In Chipman, S.F., Brush, L.R., & Wilson, D.M. (Eds.), Women and Mathematics: balancing the equation. Hillsdale, NJ: Erlbaum, 1985.

mo[illegible] dently parents don't need to set good examples regarding mathematics for their children to take mathematics in school. But, they can stress the importance of mathematics and encourage their children to take it by discussing high school course selections and future career options.

A point needs to be made regarding the effects of stereotyping of mathematics on women's participation. Although an absence of teacher stereotyping of mathematics was one of the predictors for participation of senior women, most of the stereotyping measures showed a low or insignificant correlation with participation. Stereotyping may not be one of the dominant factors affecting participation, but it does deserve some attention in terms of intervention. For senior women, the "mathematics as a male domain" scale had a significant correlation with participation. Women who saw mathematics as a field of study equally appropriate for women and men were more likely to take advanced mathematics courses. Areas for intervention could include programs that help women realize the appropriateness of pursuing a career in a mathematical or technical field.

Summary

The factors affecting participation are both numerous and complex. Results reported in this study indicate that the large differences in participation between men and women have diminished considerably in the past few years. It was also found that many of the factors that affect participation are the same for males and females.

Simply because large sex differences in participation were not found, the issue of mathematics participation should not be forgotten or ignored. The importance of taking high school mathematics cannot be overemphasized. Of the 42% of all students who indicated they were in a college preparatory program, only 25% had taken the 4 years of high school mathematics necessary for the college mathematics they would need for many majors.

Participation in mathematics is mostly an issue of awareness. If parents, teachers, and counselors understand and transmit to students the necessity of taking mathematics to keep their options open and if they have the same high expectations for women as they have for men, then a basis for equal opportunity in scientific and technical fields will exist—for *men* and *women*.

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4 Self-Perceptions, Task Perceptions, Socializing Influences, and the Decision to Enroll in Mathematics

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Introduction

Competence in mathematics has long been identified as a critical skill directly related to educational and occupational choices. Mathematical skills are important for admission to many college majors, for a number of professional occupations, and increasingly for computerized technical occupations. Yet compared to male students, fewer female students elect to take mathematics beyond the minimal requirements. Although females may receive less encouragement from parents and teachers, it is not the case that they are being systematically excluded through discriminatory course availability. On the contrary, all too frequently females *choose* not to take more advanced mathematics courses (Meece, Parsons, Kaczala, Goff, & Futterman, 1982; Sells, 1980; Sherman & Fennema, 1977).

The purpose of this research project is to investigate determinants of students' course selection in mathematics. In most schools students have the choice of whether or not to continue in math after 1 year of high school math. Although some of the factors influencing this decision are difficult to change, such as parents' education or their careers, other factors are modifiable. Identification of these modifiable factors will lay the foundation for the design of appropriate intervention programs aimed at increasing the likelihood of students continuing to take mathematics.

To date, there has been extensive research on the possible causes of sex differences in math achievement and course selection. This research has yielded four basic explanations for this problem:

1. Males outperform females on spatial problem-solving tasks and on other mathematics aptitude measures. Consequently, they are more able

to continue in math (Aiken, 1971; Astin, 1974b; Maccoby & Jacklin, 1974; Wittig & Petersen, 1979).

2. Males receive more encouragement than females from parents, teachers, and counselors to enroll in advanced mathematics courses or to pursue math-oriented careers (Casserly, 1975; Fox, Tobin, & Brody, 1979; Haven, 1971; Luchins, 1976).

3. Mathematics is commonly perceived as a male achievement domain. Consequently, because of its potential conflict with their sex-role identity, females are more likely to avoid mathematics (Armstrong & Kahl, 1979; Ernest, 1976; Fennema & Sherman, 1977a, b; Fox, 1975a; Nash, 1979; Sherman & Fennema, 1977; Stein & Smithells, 1969).

4. Males perceive themselves as more competent and report greater confidence in learning mathematics than females (Ernest, 1976; Fennema & Sherman, 1977a, b; Fox, Tobin, & Brody, 1979; Robitaille, 1977).

Each of these bodies of research has provided insights into the mechanisms contributing to students' math achievement behaviors. However, researchers have approached this area of study from a variety of theoretical perspectives, focusing their research on a subset of possible causes. Consequently, there has been no general model linking together the findings. What is needed is a theoretical framework that acknowledges the complex interplay of these factors, takes into account the sociocultural context in which mathematics learning takes place, and provides a more comprehensive approach to the problem. An integrative model of math achievement and course choice can aid in the identification of the determinants of individual differences on these variables and the specification of the relation of these differences to course plans.

Decision, achievement, and attribution theorists (e.g., Atkinson, 1964; Edwards, 1954; Weiner, 1974) have all addressed the issue of choice behavior. Applying these theories of behavior to students' decisions to continue taking mathematics, we have proposed a model of achievement behavior that links students' enrollment decisions to their expectations for their performance in a particular math course and to students' perceptions of the importance or incentive value of taking mathematics (Eccles-Parsons, Adler, Futterman, Goff, Kaczala, Meece, & Midgley, 1983). Figure 4.1 presents this model. According to this model, choice is influenced most directly by the students' values (both the utility value of math for attaining future goals and the attainment or interest value of ongoing math activities) and the students' expectancies for success at math. These variables, in turn, are assumed to be influenced by students' goals, and their concepts of both their own academic abilities and the task demands. Individual differences on these attitudinal variables are assumed to result from students' perceptions of the beliefs of major socializers, the students' interpretation of their own history of academic

