect is the product of the path coefficients between an independent variable and its mediating variable, and the mediating variable and the dependent variable; there may be more than one intervening variable, so that the final indirect effect may be the product of more than two path coefficients (Duncan, 1966; Land, 1969). Thirdly, the total effect is the sum of the direct effect and all the indirect effects of the independent variable on the dependent variable. By knowing the value of these effects, not only the variables which are the best predictors but also the variables which contribute the most can be identified (by direct and indirect effects, respectively).

To discuss the relative effects of the variables in the model for each of the three ethnic groups, the significant standardized regression (path) coefficients are examined.

Model for Hispanic Women

Looking at the estimates for the Hispanic model (Table 11), there are 17 significant (at the .05 level) paths with an R^2 of .46. Five independent variables significantly affect the dependent variable.

Mathematics-related experience has the largest direct influence (.50) on mathematics-related attainment. This means that holding the other variables constant, for each one standard deviation increase in mathematics-related experience, there is an increase of one-half of a standard deviation in mathematics-related attainment.

The only other variable directly affecting mathematics-related attainment is educational expectations, which has about one-half the direct effect (.24) that mathematics-related experience has on the dependent variable. However, educational expectations has a very strong indirect effect (.28) through mathematics-

Table 11

Standardized and Unstandardized Regression Coefficients for the 1976 Mathematics-related Attainment of Hispanic Women (N=146)

Dependent Variables	Independent Variables										
	SES	H.S. exper.	H.S. achiev.	Psy. self-con.	SOPCI	Educ. expect.	Occup. expect.	Math-rel. exper.	Sex-role orient.	Family status	R^2
H.S. exper.	-.09 -.18 (.17)										.01
H.S. achiev.	.22*4.09 (1.36)	.48*4.35 (.66)									.26
Psy. self-con.	.09 .08 (.08)	.19* .09 (.04)	.07 .00 (.00)								.06
SOPCI	.13 .07 (.04)	.12* .03 (.02)	.24* .01 (.00)	.08 .05 (.05)							.15
Educ. expect.	.12 .17 (.10)	.41* .29 (.05)	.19* .01 (.01)	-.10 -.16 (.10)	.29* .79 (.19)						.45
Occup. expect.	.13 .10 (.06)	.31* .12 (.03)	.22* .01 (.00)	-.11 -.10 (.07)	.02 .03 (.12)						.23
Math-rel. exper.	.12 .16 (.09)	.01 .00 (.06)	-.06 -.00 (.01)	.04 .06 (.10)	-.06 -.15 (.19)	.55*.48 (.09)	.10 .16 (.13)				.35
Sex-role orient.	-.18*-.10 (.04)	-.20*-.06 (.03)	.16 .00 (.00)	-.05 -.03 (.05)	-.13 -.13 (.09)	.49*.19 (.04)	.12 .09 (.06)	.05 .02 (.04)			.29
Family status	-.09 -.11 (.11)	-.02 -.01 (.07)	.11 .01 (.01)	-.23*-.32 (.12)	-.10 -.25 (.22)	.20 .17 (.12)	-.08 -.13 (.16)	-.11 -.11 (.10)	-.19*-.42 (.21)		.11
Math-rel. attain.	-.01 -.02 (.09)	.06 .04 (.05)	-.01 -.00 (.01)	.01 .01 (.10)	-.01 -.03 (.18)	.24*.21 (.10)	.06 .11 (.13)	.50* .51 (.08)	-.14 -.33 (.17)	-.04 -.05 (.07)	.46

Note. Standardized coefficients are to the left of the unstandardized coefficients; standard errors are in parentheses.

* is significant at the .05 level.

related experience on mathematics-related attainment, making its total effect (.52) greater than that of mathematics-related experience. Educational expectations is also an important intervening variable, mediating the effects of high school experience, high school achievement, and significant others' perceived college influence on mathematics-related attainment.

High school experience, although not directly affecting mathematics-related attainment, has indirect (and thus, total) effects of .28; its effects are mediated through educational expectations and mathematics-related experiences (.11), through educational expectations (.10), through high school achievement, educational expectations and mathematics-related experience (.04), and through high school achievement and educational expectations (.03).

The significant others' perceived college influence variable (.15) has about one-half the effect on mathematics-related attainment that high school experience does. These indirect effects are mediated through educational expectations (.07) and through educational expectations and mathematics-related experience (.08).

The last variable to significantly affect Hispanic women's mathematics-related attainment is high school achievement (.13). This effect is achieved indirectly through significant others' perceived college influence and educational expectation (.02); significant others' perceived college influence, educational expectations and mathematics-related experience (.02); educational expectations (.04); and educational expectations and mathematics-related experience (.05).

Model for Black Women

Table 12 provides the standardized regression coefficients for the black model. This model fits black women sightly better than it does Hispanics, with R^2 = .49 and 23 significant paths.

Of the eight independent variables significantly affecting the dependent variable, three variables directly affect mathematics-related attainment. Mathematics-related experience again has the strongest effect (.64); it also exerts a .01 indirect effect mediated by family status, making a total effect on mathematics-related attainment of .65.