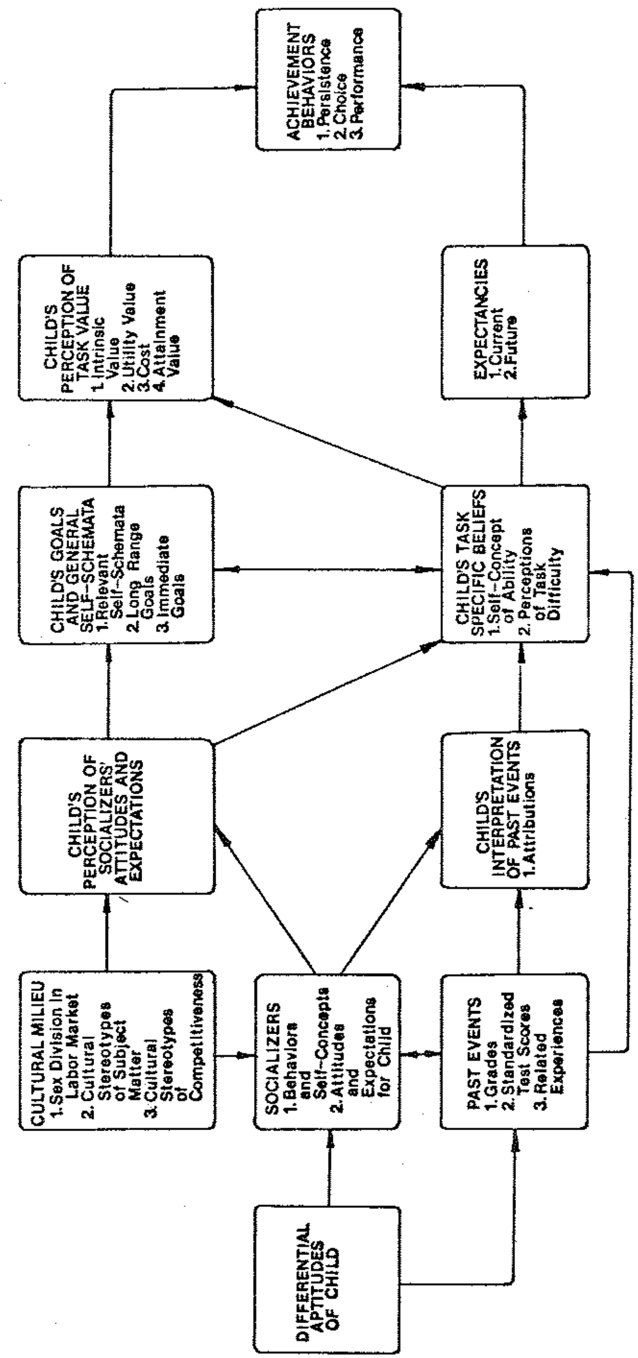


FIG. 4.1 General model of academic choice. (Adapted from Parsons, J. E., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. Expectancies, values, and academic behaviors. In J. T. Spence (Ed.) *Perspectives on achievement and achievement motivation*. San Francisco, CA: Freeman, 1983).

performance, and the students' perception of appropriate behaviors and goals.

This theoretical model seems particularly relevant to the problem of sex differences in students' course selection in mathematics. The model assumes that the effects of experience, namely past history of grades in math, are mediated by the individual's interpretation of the events rather than the events themselves. For example, doing well in math is presumed to influence one's future expectations to the extent that doing well is attributed to one's ability. Past research has shown that girls do as well in math as boys throughout their formative years, yet they do not expect to do as well in the future nor are they as likely to go on in math. This apparent paradox is less puzzling if we acknowledge that it is the subjective meaning and interpretation of success and failure that determine an individual's perceptions of the task and not the objective outcomes themselves. The extent to which boys and girls differ in their interpretation of outcomes and the extent to which they receive different information relevant to their expectations of success and to the value of various achievement options might account, in part, for the observed sex differences in students' enrollment in math courses.

The model also assumes that the decision to take mathematics is made in the context of a variety of choices and is guided by core values such as achievement needs, competency needs, and sex-role values, and by more utilitarian values such as the importance of math achievement for future goals. Thus, if a girl likes math but feels that the amount of effort it will take to do well is not worthwhile because it decreases the time she will have available for more preferred activities (i.e., activities more consistent with her personal values), then she will be less likely to continue taking math. If a girl stereotypes mathematics or careers involving competency in mathematics as masculine and not consistent with her own sex-role values, then she will be less likely to value mathematics learning and less likely to continue her mathematical studies, especially if she does not expect to do well.

To test these hypotheses, a 2-year cross-sectional/longitudinal project was designed with the following specific goals:

1. The plotting of the developmental emergence of individual differences on the various psychological factors selected for study in the cross-sectional samples of fifth- through twelfth-grade students;
2. The assessment of the relative importance of these factors in mediating differential participation in mathematics; and
3. The identification of the developmental origins of individual differences on these variables.

The selection of specific variables for study was guided by this theoretical model.

RESEARCH DESIGN AND METHODOLOGY

The project used both longitudinal and cross-sectional methods. In yea one, a cross section of 339 students in grades 5–11 were selected as th main sample. Their parents and their math teachers were included in thi wave of testing. In year two, these same children were re-tested. Thes data comprised the longitudinal portion of this study.

Data were collected in several forms: student record data, a studen questionnaire, a parent questionnaire, a teacher questionnaire, and class room observations. Information taken from each student's school recorc included final grades in mathematics for the 4 years between 1975 anc 1979 and standardized achievement test scores.

The student questionnaire included measures of expectancies for success, incentive values, perceived ability, perceived task difficulty, sex-role identity, sex sterotyping of math as a male domain, perceived cost of success, and causal attributional patterns, as well as measures of the children's perceptions of their parents' and teachers' beliefs regarding the children's abilities and the importance of math. The major attitudinal scales were factor analyzed using a maximum likelihood factor analytic procedure developed by Jöreskog, Sorbom, and Magidson (1979). These factor scales were used primarily as summary variables for the path analyses. Several additional composite scores based on only two or three items were formed for specific analyses. These are discussed where appropriate in the presentation of our findings.

Parents completed a similar battery assessing attitude regarding both themselves and their children. Teachers completed a brief questionnaire assessing their beliefs about the causes of the sex-differentiated participation rates and their judgments of each child's math ability and performance.

Using an observational system based on the systems developed by Brophy and Good (1974) and Dweck, Davidson, Nelson, and Enna (1978), observers coded interactions between teachers and individual students during 10 classroom sessions. These data were then used to describe both variations in the general social milieu across math classrooms and variations in the specific teacher-student interaction patterns across children.

During the first year of the study the measures were administered to a sample of students in grades 5–11. Because junior high school has been suggested as a particularly critical period for the formation of high school course plans and because many of the analyses of the observational data were to be based on the classroom as the unit of analysis, particular attention was paid to seventh and ninth grades. Thus, the 18 mathematics classes observed included two fifth-grade classes, one sixth-grade class, eight seventh-grade classes, and seven ninth-grade classes.

During the second year, 94% of the first-year sample was relocated. Slightly modified questionnaires were administered to the relocated students, and their current mathematics teachers. There were no classroom observations in Year 2.

During the second year, an additional control group of 329 students was drawn from the schools sampled during the first year of the study. This sample included students in grades 5–12. Selection of this sample allowed for comparisons suggested by Nesselroade and Baltes (1974) and Schaie (1965). In particular, we used this sample to assess test-retest effects and to rule out the possibility that our longitudinal findings reflect the impact of unique historical effects rather than general developmental processes. These analyses indicated that the control sample and the Year 2 main sample did not differ. Thus, we can safely conclude that test-retest effects were minimal. The control sample and the Year 1 sample also did not differ; therefore, changes in the students' attitudes from Year 1 to Year 2 do not reflect the impact of unique historical events. Based on these results and on the fact that the questionnaire had been modified slightly from Year 1 to Year 2, the control and Year 2 sample were merged making a total Year 2 sample of 668 children; Year 1 and Year 2 data were analyzed separately, except for the longitudinal analyses.

FINDINGS

Student Attitudes and Course Plans

Descriptive Analyses

To assess the effects of grade and sex on the student variables, analyses of variance using grade and sex as the independent variables were performed on each of the student scales. Table 4.1 and Table 4.2 summarize the results.

Descriptive Analyses: Sex. Relatively few sex differences emerged but they formed a fairly consistent pattern. Across both years, boys, compared to girls, rated their math ability higher, felt they had to exert less effort to do well in math, and held higher expectancies for future successes in math, even though there had been no difference between the past math performances (both standardized test scores and course grades) of these same boys and girls. In addition, boys in Year 1 rated both their current math courses and advanced math courses as easier than did the girls; boys in Year 2 had higher expectancies for success in current (as well as future) math courses; and boys in Year 2 rated math as more useful than the girls. Thus, to the extent that there are sex differences on

TABLE 4.1
Summary of Significant Sex Differences from Analyses of Variance: Years 1 and 2

Variables yielding significant sex effects	*Direction of Effect*	*P*
	Year 1	
Future expectancies for success in math	M > F	.01
Difficulty of current math course	F > M	.01
Anticipated difficulty of future math	F > M	.01
Effort to do well in math	F > M	.01
Task difficulty of math for self*	F > M	.05
Self-concept of math ability*	M > F	.05
Femininity score	F > M	.0001
Masculinity score	M > F	.0001
Perceived math utility for females	M > F	.01
Stereotyping of math as male domain	F > M	.05
Parents' perceived importance of math*	M > F	.01
Father's perception of task difficulty*	F > M	.01
Mother's perception of task difficulty*	F > M	.01
	Year 2	
Math ability (subjective estimate)	M > F	.01
Current expectancies for success in math	M > F	.04
Future expectancies for success in math	M > F	.01
Effort to do well in math	F > M	.01
Self-concept of math ability*	M > F	.05
Utility of mathematics	M > F	.01
Utility of advanced math	M > F	.001
Femininity score	F > M	.0001
Masculinity score	M > F	.0001
Perceived math utility for females	F > M	.05
Sex stereotyping of math ability	M > F	.05

*These scales are composites developed through factor analyses.

these self and task perception variables, boys have a more positive view of both themselves as math learners and of math itself.

Boys and girls also differed in the causal attributions they made for previous successes and failures in math. Chi-square tests of sex by attributions in both years indicated that boys attributed failure less to ability than did girls (Year 1: $X^2 = 9.76, p < .05$; Year 2: $X^2 = 9.77, p < .05$); the boys also attributed success more to ability than the girls (Year 1: $X^2 = 7.99, p < .05$; Year 2: $X^2 = 16.0, p < .05$). In contrast, the girls attributed success more to consistent effort than did the boys (Year 1: $X^2 = 8.80, p < .05$; Year 2: $X^2 = 5.73, p < .016$). When we divided the Year 1 sample into expectancy groups (low, medium, or high), we found that these attributional differences were characteristic only of high expectancy students. It was the high expectancy girls who attributed their

TABLE 4.2
Summary of Significant Age Effects

Variables yielding significant age effects	*Direction of Effect*	*P*
Year 1		
Math aptitude[1]	O > Y[2]	.01
Math ability (subjective estimate)	Y > O[3]	.01
Performance in math (subjective estimate)	Y > O	.01
Current expectancies for success in math	Y > O	.01
Difficulty of current math course	O > Y	.001
Task difficulty of math for self*	O > Y	.0001
Self-concept of math ability*	Y > O[3]	.001
Importance of math	Y > O	.01
Utility of advanced math	Y > O	.001
Interest in math	Y > O	.01
Subjective math value*	CURV. U[4]	.01
Liking of teacher	Y > O	.01
Perceived math utility for males	CURV. U	.01
Sex stereotyping of math ability	CURV. ∩	.05
Student perception of socializers' perception of math difficulty*	O > Y	.01
Student perception of socializers' perception of math ability*	Y > O	.0001
Student perception of others' expectancies for math	Y > O	.01
Mother's perception of task difficulty*	O > Y	.05
Teacher's rating of child's math ability	Y > O	.0001
Year 2		
Math ability (subjective estimate)	Y > O	.01
Performance in math (subjective estimate)	Y > O	.0001
Current expectancies for success in math	Y > O	.001
Difficulty of current math course	O > Y	.001
Anticipated difficulty in future math	O > Y	.0001
Self-concept of math ability*	Y > O	.0001
Utility of advanced math	Y > O	.001
Interest in math	Y > O	.01
Liking of teacher	Y > O	.0001
Masculinity score	CURV. U	.0001
Perceived math utility for females	Y > O	.0001
Perceived math utility for males	Y > O	.0001
Sex stereotyping of math ability	O > Y	.001
Student perception of socializers' perception of math difficulty*	O > Y	.0001
Student perception of socializers' perception of math ability*	Y > O	.0001
Student perception of others' expectancies for math	Y > O	.0001

[1]Tested only in Year 1.

[2]O > Y = linear trend increasing with age

[3]Y > O = linear trend decreasing with age

[4]CURV. U-curvilinear relationship with age, decreasing and then increasing

math failures more to lack of ability and their math success less to ability than the high expectancy boys ($X^2 = 6.95$, $p < .05$). It was also high expectancy girls who attributed their math successes more to consistent effort than the boys ($X^2 = 11.03$, $p < .05$). The boys and girls in the other two expectancy groups did not differ in their attributional pattern.

These differences in attributional patterns and attitudes toward mathematics reflect very different perceptions of both the task demands inherent in math and the potential value and cost of enrolling in advanced math courses. The girl who attributes her math success to consistent effort rather than ability may have low future expectancies precisely because she thinks future courses will be more difficult, demanding even more effort than her current math course. The amount of effort she can, or is willing to, expend on math has limits. Consequently, perceptions of the need for even greater effort may lower her expectancies for future success in math and predispose her against continuing to take math, especially if she feels that math is not very useful for her long range goals. The same dynamics would not apply to a boy who views his ability rather than his efforts as the more important cause of his successes in math. He may well assume that his ability will allow him to continue performing well with little or no additional effort. Combining these results with the fact that boys also rate math as more useful than girls leads us to predict that more boys than girls in this sample will enroll in difficult advanced math courses. In fact, our longitudinal follow-up data indicate that they do ($p < .05$). But the difference is quite small, as are the differences associated with most of the relevant attitudinal variables. (More details on the attributional data can be found in Eccles-Parsons, Meece, Adler, & Kaczala, 1982.)

Descriptive Analyses: Grade. Grade effects were both more numerous and, in general, stronger than sex effects. What emerges from an inspection of Table 4.2 is a sense that children become more pessimistic and negative about math as they grow older. The older children had lower expectancies for their current math performance, rated both their math ability and math performance lower, saw both their present and future math courses as more difficult, thought their parents shared these pessimistic views of their abilities and performance potential, were less interested in math activities in general, liked their math teachers less, and rated the utility of advanced math courses as lower than the younger children. For most of these variables, there was a consistent downward linear trend as a function of grade with the girls preceding the boys. No consistent grade by sex interactions emerged.

Descriptive Analyses: General. Several additional findings emerged that are of interest. Each is discussed in this section.