The direct effect of educational expectations (.13) is about one-fifth that of mathematics-related experience. Unlike the Hispanic model, educational expectations does not have an indirect effect on the dependent variable. It does, however, act as an intervening variable for SES, high school achievement, high school experience, significant others' perceived college influence, and psycho-

Table 12

Standardized and Unstandardized Regression Coefficients for the 1976 Mathematics-related Attainment of Black Women (N=543)

Dependent Variables	Independent Variables										
	SES	H.S. exper.	H.S. achiev.	Psy. self-con.	SOPCI	Educ. expect.	Occup. expect.	Math-rel. exper.	Sex-role orient.	Family status	R^2
H.S. exper.	.12* .22 (.08)										.01
H.S. achiev.	.00 .02 (.74)	.33*3.18 (.40)									.11
Psy. self-con.	-.01 -.01 (.04)	.01 .01 (.02)	.02 .00 (.00)								.00
SOPCI	.15* .08 (.02)	.15* .04 (.01)	.22* .01 (.00)	.04 .02 (.02)							.13
Educ. expect.	.14* .25 (.06)	.08* .07 (.04)	.22* .02 (.00)	.12* .20 (.06)	.36*1.16 (.12)						.31
Occup. expect.	.03 .02 (.03)	.19* .08 (.02)	.21* .01 (.00)	.03 .02 (.03)	.10* .15 (.06)						.14
Math-rel. exper.	-.01 -.02 (.05)	.19* .13 (.03)	.18* .01 (.00)	.02 .03 (.05)	-.02 -.04 (.11)	.09 .07 (.04)	-.01 -.01 (.07)				.11
Sex-role orient.	.11* .06 (.02)	.02 .01 (.01)	.07 .00 (.00)	-.03 -.02 (.02)	.05 .05 (.05)	.10 .03 (.02)	.03 .02 (.03)	.04 .02 (.02)			.06
Family status	-.15*-.27 (.08)	-.09*-.09 (.05)	-.15*-.01 (.00)	-.00 -.00 (.08)	-.08 -.26 (.16)	.02 .02 (.05)	.01 .03 (.10)	-.12*-.17 (.06)	-.00 -.00 (.14)		.11
Math-rel. attain.	.00 .00 (.04)	-.03 -.02 (.02)	.00 .00 (.00)	.01 .01 (.04)	.05 .10 (.08)	.13*.09 (.03)	-.03 -.05 (.05)	.64* .59 (.03)	-.05 -.11 (.07)	-.11*-.07 (.02)	.49

Note. Standardized coefficients are to the left of the unstandardized coefficients; standard errors are in parentheses.

* is significant at the .05 level.

logical self-concept.

The third direct, although negative, effect on mathematics-related attainment is from family status. A black woman's mathematics-related attainment will decrease by .11 units for each unit increase in family status, holding the other factors constant. This result is further verification of the negative impact of marriage and children on black women's attainment that was determined from the correlation coefficients.

Several other variables indirectly affect the dependent variable. High school experience, indirectly through mathematics-related experience (.12), through high school achievement and mathematics-related experience (.05), through family status (.01), and through significant others' perceived college influence and educational expectations (.01) has a total effect of .19 on mathematics-related attainment. High school achievement also has a strong total effect (.18) on the dependent variable through mathematics-related experience (.12), educational expectations (.03), family status (.02), and significant others' perceived college influence and educational expectations (.01). In addition, the SES variable, indirectly through high school experience and mathematics-related experience (.03), educational expectations (.02), family status (.02), and significant others' perceived college influence and educational expectations (.01), exerts a total effect of .08 on mathematics-related attainment. It is noteworthy that the variable psychological self-concept only exerts an influence--a small indirect one at that--on mathematics-related attainment in the case of black women.

Model for White Women

Information about the path analysis for white women is found in Table 13. The mathematics-related attainment model best fits the white model, with an R^2 of .52 and 37 significant paths. All independent variables except the psychological self-concept variable have a significant effect on the dependent variable.

Consonant with the Hispanic and black models, mathematics-related experience most influences mathematics-related attainment with a direct effect of .68. That is, controlling for all other variables in the model, a one unit increase in mathematics-related experience increases mathematics-related attainment by about two-thirds of a unit.

Four other variables also directly affect the dependent variable. Sex-role orientation exerts a significant and direct effect of .06. It also plays the role of a mediating variable between occupational and educational expectations and mathematics-related attainment. High school experience exerts an almost equivalent direct

Table 13

Standardized and Unstandardized Regression Coefficients for the 1976 Mathematics-related Attainment of White Women (N=2913)

Dependent Variables	Independent Variables										
	SES	H.S. exper.	H.S. achiev.	Psy. self-con.	SOPCI	Educ. expect.	Occup. expect.	Math-rel. exper.	Sex-role orient.	Family status	R^2
H.S. exper.	.08* .16 (.04)										.01
H.S. achiev.	.05* .87 (.31)	.34*3.08 (.16)									.12
Psy. self-con.	.07* .07 (.02)	.00 .00 (.01)	.12* .01 (.00)								.02
SOPCI	.23* .12 (.01)	.13* .04 (.00)	.26* .01 (.00)	.05* .02 (.01)							.18
Educ. expect.	.10* .15 (.02)	.11* .08 (.01)	.17* .01 (.00)	.05* .07 (.02)	.42*1.12 (.05)						.34
Occup. expect.	.03 .02 (.01)	.15* .06 (.01)	.09* .00 (.00)	.01 .01 (.01)	.18* .26 (.03)						.10
Math-rel. exper.	.09* .11 (.02)	.13* .08 (.01)	.14* .01 (.00)	-.00 -.00 (.02)	.04* .09 (.05)	.19* .16 (.02)	.06* .10 (.03)				.17
Sex-role orient.	.06* .04 (.01)	.01 .00 (.01)	.05* .00 (.00)	.02 .01 (.01)	-.01 -.02 (.03)	.14* .07 (.01)	.06* .05 (.02)	.05* .02 (.01)			.06
Family status	-.07*-.07 (.02)	-.01 -.01 (.01)	-.03 -.00 (.00)	.02 .02 (.02)	-.01 -.02 (.04)	-.08*-.06 (.02)	-.01 -.02 (.03)	-.06*-.05 (.02)	-.13*-.20 (.03)		.06
Math-rel. attain.	.01 .01 (.02)	.05* .03 (.01)	.02 .00 (.00)	-.00 -.00 (.02)	-.02 -.04 (.04)	.03 .03 (.01)	-.04*-.06 (.02)	.68* .68 (.01)	.06* .11 (.02)	-.03*-.04 (.02)	.52

Note. Standardized coefficients are to the left of the unstandardized coefficients; standard errors are in parentheses.