All students rated math as more useful for males (Year 1, $\bar{X} = 5.60$; Year 2, $\bar{X} = 5.03$) than for females (Year 1, $\bar{X} = 2.98$; Year 2, $\bar{X} = 4.22$; $p < .0001$ in each year). Students in general, however, did not rate males as having more math ability than females. The stereotyping of math as more useful for males than for females (calculated by subtracting the usefulness for women score from the usefulness for men score; hereafter referred to as the stereotyping of math as a male domain) dropped from Year 1 to Year 2. This drop was due largely to the increase in the rating of the usefulness of math for women from Year 1 to Year 2. Neither grade nor sex influenced these results.

We had the tenth to twelfth grade, Year 2 students rate the amount of encouragement to continue in math they had received from each of the following sources (listed in descending order of the mean encouragement score): father, mother, last year's teacher, guidance counselor, older friends, siblings, and peers. Of these, only fathers, mothers, and previous math teacher were perceived as having provided any encouragement. The other individuals were perceived as having neither encouraged nor discouraged the students. Peers were *not* seen as having discouraged the students' decision. One sex difference emerged: boys, in comparison to girls, felt that their counselor had provided them with more encouragement ($p < .05$). Counselor encouragement did not, however, predict future course plans.

The students also rated the importance of various reasons in influencing their decision to take math. Three reasons emerged as the most influential: preparation for either a college major or career, gaining admission to a prestigious college, and the importance of math in a well rounded education. Intrinsic properties of math, such as its challenge, ease, or interest value were clearly seen as less important. One sex difference emerged: boys rated the importance of future plans (college or career) in their decision higher than did girls ($p < .01$).

Relational Analyses

Relational Analyses: Sex-Role Measures. Several researchers have suggested that the stereotype of math as a male domain inhibits female participation. To evaluate this hypothesis and its many variations, we correlated the students' rating of the usefulness of advanced math for both males and females, their perception of math as being more useful to males, their sex stereotyping of math ability, and their ratings of themselves on a simplified version of the PAQ (Spence, Helmreich, & Stapp, 1975) with the other student measures.

Femininity as measured by the PAQ related to very few student measures in either year; no relationship was consistent across years. Masculinity, however, usually related significantly and positively to measures of expectancy and self-concept of math ability for both boys and girls (see Eccles–Parsons et al., 1983 for more details). The fact that masculinity was so consistently related to self-concept of math ability in both boys and girls could be because the character traits of rationality and an analytical approach to life commonly ascribed to males are also characteristic of individuals who are able in mathematics. Or, "masculinity" may actually be a measure of a form of self-confidence, instrumentality, or self-esteem rather than sex-role typing. This latter conclusion, which is in line with recent suggestions of several other researchers in the field of androgyny, for example, Locksley and Colten (1979) and Spence and Helmreich (1979), makes the use of the PAQ or other personality inventories as measures of sex-role identity suspect. In fact, Spence and Helmreich (1979) now advise against using the PAQ as a measure of sex-role identity.

Further support for the latter conclusion comes from our analyses of the multivariate contingency tables. The variables used in these analyses included the sex-role typing of the individual (neuter, feminine, masculine, or androgynous, formed using the median-split procedures outlined by Spence, Helmreich, & Stapp, 1974), the stereotyping of math as a male domain (neuter, moderately or highly masculine, formed using a composite score of the sex-stereotyping of math's usefulness and of math ability), sex of student, and each of the following student attitudinal variables: self-concept of math ability, concept of task difficulty, concept of the value of math, estimates of the utility of math for future goals, current expectancies, and interest. A student's sex-role classification had no significant influence on any of the dependent measures (see Eccles–Parsons et al., 1983 for more details). This finding, in conjunction with the correlational findings reported earlier, suggests that it is *only* the responses to the "masculine" items that are related to the attitudinal measures. Sex-role typing as conceptualized by researchers on androgyny is not a critical factor. This finding does not, however, invalidate the significance of a student's sex-role identity as an influence in his/her course selection. What it does suggest is that the masculine scale of the PAQ items is best interpreted as a measure of instrumentality rather than "masculinity."

Responses to the usefulness items yielded several interesting findings. First, whereas math was seen as more useful to men, the magnitude of this stereotype decreased over the 2 years of our study. Given this decrease and the difficulty in its interpretation, we correlated the Year 1 stereotyping measures with both Year 1 and Year 2 attitudinal measures; the Year 2 stereotyping measures were correlated only with the Year 2 student measures.

In Year 1 the usefulness of math for females was generally *not* related to other variables. It was, however, negatively related to two measures of the value of math for both boys and girls. Seeing math as useful for women did not increase its value for girls as one might expect. Instead it was the usefulness of math for males that predicted positively its value for both boys and girls as measured by interest in math ($r = .38$), importance of doing well in math ($r = .44$), and the utility of advanced math ($r = .38$) (see Eccles et al., 1983 for more details). One could conclude from these data that the stereotype of math as a male domain has a positive effect for everyone and ought to be encouraged; but results from other studies and the Year 2 data suggest that this conclusion is oversimplified. Instead, what it does suggest is that perceiving math as very useful for males does not necessarily have a negative consequence for girls, perhaps especially when the stereotype reflects an awareness of the high status jobs that are both male-dominated and math-related. In this case, it may be the status of the job rather than its male domination that elevates the perceived usefulness of advanced math courses for both high ability boys and girls.

What is striking about the Year 2 results is that, for both boys and girls, the stereotyping of math as useful for *either* men or women yielded identical patterns of relations: the higher the rating of usefulness, the higher the students' ratings of future expectancies, current expectancies, interest, utility, self-concept of ability, and concept of the value of math. Further, the stereotyping of math as a male domain was not related to anything. Recall that stereotyping of math as a male domain had dropped from Year 1 to Year 2. These data, taken together, suggest that math is either becoming less sex-typed or that students are less willing to report sex-typed attitudes.

To test whether the effects of stereotyping math as a male domain had disappeared, we correlated Year 1 sex-typing questions with Year 2 attitudes. What we found was quite interesting. Year 1 sex-typing measures correlated in exactly the same pattern with Year 2 measures of the value of math as they had with Year 1 measures of the value of math. Past sex-typing of the usefulness of math was still influencing attitudes even if the current sex-typing was not. Further, the Year 1 and Year 2 measures of the stereotyping of math as a male domain did not correlate with each other and the correlation of the perceived usefulness of math for women in Year 1 correlated negatively with Year 2 measures of the perceived usefulness of math for both women ($r = -.38$) and men ($r = -.23$). This shift in the use of the scales was not apparent in the correlations of the Year 1 measure of the perceived usefulness of math for men with Year 2 variables.

This strange set of findings led us to question the validity of the responses of the Year 2 sample on our sex-stereotyped questions and left us with one major conclusion: stereotyping math as a masculine domain does not necessarily have an adverse effect on girls' math attitudes or course plans. Results from our multivariate contingency table analyses provided

further support for this conclusion. Neither sex, nor personal sex-typing (neutral, feminine, masculine, or androgynous) had any consistent effect on the dependent measures tested. The stereotyping of math as a male domain did; people who stereotyped math as a male domain saw it as having higher future utility, being more enjoyable, and in general being more valuable.

Nash (1979) and others, ourselves included, have suggested that one must take account of the sex of the individual, the sex-role identity of the individual, and the sex stereotype of math in order to explain math achievement behaviors. Admittedly, the PAQ does not appear to be a good measure of sex-role identity and thus may not allow for a truly adequate test of this hypothesis. Nonetheless, using our measures, we found little evidence for the need of an interactive model to explain relations among these variables in our sample. Three-way interactive effects emerged only in the analysis of the concept of the value of math. In this case, only one cell of the multivariate contingency table had a higher frequency than one would expect by chance: girls who valued math highly perceived themselves as neutrally sex-typed and saw math as moderately male stereotyped. The other cells, which one would expect to support commonly predicted relations, did not have unusually high or low frequencies.

Relational Analyses: Students' Attitudinal Items. We assessed the relations among the student attitudinal variables using correlational and multivariate analyses. The zero order correlation matrices of selected variables for each year are presented in Table 4.3. As predicted for both boys and girls, in each year self-concept items correlated positively with each other, and in most cases with intent to continue in math; they correlated negatively with ratings of task difficulty. Self-concept items also correlated positively with the value of math items and negatively with the cost of math participation items.

To assess the origin of these attitudes we correlated the student attitudinal measures to teacher behavior, parents' attitudes and beliefs, and to a composite standardized score reflecting both past math grades and performance on either the CAT or MEAP. The analyses relating the student measures to the socializer measures are discussed in later sections. The relation of the math aptitude score to the other student measures varied depending on the sex of the student. Boys' past math aptitude was consistently related to their self-concept measures; girls' past math aptitude scores were not (see Eccles, Adler, & Meece, 1984, for more details).

Relational Analyses: Path Analyses. Path analyses were done separately for the Year 1 and Year 2 samples. Because the Year 2 sample included over 90% of the Year 1 students, and because the questionnaire had been improved based on Year 1 data, only the Year 2 data are dis-

TABLE 4.3
Correlation Matrix of Selected Student Attitudinal Variables

	1	2	3	4	5	6	7	8
1. Intention to take	–	.26	.29	.45	-.06	.41	.47	.04
more math	–	.19	.42	.53	-.08	.43	.36	-.01
2. Math aptitude	-.11	–	.34	.12	-.22	.01	[.28	.05
	.14	–	.49	.19	-.36	.03	.49]	-.08
3. Self-concept of	.30	.18	–	[.40	-.65	.32	.82	.06
math ability	.36	.30	–	.60]	-.57	.40	.86	-.10
4. Subjective value	.43	-.06	.51	–	-.05	.77	.57	-.10
of math	.44	.13	.58	–	-.08	.81	.69	-.19
5. Task difficulty	-.15	-.15	-.68	-.13	–	-.09	-.38	.00
of math for self	-.16	-.26	-.60	-.17	–	-.10	-.39	-.02
6. Utility of advanced	.23	-.13	.32	.77	-.09	–	.41	-.17
math	.26	-.01	.39	.80	-.13	–	.53	-.14
7. Future expectancies	.44	.15	.77	.63	-.37	.46	–	.00
for success in math	.41	.31	.80	.64	-.39	.47	–	-.10
8. Sex stereotyping of	-.03	-.02	[-.19	-.11	.07	[-.11	[-.16	–
math ability	.09	.02	.21]	.16	-.14	.21]	.24]	–

*Upper half of matrix contains correlations for Year 1; lower half of the matrix contains correlations for Year 2. Females are top correlation, males are bottom correlation in each pair.
$r > .19$ is significant at $p < .05$; $r > .27$ is significant at $p < .01$.
[ ] indicates significant ($p < .05$) sex difference in the magnitude of the correlation.

cussed here (Fig. 4.2). In addition, because the measure of stereotyping math as a male domain appeared to be reactive in Year 2, the Year 1 measure was used to provide the maximal likelihood of sex-typing effects emerging if they were in fact influencing students' math attitudes.

Path coefficients were calculated using a series of regression equations with each variable regressed on the set of variables to its left (those theorized to have had a causal effect on it). The standardized beta weights derived from the appropriate regression analyses are the path coefficients and reflect the relative strength of the relations specified by each path. Figure 4.2 represents a reduced path model depicting only those path coefficients significant at the $p < .01$ level or better. Less significant paths were omitted for clarity of presentation.

As predicted, intentions to continue taking math were most directly influenced by the perceived value of math and combined expectancies (current and future). These concepts, in turn, were related to students' estimates of both their own math ability, and of their parents' and teachers' beliefs regarding their math ability. Past history of math grades and performance on math achievement tests (Past Math Performance) did not have a direct effect on students' intention to take more math, on their expectancies for current or future performance, or on their subjective