* is significant at the .05 level.

effect (.05), but also indirectly affects mathematics-related attainment through high school achievement and mathematics-related experience (.03), while family status directly affects the dependent variable half as much as sex-role orientation does and in a negative way (-.03).

Although the direct effect of occupational expectations on mathematics-related attainment is -.04, this is virtually cancelled out by the +.04 indirect effect through mathematics-related experience and the minimal (less than .01) positive indirect effect mediated by sex-role orientation and mathematics-related experience. The total effect of occupational expectations for whites then, is significant but only slightly more than zero; however, it has no significant effect at all for Hispanics or blacks.

Other variables have only indirect effects. Educational expectations for whites, unlike Hispanics and blacks, exerts an indirect effect through mathematics-related experience (.13) and sex-role orientation (.01). High school achievement also affects mathematics-related attainment (.13) through mathematics-related experience (.10), educational expectations and mathematics-related experience (.02), and significant others' perceived college influence, educational expectations, and mathematics-related experience (.01).

SES has a slighly more modest effect (.08) on the dependent variable through mathematics-related experience (.06), educational expectations (.01), and significant others' perceived college influence, educational expectations, and mathematics-related experience (.01). Significant others' perceived college influence, through educational expectations and mathematics-related experience (.05) also affects mathematics-related attainment.

The path coefficients--standardized partial regression coefficients--are compatible with some patterns found by looking at the zero-order correlation matrices for each group. For Hispanics, the high correlations between mathematics-related attainment and both mathematics-related experience and educational expectations are borne out in the path analyses: these two independent variables are the two best predictors of the dependent variable. For blacks, the high positive correlation between mathematics-related attainment and mathematics-related experience, as well as the strong negative correlation between mathematics-related attainment and family status, is also reflected in the effects that mathematics-related experience and family status have on the dependent variable. For white women, the correlation between mathematics-related attainment and mathematics-related experience is indicative of the effect of the latter on the former, while the zero-order correlations between mathematics-related achievement and high school experience, high school achievement, and educational expectations, are translated into total effects on mathematics-related achievement. Significant zero-order correlations between the dependent variable and sex-role orientation (.16), SES (.14), occupational expectations (.14) and family status (-.14) also demonstrated significant relationships when the total effects each had on the dependent variable was calculated.

Thus, as anticipated, the model estimates the mathematics-related attainments of the three groups of women quite well, although there are differences in the numbers of variables, and the way (direct or indirect) the variables exert influence. To further compare the three models, it is necessary to look at their unstandardized metric coefficients.

Comparisons among the Three Groups

To compare the mathematics-related attainment model across the groups of Hispanic, black, and white women, unstandardized (metric) regression coefficients are used (see Tables 11-13). Five variables in the model exhibit significant effects for all ethnic groups of women, two have significant effects in two groups, and three significantly affect women in only one group.

Mathematics-related experience is the only variable to directly affect all three groups of women's mathematics-related attainment. The effect is very substantial for all three groups, although the impact for whites (b = .68) and blacks (b = .59) is, respectively, about 30% and 15% stronger than that for Hispanics (b = .51).

Educational expectations has the greatest total effect on Hispanic mathematics-related attainment (.45); this effect is five times greater than that for blacks (.09) and about quadruple that for whites (.12). A breakdown of total Hispanic effects for educational expectations reveals that these direct and indirect effects are also individually greater when compared with the black and white effects.

Three other variables have indirect effects for all three groups: significant others' perceived college influence (SOPCI), high school experience, and high school achievement. The SOPCI variable indirectly affects the mathematics-related attainment of Hispanic women (.33) at about triple the rate that it does for blacks (.10) and whites (.12); the indirect effect of high school experience for Hispanics (.15) is also three times that for whites (.05), but only 50% more than that for blacks (.11). The last variable to exhibit significant indirect effects for all ethnic groups--high school achievement--does so equally (about .01 for all groups).

The five common variables discussed above were the only variables which had significant effects for the Hispanics. The two group comparisons, then, will be between the black and white groups: the SES variable showed almost equivalent strength for the two groups (.07 and .08 for blacks and whites, respectively), whereas the negative direct effect of family status on blacks' mathematics-related attainment (-.07) was almost double that for whites (-.04).

Three variables--sex-role orientation, occupational expectations, and psychological self-concept--had significance in only one group. For whites, the total effects for sex-role orientation were composed of a .11 direct effect and .02 indirect effect on mathematics-related attainment. The direct and indirect effects of occupational expectations on mathematics-related attainment for whites were -.06 and +.08, for a total effect of +.02. For blacks, psychological self-concept also had a total effect of .02.

In this chapter, the objectives of this study--to provide descriptive profiles, to test a model of mathematics-related attainment, to determine which variables make important contributions, and to compare the model for the samples of Hispanic, black, and white women--are met by imparting the information gathered from weighted means and frequencies, correlations, and path analyses. It is left to the next chapter to interpret these results and discuss their implications.

CHAPTER 5

Conclusions and Implications

This research concentrated on factors affecting Hispanic, black, and white women's mathematics-related attainment. These factors included socioeconomic status (SES); a high school experience variable composed of the number of semesters of high school mathematics and science courses, and curriculum; a high school achievement variable which is a combination of a mathematics ability score, high school class rank, and academic self-concept; psychological self-concept; a significant others' perceived college influence variable (SOPCI) encompassing the perceived college influence of parents, teachers/counselors, and peers; two expectations variables--educational and occupational expectations; a mathematics-related college experience variable; sex-role orientation; and family status, a linear combination of the marital and child status of the respondent.

The study used a nationwide probability sample of Hispanic, black, and white women who graduated from high school in 1972 and subsequently attended college for at least two years between 1972 and 1976. Having entered post secondary educational institutions, these women were a select group.