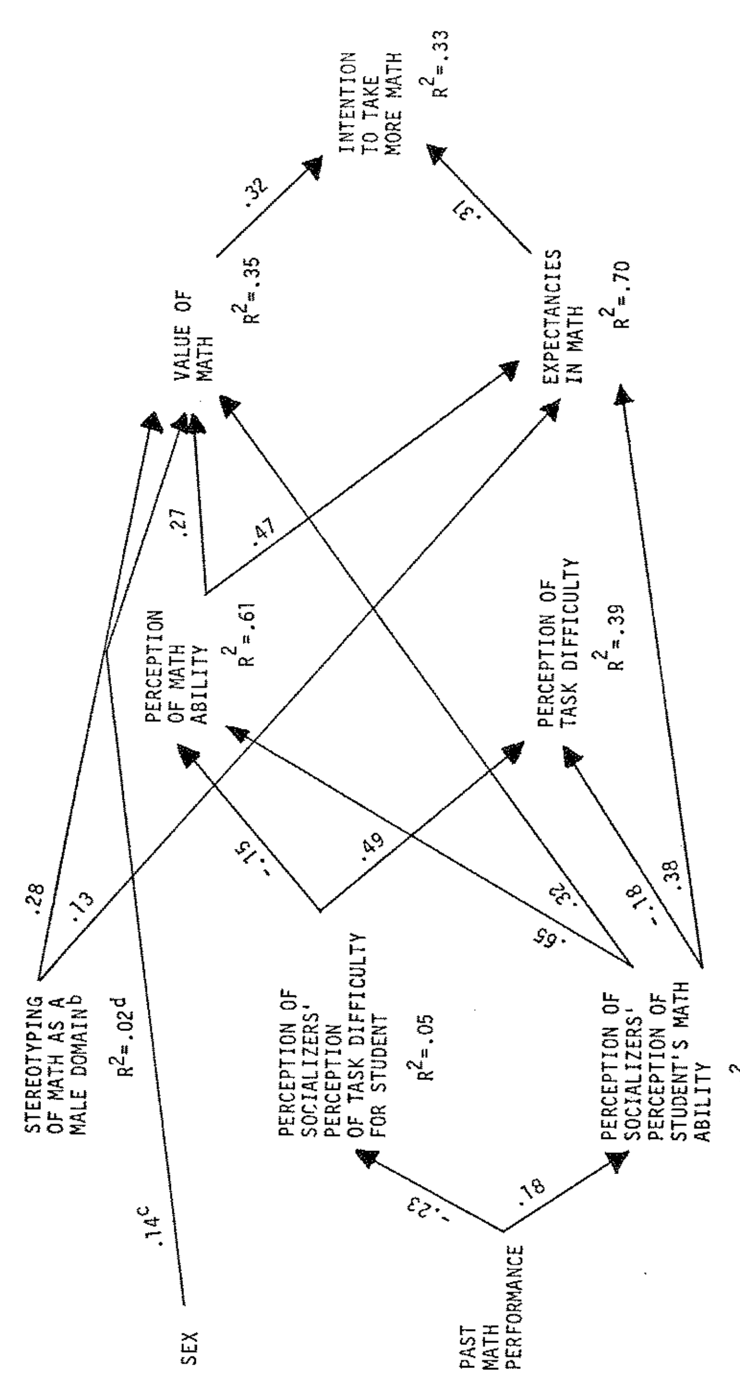
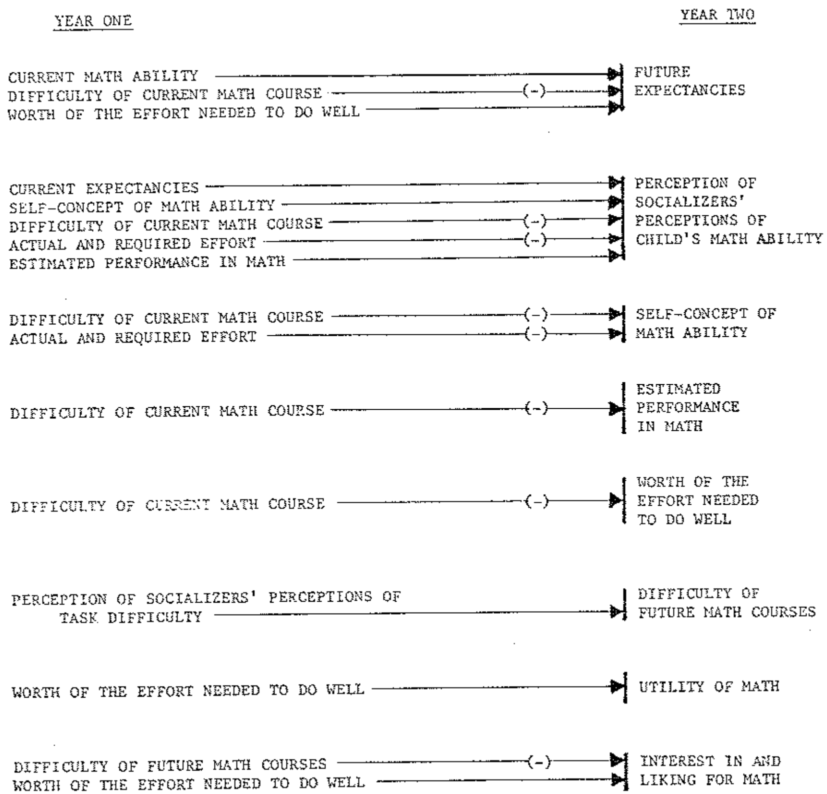


FIG. 4.2 Student attitudinal variables: year two[a].
[a]All paths significant at $p \leq .01$; N = 278.
[b]Based on year one data.
[c]Standardized beta weights are shown on path.
[d]R_2 = percent of variance accounted for one each criterion measure by all preceding predictor variables; each R^2 is listed under its criterion measure.



[a]All causal effects lead to increases in Year Two Variables except where indicated by negative (-) sign. Negative sign indicates a causal effect leading to decrease in Year Two Variables.

FIG. 4.3 Causal effects from cross-lagged panel analyses.[a]

estimates of either their own math ability or the difficulty of math. In addition, as predicted, stereotyping of math as a male domain increased the value of math, and, to a lesser extent, expectancies. Thus, it is clear that students' perceptions of themselves as math learners and of math itself are more important mediators of math course plans than are past performance and course grades.

Relational Analyses: Longitudinal Analyses. Our relational analyses culminated in a series of cross-lagged panel longitudinal analyses. This statistical technique makes use of longitudinal data to test causal inferences from correlational data. Cross-lagged panel analyses consist of the examination of the correlations between pairs of variables both within and between data collection points.

Our results are illustrated in Figure 4.3. All causal effects leading to increases in Year 2 variables are represented by a unidirectional arrow. A negative sign on this arrow indicates a causal effect leading to a decrease in a Year 2 variable. Interpreting these arrows, then, we see that shifts in future expectancies are caused by one's self-concept of math ability, by one's beliefs about the difficulty of current math courses, and the value of the effort needed to do well. Shifts in one's self-concept of math ability in turn are caused by one's beliefs about the difficulty of current math courses, and by one's perception of the actual and required effort to do well. Both estimated performance in math and the worth of the effort needed to do well are also influenced by the perceived difficulty of the current math course. Student perceptions of socializers' attitudes enter the figure as important particularly in the prediction of the difficulty of future math courses, a variable which in turn predicts an interest in and a liking for math.

Summary. In summary, the proposed model provides an adequate explanation of these data. The variables included in the model explain 32% to 36% of the variance in intentions to take math. The path diagram graphically illustrates that intentions to continue in math are indeed affected by expectancies for success and assessment of the personal value of math. These, in turn, are mediated by perceptions of one's own math ability. This pattern suggests that to be effective, an intervention program designed to promote higher math participation should focus on the following goals: (1) heightening girls' expectancies for success in math achievement situations, (2) providing the girls with accurate information regarding the utility of math for their futures, and (3) working to increase the intrinsic interest value of math. Because sex-typing math as a male domain did not appear to have detrimental effects on girls' plans or attitudes toward math, our data suggest that programs aimed at decreasing the stereotyping of math as a male domain without also pointing out its potential value for the individual will not be effective in increasing girls' participation in advanced math.

DEVELOPMENTAL ORIGINS

Teacher Effects

The effects of teachers' expectancies on their students' performance have been studied extensively since the publication of Rosenthal and Jacobson's *Pygmalion in the Classroom* (1968). While their results have been difficult to replicate, research by Brophy and Good (1974) has shown that teachers' naturally occurring expectancies for the students in their classrooms affect the kinds of interactions teachers have with their students and that these interactions can affect the children's achievement. Of particular importance is the finding that some teachers treat girls for whom they have high expectancies in ways that are less facilitative of achievement than the way they treat comparable groups of boys.