The analysis for this study was conducted on two levels. Initially, a descriptive profile for each group of women was developed from weighted percentages and means. Weighted correlation matrices were then generated to use as input for path analysis; standardized and unstandardized regression coefficients were calculated in order to compare the influence each of the variables had within each group and across the three groups, respectively.

In this chapter, interpretations and implications of the results are discussed. In addition, suggestions for additional research in this area are proposed. The chapter closes with the contributions this study makes to the existing body of knowledge and recommendations for the future.

Interpretations and Implications

This section includes discussion and speculation about the 1976 mathematics-related attainment of Hispanic, black, and white women; the variables in the model; and the way the components of the models behave for each group of women. Although little has been written about the mathematics-related attainment of Hispanic and black women, and only slightly more material can be found relating to that for white women, comparisons with the literature, as well as opinions, will be included when possible.

Mathematics-related Attainment

Although the proportions and actual numbers of NLS women who graduated from college in 1976 are smaller for the two racial minority groups--18% of the whites, 12% of the blacks, and 5% of the Hispanics completed college (Lichtman, Rothschild, & Peng, in press)--a greater percentage of Hispanic and black women than white women graduate in the highly mathematics-related fields of study (25.1% and 22.3%, respectively, versus 14.7% for whites). The attainment of these higher level skills should help these two groups overcome their double minority handicaps in the labor force. In American society, one may believe that women must often be better than men in order to succeed; similarly, these results seem to indicate that minority women are more highly qualified than majority white women when they graduate.

This pattern of attainment is quite similar to the rankings of the proportions of those women expecting to have highly mathematics-related graduate school majors: a greater percentage of Hispanic women expect to be in highly mathematics-related graduate school majors. Caution, however, should be taken in the interpretation of these results, since the actual numbers of Hispanic women are small and their high percentages would change dramatically if just one or two respondents were in another category.

Variables in the Model

Of all the variables in the model, the greatest possibility of intervention exists with respect to high school experience variable components. The results of this research (see Tables 14-15) reveal that the high school experience variable, for each group of women, strongly affects their mathematics-related attainment through high school achievement, educational expectations, and mathematics-related experience. The effect of high school experience is strongest for Hispanics and weakest for whites. Yet, the high school experience of white women is more mathematics/science oriented than that for Hispanics or blacks. This could be considered an unfortunate finding because if a woman is not in a high school academic curriculum and additionally taking mathematics and science classes, she may be even less able to enter mathematics-related fields of study. This, in turn, may further disadvantage her in competition within the labor market.

A similar situation occurs with respect to the high school achievement variable. This composite variable also exerts strong indirect effects (mainly through SOPCI, educational expectations, and mathematics-related experience) on the dependent variable for each group of women. Although the comparative effect of high school achievement is about

Table 14

Significant Standardized Effects on Mathematics-related Attainment

Variables	Groups of Women								
	Hispanic[a]			Black[b]			White[c]		
	D	I	T	D	I	T	D	I	T
SES	---	---	---	---	.08	.08	---	.08	.08
H.S. exper.	---	.28	.28	---	.19	.19	.05	.03	.08
H.S. achv.	---	.13	.13	---	.18	.18	---	.13	.13
Psy. self-con.	---	---	---	---	.02	.02	---	---	---
SOPCI	---	.15	.15	---	.05	.05	---	.05	.05
Educ. expect.	.24	.28	.52	.13	---	.13	---	.14	.14
Occup. expect.	---	---	---	---	---	---	-.04	+.04	+.00
Math-rel. exper.	.50	---	.50	.64	.01	.65	.68	---	.68
Sex-role orient.	---	---	---	---	---	---	.06	---	.06
Family status	---	---	---	-.11	---	-.11	-.03	---	-.03

Note. D = direct, I = indirect, and T = total effects; all effects are significant at the .05 level and have an absolute value of at least .01.

[a]Sample size for Hispanics is 146.

[b]Sample size for blacks is 543.

[c]Sample size for whites is 2913.

Table 15

Significant Unstandardized Effects on Mathematics-related Attainment

Variables	Groups of Women								
	Hispanic[a]			Black[b]			White[c]		
	D	I	T	D	I	T	D	I	T
SES	---	---	---	---	.07	.07	---	.08	.08
H.S. exper.	---	.15	.15	---	.11	.11	.03	.02	.05
H.S. achv.	---	.00	.00	---	.01	.01	---	.01	.01
Psy. self-con.	---	---	---	---	.02	.02	---	---	---
SOPCI	---	.33	.33	---	.10	.10	---	.12	.12
Educ. expect.	.21	.24	.45	.09	---	.09	---	.12	.12
Occup. expect.	---	---	---	---	---	---	-.06	.08	.02
Math-rel. exper.	.51	---	.51	.59	.01	.60	.68	---	.68
Sex-role orient.	---	---	---	---	---	---	.11	.02	.13
Family status	---	---	---	-.07	---	-.07	-.04	---	-.04

Note. D = direct, I = indirect, and T = total effects; all effects are significant at the .05 level and have an absolute value of at least .01.

[a]Sample size for Hispanics is 146.
[b]Sample size for blacks is 543.
[c]Sample size for whites is 2913.

equal for Hispanics, blacks, and whites, the whites still maintain an advantage over the black and Hispanic women in terms of a higher level of academic achievement for whites. If the effects of high school achievement yield essentially equal returns for all the women and if white women have a higher achievement level, their return to mathematics-related attaiment will be greater than that for Hispanic or black women.

Since the sample was limited to women who attended college, it follows that the overwhelming majority of them perceived being influenced to go to college from the three significant others groups. However, this perceived influence is much more important for mathematics-related attainment for Hispanics than for blacks and whites: the indirect effect for Hispanic women mediated through educational expectations and mathematics-related experience is nearly triple that for the other two groups.