Another mechanism that might explain girls' lower expectancies for success in math has been proposed by Dweck and her colleagues (Dweck et al., 1978). Their model emphasizes the importance of the relative proportion of praise and criticism allocated by the teacher to academic work versus the form of the work and the student's conduct. They argue that boys receive frequent criticism for non-academic as well as academic behaviors and consequently can discount these negative evaluations as indicators of their own abilities. Girls, in contrast, receive less criticism than boys, and when it occurs, it is directed specifically to the quality of their academic work. Because of its very specific use, these authors suggest that criticism cannot be discounted as easily by the girls. They propose a similar though reversed pattern for praise. In addition, they suggest that teachers are more likely to attribute boys' failures to lack of effort than to lack of ability, thus further reinforcing the boys' sense of control and confidence.

Based on these studies, we tested the following hypotheses: (a) teachers' behaviors would influence students' expectancies for success; (b) students who received positive feedback would have higher expectancies for success than those who received negative feedback; (c) boys would receive more indiscriminate criticism (criticism toward both the quality and form of their academic work and toward their conduct) than girls; (d) girls would receive more discriminate criticism (criticism directly only to the quality of their work) and more indiscriminate praise than boys; and (e) teachers' attributions to effort would influence students' expectancies positively.

A Sex X Grade X Expectancy group (High, Low) analysis of variance (using the classroom as the unit of analysis and using scores standardized within each classroom) was done on each of our 51 classroom variables. Of the 51 variables, significant effects ($p < .01$) were found on only three, each of which was a main effect due to sex. Girls received less criticism than did boys during dyadic interactions, received less criticism for work, and a lower percentage of girls' dyadic interactions were criticized.

Contrary to our predictions, then, teachers did not give more positive feedback to students in the high expectancy group, and boys and girls did not differ in the amount of discriminate and indiscriminate praise and criticism they received for the quality or form of their work, or their conduct (see Heller & Parsons, 1981 and Eccles-Parsons, Kaczala & Meece, 1982 for details). No support was found for the suggestions of Dweck et al. (1978). The only significant main effect of sex on evaluative feedback was the amount of criticism from the teacher directed toward the work and toward the quality and form of the work combined; girls received less work-related criticism than did boys, and less criticism to the quality plus form of their work. Surprisingly, boys and girls did not differ in the amount of criticism directed to their conduct or on any of the forms of praise. Further, in a series of stepwise regression analyses, classroom interactional measures did not emerge as significant predictors of student attitudinal variables. However, teachers' expectancies, measured by the teacher questionnaire, were predictive of student expectancies (see Heller & Parsons, 1981 for details). Thus, while the proposed relations between teachers' expectancies and students' expectancies were supported, the mediating effects of classroom behavior on expectancies were not demonstrated.

The analyses reported thus far were performed on the entire sample. It is possible that the effects of classroom behaviors are dependent on teacher style. For example, some teachers may treat boys and girls differently, whereas others may not. By collapsing across all of our teachers, these effects would have been masked. To explore this possibility, we selected from the sample the five classrooms with the largest sex differences in the students' self-reported expectancies and the five classrooms with no significant sex differences in expectancies and reanalyzed the data using raw frequency scores to allow for classroom comparisons.

As was true for the previous analyses, most variables did not yield significant differences. None of the variables predicted by Dweck's model yielded classroom-type effects. Those effects that were significant were divided into three types: behaviors characteristic of teacher style (teacher behaviors under primary control of the teacher, e.g., use of praise following a correct answer), behaviors characteristic of student style (behaviors under primary control of the student, e.g., student-initiated dyadic interactions), and behaviors dependent on both teacher and student style (behaviors requiring interactive responses of both the teacher and the student, e.g., total dyadics). Clearly, these classroom types differed in the dynamics we observed. Teachers in high sex-differentiated classrooms were more critical, were more likely to use a public teaching type (asking open questions, giving opportunities for responses, receiving answers) and less likely to rely on more private dyadic interactions, and gave more praise ($p < .01$) (see Eccles-Parsons, Kaczala, & Meece, 1982 for details).

Several interesting sex differences ($p < .01$) also emerged in these analyses. In the low-difference classrooms girls interacted more than boys (gave more responses, asked more questions, initiated more interactions) and they received more praise for work and criticism for form. In high-difference classrooms, boys interacted more (having more response opportunities, asking more questions and giving more answers) and received more praise for work and criticism for form. Boys' expectancies did not differ across the two classrooms while the girls' did; in fact, the girls' expectancies in high-difference classrooms were significantly lower than the expectancies of any other group.

To test whether teacher behavior accounted for this sex difference in expectancy, we correlated the teacher-style variables that discriminated the low from the high sex-differentiated classrooms with the students' attitudinal variables. Unfortunately, none of these correlations were significant. As we had found earlier, however, teacher's expectancies as reported on the questionnaire were strongly related to both boys' and girls' current and future expectancies and their perceptions of the current difficulty of math and their math ability (see Eccles-Parsons, Kaczala, & Meece, 1982).

Next we divided the sample into two additional groups: those students for whom the teacher had high expectancies ("bright" students) and those students for whom the teacher had low expectancies. In general, we found that both "bright" males and "bright" females were treated quite differently in each of the two classroom types ($p < .01$; see Eccles-Parsons, Kaczala, & Meece, 1982). "Bright" girls interacted the most, answered more questions, received more work and form praise and less criticism in the low sex-differentiated classrooms. In contrast, "bright" boys were accorded the most praise and interacted the most in the high sex-differentiated classrooms. "Bright" girls were accorded the *least* amount of praise of *any* of the eight factorial groups in the high sex-differentiated classrooms. But whether this differential use of praise was "causing" the "bright" girls to have lower expectancies in some classrooms and how such an effect might have been mediated cannot be determined from our data.

In concluding, these additional points are important to stress: first, the frequency rates of all these interaction variables are quite low. Second, interaction variables are not as predictive of students' expectancies as are other variables we measured, for example, students' sex and teachers' expectancies. Third, the effect of classroom type may be mediated by the general social climate in the classroom rather than by the direct effects of one-to-one teacher-student interactions. Social climate is a function of both the teacher and the set of students in each particular class. Consequently, whereas classroom interactions may be having an effect on children's expectancies, the effects are not large and may be as much a function of the children as the teacher. Finally, we did not see teachers actively discouraging girls' attitudes toward math; nor, however, did we see them making any special effort to encourage the girls. Instead,

teachers appeared to be playing a rather passive role in the process of socializing boys' and girls' attitudes towards math. Other studies clearly suggest that teachers can play a very active role in this socialization process. Thus, to the extent that teachers can be induced to cooperate, classrooms could be a very powerful target for intervention programs.

Parent Effects

It has been suggested by many achievement theorists that parents influence their children's achievement behaviors through their roles as models and through their more direct role as expectancy and value socializers. Both of these hypotheses are discussed in this section.