Educational expectations has always been a strong correlate of educational attainment (Alexander & Eckland, 1974; Lichtman, Rothschild, & Peng, in press); thus, it is not surprising that the results of this study show that educational expectations correlates with mathematics-related attainment for all three groups of women. Additionally, for all groups of women, educational expectations are high. Corroborating the results found by Peng and Jaffe (1979) and Wise (1979) in their models of white women and mathematics, educational expectations affect mathematics-related attainment for white as well as black and Hispanic women. The type of effect, however, is different for the three groups. Most interesting is the finding that for whites, educational expectations had no direct effect on mathematics-related attainment. For blacks, the reverse was true; there is only a direct effect. Hispanics, however, have direct and indirect effects which combine to make educational expectations not only four to five times more important for Hispanics than for blacks and whites, respectively, but also result in educational expectations, for Hispanics, having the greatest total effect of any independent variable on mathematics-related attainment. Since very few substantial studies on educational expectations of Hispanics (see Wolfle and Lichtman's 1980 review of the literature on Mexican-Americans and status attainment for further information), let alone research on their mathematics-related attainment, exist, it is difficult to know how unusual these results are.

The sex-role orientation variable, for Hispanic women, has significant correlations with many of the independent variables. However, partially due to sample size, the direct effect on mathematics-related attainment is not statistically significant at the .05 level. There is no significant sex-role orientation effect for blacks either. For whites, however, there is a significant positive direct effect. This result is congruent with those previously reported by Fitzpatrick (1978), Hawley (1972), and Safilios-Rothschild (1979), among others.

Marriage and children are often cited as two impediments to women interested in pursing mathematics and science. Based on samples of white women, these conclusions (Astin & Myint, 1971; Bielby, 1978; Erlick & LeBold, 1975; McLure & Piel, 1978; Rossi, 1965b; Steel & Wise, 1979) are verified in this study: family status has a significant negative effect on white women's mathematics-related attainment. In addition, for blacks, who are single parents more often than Hispanics or whites are (Staples & Miranda, 1980; U.S. Bureau of the Census, 1979), family status is a significant negative predictor of mathematics-related attainment.

It is also informative to discuss variables which are not significant. Psychological self-concept and occupational expectations are two which do not significantly impinge on most of the other variables in the model; in addition, very few variables affect them. Because the literature demonstrates the importance of a mathematics self-concept measure (Fennema & Sherman, 1977, 1978) and even a general self-concept measure as a surrogate (Steel & Wise, 1979), it would be reasonable to assume that a more appropriate indicator of self-concept is called for. One possible reason for the insignificant relationship between the dependent variable and occupational expectations is that occupational expectations was measured at the conclusion, rather than at the beginning, of high school, which may be a more appropriate time. Additionally, this variable was not coded on the preferable mathematics-related scale, due to the nature of the questionnaire responses. Caution should be taken, therefore, in interpreting occupational expectations' seeming lack of influence.

Comparisons of the Groups

Although the model explains approximately 50% of the variance in mathematics-related attainment for each group (there is no significant difference among the three groups: $\chi^2 = 1.62$ which is less than $\chi^2_5\ (.05) = 11.07$; see Cohen and Cohen, 1975, pp. 50-52), there are marked dissimilarities in both the strength of the contribution each variable makes as well as in which variables make contributions.

For white women, all but one of the variables in the model have direct or mediated effects. However, only three of the nine variables in the model for whites have standardized effects greater than .10, a benchmark value often used by researchers to identify notable coefficients (Alexander & Eckland, 1974; Rosenbaum, 1980). The model for Hispanic women, on the other hand, contains only five variables of significance, but all five have effects larger than .10. The model for blacks exhibits a similar pattern to that for the Hispanics in terms of the number of variables with total effects greater than .10; five have total effects whose absolute value exceeds .10. It is also similar to the model for whites in that most of the variables--eight out of ten--do have significant total effects.

Although some of the variables which exhibit significant effects are similar, their order of importance and their type of effect differ.

The most direct influential factor for each group of women is mathematics-related experience. Comparing the three groups, the effect is greatest in magnitude for white women and smallest for Hispanic women.

For Hispanics and blacks, the second most important direct effect is educational expectations; its effect is much larger for Hispanics than for blacks. While educational expectations does not affect white women directly, it does affect them indirectly. The magnitude of this indirect effect is much smaller for white women than for

Hispanics. There is no direct effect of educational expectations for black women.

The variable which has the second largest direct effect for whites is sex-role orientation. This variable has no direct effect for Hispanics or blacks; it also has no indirect effects for either group.

There are no other variables which directly affect mathematics-related attanment for Hispanics. For blacks, however, there is one other variable--family status--and it exerts a negative direct effect.

Three more variables have direct effects for whites. High school experience exerts a positive direct effect while occupational expectations and family status have negative influence.

There are disparities among the groups in terms of significant total effects, as well as in terms of direct effects. The four most important variables exhibiting total effects are different for each group. For Hispanic women, educational expectations exert the greatest influence, followed by mathematics-related experience, high school experience, and significant others' perceived college influence. Mathematics-related experience has the greatest total effect for blacks, followed by high school experience, high school achievement, and educational expectations. Mathematics-related experience is also first for whites, whereas educational expectations is second, high school achievement is third, and socioeconomic status is fourth.

One conclusion reached, in light of these comparisons, is that the variables included in the model are appropriate because they account for about 50% of the variance in mathematics-related attainment. In addition, all independent variables have significant effects for at least one of the three groups of women. Most importantly, however, the components of the model operate differently.

The generally acceptable method for comparing path models for different independent populations is descriptive. (See Alexander and Eckland, 1974; Falk and Falkowski, 1980; Howell and Frese, 1979; and Porter, 1974 for other descriptive comparisons of path models for distinct subgroups.) It is possible, then, that the reason the mathematics-related attainment process appears to be different for the three groups of women is largely due to the noncomparable sample sizes which affect both the accuracy of the beta weights (path coefficients) and the levels of significance. Some attempt has been made to alleviate this problem by using weighted samples, but until new path model comparison techniques are discovered, the conclusions should be tempered by this caution.

Suggestions for Future Research

In education, there is always a need for further research and refinement. The complexity of the issues makes it difficult to be precise in identifying factors of concern; even when these factors are determined, many have measures which cannot be properly captured, let alone controlled for. Too, there are a variety of ways to analyze data--thus, the numerous secondary analyses of Coleman's landmark Equality of Educational Opportunity (EEO) data by Mayeske and his coworkers at the Office of Education. (See Bridge, Judd, and Moock, 1979 for further discussion.) Several suggestions can, therefore, be offered to researchers interested in conducting further studies in the area of the mathematics-related attainment of ethnic women.

One suggestion pertains to the data. In this study, the NLS data base included data from the 1976 follow-up. The 1979 NLS follow-up data have just been released. Since most women do not complete their education within four years of high school graduation, this seven year time lapse would enable more women to enter the sample, thus making the sample approximate more realistically the general population of Hispanic, black, and white women with career intentions.

The most obvious suggestion relating to the variables is to extend the model to include mathematics-related occupational attainment and to use this factor as the dependent variable, with mathematics-related educational attainment as its direct antecedent variable. Using the NLS data base, this is a definite possibility, assuming that the follow-ups continue. Another desirable addition to the model, although not probable unless future NLS follow-up questionnaires elicit this information, is to include a retrospective variable pertaining to the availability of role models. In descriptive studies, researchers (Casserly, 1975, 1979; Fox, 1976; Levine 1976; Luchins, 1976; Westervelt, 1975) have repeatedly found that role models are important factor for women considering "non-feminine" mathematical/scientific careers.

Another area of improvement lies in the construction of the model. Land (1969) discussed the three primary sources of information from which assumptions of order are usually derived: temporal order usually originating from longitudinal data, existing experimental or case study results, and theoretical assumptions of the substantive area being investigated. Even when using these three sources, however, alternative models always exist.

The model formulated for this study is a recursive one; that is, there is a unidimensional flow. Several researchers (Everett, 1980; Featherman & Hauser, 1976;

Hout & Morgan, 1975), however, posit that some variables exhibit reciprocal relationships and that this needs to be taken into account in the model. For example, a student's achievement may influence significant others' perceived college influence which, in turn, may affect the student's achievement. This relationship can only be explicated in a non-recursive manner, thus changing the model to a non-recursive one.

The ordering of the variables in the model could also be changed. In the status attainment literature, several variables are fixed in position, but others do vary. Falk and Falkowski (1980) have argued that for their five variable model of educational expectations for women, parental encouragement will precede grades, a position supported by, among others, Hout and Morgan (1975), in their educational and occupational expectations models for Louisville, Kentucky black female high school seniors, and Porter (1974), in his analysis of educational and occupational attainment of Project TALENT white males; this position, however, is opposed by Hout and Morgan (1975) in their model for white female and black male Louisville, Kentucky high school seniors, as well as by Sewell, Haller, and Portes (1969) in their social/psychological extension of the basic Blau and Duncan attainment model for Wisconsin data males with a farm origin.

Final suggestions relate to the methodological procedures utilized in this analysis. One issue relates to the analysis method itself. If a non-recursive model were to be tested, ordinary least squares regression path analysis could not be used. Possible methods would include two stage least square regression analysis as well as LISREL, a covariance model utilizing maximum likelihood procedures (see Everett, 1980; Wolfle 1980) which presumes to remove measurement error. These two methods are also available for conducting analyses with recursive path models.

Finally, there appears to be no agreement as to how to statistically compare correlation matrices and path coefficients across groups, especially if the groups have disparate sample sizes which are reflective of the population as a whole. The generally acceptable method is descriptive; there is no widely practiced analytic method such as a correlation/path coefficient analog to the analysis of variance for means. This is a methodological consideration of importance to researchers and users of path analytic models.

Contributions and Recommendations

Before the completion of this study, there were few, if any, comprehensive studies on the process of mathematics-related attainment. This research has proposed a model which includes a wide range of independent variables, one of which--sex-role orientation--is rarely used in any attainment model (Lipman-Blumen, 1972, is an exception). In addition, because it has been difficult to quantify mathematics-related attainment, it was not a frequently used dependent variable. Presumably, only Steel and Wise (Steel & Wise, 1979; Wise, 1979) have published a hierarchical listing of college major fields of study and careers based on the amount of required mathematics training. This study uses their classification scheme, thus translating categorical field of studies variables into interval level data. Other researchers can employ this method and/or seek out better ones so that research can continue in this area.

No previously known longitudinal research on mathematics-related attainment has been conducted on a current and nationally representative sample of Hispanics, black, and white women. For this reason alone, this study is valuable. Some studies have attempted to compare men and women or white and black women, but with projections for Hispanics becoming the largest minority group by 1990, and with women invading the labor force at a younger age and for a longer time span, it has become increasingly important to have more research conducted to facilitate policy decisions based on relevant empirical evidence.

The study concludes that the components of the model of mathematics-related attainment are different for the three groups of Hispanic, black, and white high school women who graduated in 1972 and who subsequently attended at least two years of college. This conclusion is based on a detailed look at path analytic results. For, if only direct effects--easily obtainable from a regression prediction equation--were employed, much of the data concerning the interrelationship of the variables would be lost. The extraction and highlighting of the indirect effects in this study yields additional and important information about the relationships of the independent variables to mathematics-related attainment.

In terms of equity, the forecast for women in the labor force is not promising. Women still earn only three-fifths of what men do, and are clustered in low status, low paying jobs. Given the link between economics, occupation, and education, the high school years are important ones. During this time span, young women begin to focus on their educational and occupational choices. That is not to say that the earlier years are not important, for it is known that a lot can happen in the earlier years that may be reflected in decisions made during and after the senior year in high school (Skypeck, 1980). However, in relation to this research, it is not possible to address this time frame, nor is it feasible to detail the part that role models, counseling, career awareness, and math anxiety play in influencing the direction taken in the high school years and beyond. Suffice it to say that much can be done to help influence these women so that they will choose to expand their interests, receive better educational training, and increase their value and flexibility in the job market.

Bill S-568 was passed by Congress and signed into law--Public Law 96-516--on December 12, 1980 (U.S. Congress, 1980) Part B--Women, Minorities, Science and Technology--states that

> it is the policy of the United States to encourage men and women, equally, of all ethnic, racial, and economic backgrounds to acquire skills in science and mathematics, to have equal opportunity in education, training, and employment in scientific and technical fields, and thereby to promote scientific literacy and the full use of the human resources of the Nation in science and technology. To this end, the Congress declares that the highest quality service over the long-term requires substantial support, from currently available research and educational funds, for increased participation in science and technology by women and minorities. The Congress further declares that the impact on women and minorities which is produced by advances in science and technology must be included as essential factors in national and international science, technology, and economic policies.

These statements are congruent with the findings of the study on mathematics-related attainment. The results of this research suggest that intervention programs should be designed to address the varying needs of each group of college-bound women. These programs should increase the level of mathematics for all women so that they, and thus society, can realize their educational and occupational potential.

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APPENDIX A

Computer Program and Output for Three Principal Axis Factor Analyzed Composite Variables: High School Experience, High School Achievement, and SOPCI

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NOTE: THE JOB B0022NMW HAS BEEN RUN UNDER RELEASE 79.3A OF SAS AT VPI & SU.

          * THIS PROGRAM WILL PRODUCE THESE NEW COMPOSITE VARIABLES:  HIGH
          SCHOOL EXPERIENCE, HIGH SCHOOL ACHIEVEMENT, SIGNIFICANT OTHERS PERCEIVED
          COLLEGE INFLUENCE.;
          OPTIONS NODATE NONUMBER;
          PROC FACTOR DATA=AND.REW METHOD=PRIN ROTATE=VARIMAX
          SCORE;
          PRIORS MAX;
          VAR V74 V46 V196A;
          TITLE1    ;
          TITLE10 FACTOR ANALYSIS FOR HIGH SCHOOL EXPERIENCE VARIABLE;

NOTE: THE PROCEDURE FACTOR USED 2.33 SECONDS AND 156K AND PRINTED PAGES 1 TO 3.

          PROC FACTOR DATA=AND.REW METHOD=PRIN ROTATE=VARIMAX SCORE;
          PRIORS MAX;
          VAR ACSLFCON V620 V631;
          TITLE1    ;
          TITLE10 FACTOR ANALYSIS FOR HIGH SCHOOL ACHIEVEMENT VARIABLE;

NOTE: THE PROCEDURE FACTOR USED 2.32 SECONDS AND 156K AND PRINTED PAGES 4 TO 6.

          PROC FACTOR DATA=AND.REW METHOD=PRIN ROTATE=VARIMAX SCORE;
          PRIORS MAX;
          VAR PARCOLIN V271A V276A;
          TITLE1    ;
          TITLE10 FACTOR ANALYIS FOR SOPCI VARIABLE;

NOTE: THE PROCEDURE FACTOR USED 2.22 SECONDS AND 156K AND PRINTED PAGES 7 TO 9.

NOTE: SAS USED 156K MEMORY.

NOTE: SAS INSTITUTE INC.
      SAS CIRCLE
      BOX 8000
      CARY, N.C. 27511
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FACTOR ANALYSIS FOR HIGH SCHOOL EXPERIENCE VARIABLE

MEANS AND STD DEVIATIONS

	V74	V46	V196A
MEAN	3.56088	3.33329	0.45745
STD DEV	1.87828	1.75439	0.49822

NUMBER OF OBSERVATIONS= 7039

CORRELATION MATRIX

	V74	V46	V196A
V74	1.00000	0.54908	0.46643
V46	0.[illegible]908	1.00000	0.42896
V196A	0.46643	0.42896	1.00000

FACTOR ANALYSIS FOR HIGH SCHOOL EXPERIENCE VARIABLE

FACTOR METHOD: PRINCIPAL AXIS

PRIOR ESTIMATES OF COMMUNALITY MAX

V74	V46	V196A
0.549080	0.549080	0.466429

	1	2	3
EIGENVALUES	1.489975	0.081002	-0.006389
PORTION	0.952	0.052	-0.004
CUM PORTION	0.952	1.004	1.000

1 FACTORS WILL BE RETAINED.

FACTOR PATTERN

	FACTOR1
V74	0.74200
V46	0.72584
V196A	0.64232

FINAL COMMUNALITY ESTIMATES:

V74	V46	V196A
0.550558	0.526845	0.412572

FACTOR ANALYSIS FOR HIGH SCHOOL EXPERIENCE VARIABLE

ROTATED FACTOR PATTERN

	FACTOR1
V74	0.74200
V46	0.72584
V196A	0.64232

ORTHOGONAL TRANSFORMATION MATRIX

	1
1	1.00000

PROPORTIONAL CONTRIBUTIONS TO COMMON VARIANCES BY ROTATED FACTORS

FACTOR1
1.489975

SCORING COEFFICIENT MATRIX

	FACTOR1
V74	0.39452
V46	0.38312
V196A	0.29396

FACTOR ANALYSIS FOR HIGH SCHOOL ACHIEVEMENT VARIABLE

MEANS AND STD DEVIATIONS

	ACSLFCON	V620	V631
MEAN	4.05847	49.22095	59.31923
STD DEV	1.00970	9.67969	26.76503

NUMBER OF OBSERVATIONS= 6807

CORRELATION MATRIX

	ACSLFCON	V620	V631
ACSLFCON	1.00000	0.40409	0.44029
V620	0.40409	1.00000	0.57337
V631	0.44029	0.57337	1.00000

FACTOR ANALYSIS FOR HIGH SCHOOL ACHIEVEMENT VARIABLE

FACTOR METHOD: PRINCIPAL AXIS

PRIOR ESTIMATES OF COMMUNALITY MAX

ACSLFCON	V620	V631
0.440286	0.573368	0.573368

	1	2	3
EIGENVALUES	1.487346	0.104507	-0.004831
PORTION	0.937	0.066	-0.003
CUM PORTION	0.937	1.003	1.000

1 FACTORS WILL BE RETAINED.

FACTOR PATTERN

	FACTOR1
ACSLFCON	0.60429
V620	0.74167
V631	0.75638

FINAL COMMUNALITY ESTIMATES:

ACSLFCON	V620	V631
0.365165	0.550077	0.572104

FACTOR ANALYSIS FOR HIGH SCHOOL ACHIEVEMENT VARIABLE

ROTATED FACTOR PATTERN

	FACTOR1
ACSLFCON	0.60429
V620	0.74167
V631	0.75638

ORTHOGONAL TRANSFORMATION MATRIX

	1
1	1.00000

PROPORTIONAL CONTRIBUTIONS TO COMMON VARIANCES BY ROTATED FACTORS

FACTOR1
1.487346

SCORING COEFFICIENT MATRIX

	FACTOR1
ACSLFCON	0.26129
V620	0.39980
V631	0.41210

FACTOR ANALYIS FOR SOPCI VARIABLE

MEANS AND STD DEVIATIONS

	PARCOLIN	V271A	V276A
MEAN	2.29839	0.69280	0.62476
STD DEV	0.91997	0.46137	0.48423

NUMBER OF OBSERVATIONS= 5791

CORRELATION MATRIX

	PARCOLIN	V271A	V276A
PARCOLIN	1.00000	0.32221	0.40802
V271A	0.32221	1.00000	0.24851
V276A	0.40802	0.24851	1.00000

FACTOR ANALYIS FOR SOPCI VARIABLE

FACTOR METHOD: PRINCIPAL AXIS

PRIOR ESTIMATES OF COMMUNALITY MAX

PARCOLIN	V271A	V276A
0.408022	0.322205	0.408022

	1	2	3
EIGENVALUES	1.042849	0.114035	-0.018636
PORTION	0.916	0.100	-0.016
CUM PORTION	0.916	1.016	1.000

1 FACTORS WILL BE RETAINED.

FACTOR PATTERN

	FACTOR1
PARCOLIN	0.64698
V271A	0.50018
V276A	0.61163

FINAL COMMUNALITY ESTIMATES:

PARCOLIN	V271A	V276A
0.418579	0.250182	0.374089

FACTOR ANALYIS FOR SOPCI VARIABLE

ROTATED FACTOR PATTERN

	FACTOR1
PARCOLIN	0.64698
V271A	0.50018
V276A	0.61163

ORTHOGONAL TRANSFORMATION MATRIX

	1
1	1.00000

PROPORTIONAL CONTRIBUTIONS TO COMMON VARIANCES BY ROTATED FACTORS

FACTOR1
1.042849

SCORING COEFFICIENT MATRIX

	FACTOR1
PARCOLIN	0.40365
V271A	0.27611
V276A	0.37831

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FACTORS INFLUENCING THE MATHEMATICS-RELATED ATTAINMENT OF A NATIONAL SAMPLE OF HISPANIC, BLACK, AND WHITE WOMEN

by

Susan J. Schaflander Rothschild

(ABSTRACT)

For the most part, women are still employed in traditionally female occupations which require little or no mathematics training. The presence and seeming acceptance of confined, low-status occupations for women represent an enormous loss of economic and intellectual potential for the individual woman and for society as a whole.

This study examines the effects of various background, high school, and socio-psychological factors on the mathematics-related attainment of Hispanic, black, and white women. To estimate the contribution of the factors in explaining the variance in mathematics-related attainment, the following variables are considered in a structural equations model: socioeconomic status; high school experience, composed of the number of high school mathematics and science courses, and curriculum; high school achievement, including a mathematics ability score, high school class rank, and academic self-concept; psychological self-concept; perceived college influence of parents, teachers/counselors, and peers; educational and occupational expectations; mathematics-related college

experience; sex-role orientation; and family status.

The data are provided by the National Longitudinal Study of the High School Class of 1972 (NLS), a longitudinal nationwide survey which follows the progress of high school students to adulthood. Questionnaires were administered to the subjects in 1972, 1973, 1974, and 1976; the overall response rate was 85%. The sample consists of all women who declared a college major for at least two years between 1972 and 1976 (an average of 146 Hispanic, 543 black, and 2918 white women). Descriptive analyses provide group profiles; path analysis techniques are used to compare the influence each of the variables has within and across the three groups.

Results indicate that the model explains 46%, 49%, and 52% of the variance for Hispanics, blacks, and whites, respectively; however, the components of the model operate differently for each group. For Hispanic women, educational expectations exert the greatest influence, followed by mathematics-related experience, high school experience, and significant others' perceived college influence. Mathematics-related experience has the greatest total effect for black women, followed by high school experience, high school achievement, and educational expectations; family status has a significant negative direct effect. Mathematics-related experience is also first for whites women, whereas educational expectations is second, high school achievement is third, and socioeconomic status is fourth; additionally, sex-role orientation has a significant direct effect.

It is suggested that intervention programs should be designed to address the varying needs of each group of college-bound women and to increase the level of mathematics so that all women, and thus society, can realize their educational and occupational potential.