The importance of role models in socialization is a recurring theme throughout the sex difference literature. According to this hypothesis, important models, in particular parents, exhibit behaviors that children imitate and later adopt as part of their own behavioral repertoire. If mothers exhibit different behavior patterns than fathers, then, girls and boys should acquire sex-differentiated behavior patterns. With regard to math expectancies in particular, it has been hypothesized that girls exhibit more math avoidance and have lower math expectancies than boys because mothers are more likely than fathers to exhibit math avoidance behaviors. To test this hypothesis, we compared the mathematics relevant self-concepts of the mothers and fathers in our sample. (These data are presented in more detail in Eccles-Parsons, Adler, & Kaczala, 1982.)

In comparison to mothers' responses, fathers said that they were and have always been better at math, that math was and always has been easier for them, that they needed to expend less effort to do well at math, that they have always enjoyed math more, and that math has always been more useful and important to them ($p < .01$). In sum, fathers were more positive toward math and have a more positive self-concept regarding their math abilities. What is more, we found that these sex-differentiated beliefs were specific to math. Consistent with the fact that girls on the average outperform boys in school, mothers rated their general high school peformance higher than fathers did.

In line with the modeling hypothesis, one might conclude at this point that we have identified a major source of sex-differentiated math self-concept in today's school children. Boys and girls differ because their parents' behavior is sex-differentiated. But one needs to demonstrate a relation between parents' behaviors and children's beliefs before this conclusion is justified. To test the modeling hypothesis more directly, we correlated the parent self-concept variables with the children's responses to the student questionnaire and to their math aptitude score. None of the more than 100 correlations were significant at a psychologically meaningful level ($r = .25$ or greater). Thus, while parents' self-concepts did differ in the predicted direction, the influence of these differences on children's math self-concept was minimal.

The second source of influence is the parents' beliefs about the math abilities of their children and the importance of math for their children. To test these influences, we compared the parents' of boys perceptions of their sons' math ability, interest and effort, their expectancies for their sons' future performance in math, and their perceptions of the relative importance of a variety of courses for their sons to similar beliefs of the parents of girls.

The sex of the child had a definite effect ($p < .01$) on parents' perceptions of their child's math ability and on the parents' perceptions of the relative importance of various high school courses. Whereas parents did not rate their daughters' math abilities significantly lower than they rated their sons', they did think that math was harder for their daughters and that their daughters had to work harder to do well in math. Further, fathers exhibited more frequent sex-differentiated responses.

That parents feel their daughters have to try harder to do well in math is of particular interest. It suggests that both parents and their daughters share the perception of how hard girls need to try in order to do well. We do not know whether this reflects parents' echoing comments they have heard their daughters make or whether it demonstrates the parents' strength as teachers of good or bad attitudes towards math. But it seems likely that it could lead parents to support their daughters' decisions to drop out of math, especially when they don't believe math is that important for their daughters' futures. Similarly, as math is seen as relatively easier and more important for sons than for daughters, parents should be less tolerant of a son's decision to drop math.

Are these parental beliefs about their children's abilities and plans predictive of future math expectancies and future course plans? To answer this question, we correlated the major parent and child variables from Year 1 with each other. The children's current and future expectancies were related consistently ($p < .01$) in the predicted direction to variables tapping perceptions of their parents' beliefs and expectancies and to the parents' actual estimates of their children's abilities (See Eccles-Parsons, Adler, & Kaczala, 1982 for details). Thus, parents do appear to have an effect on children's expectancies, and we have found another intervention route.

Socializers: General Findings

As hypothesized, we found that parents' and teachers' beliefs are related to children's expectancies and plans. The zero order correlation matrices

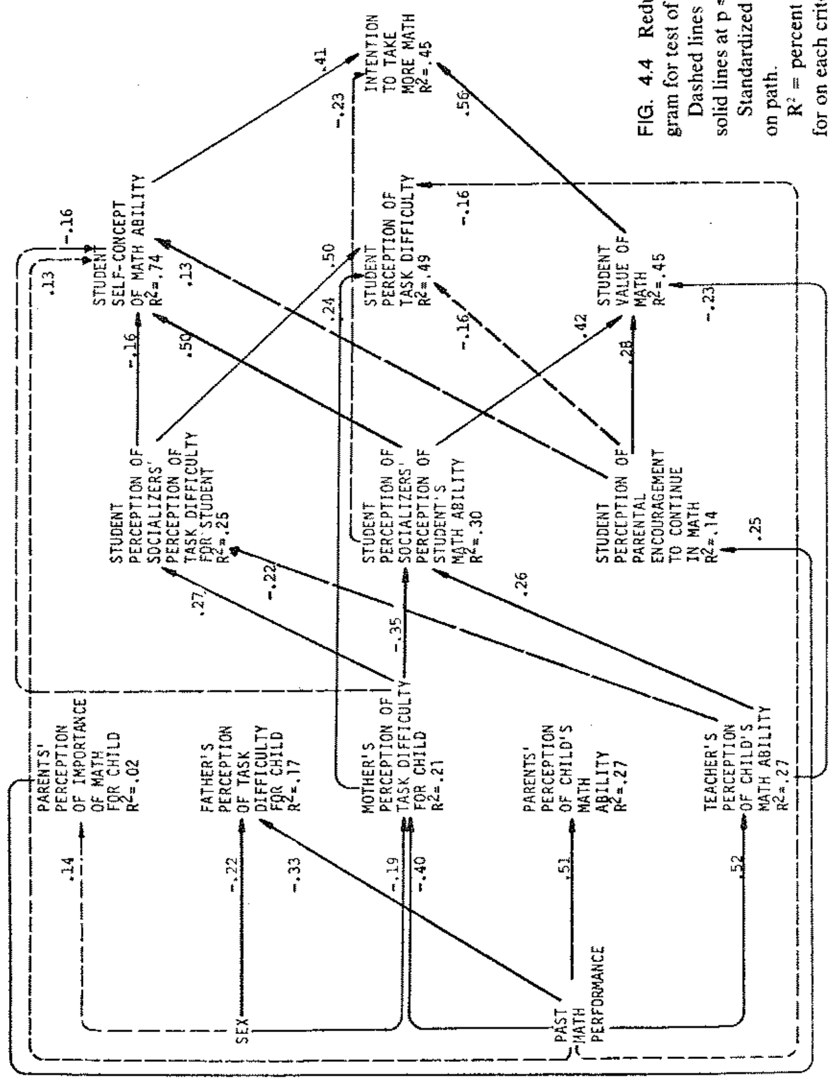


FIG. 4.4 Reduced path analytic diagram for test of socialization model. Dashed lines are significant at $p \leq .05$, solid lines at $p \leq .01$; N = 156. Standardized beta weights are shown on path. R^2 = percent of variance accounted for on each criterion measure by all preceding predictor variables; each R^2 is listed under its criterion measure.

TABLE 4.4
Correlation Matrix of Selected Student, Parent, and Teacher Variables: Year One Variables Only

	Child's self-concept of math ability	Child's perception of task difficulty	Child's rating of the value of math	Child's intention to take more math	Math aptitude	Child's future expectancies for math
1. Math aptitude	.34 / .48	-.21 / -.36	.12 / .19	.26 / .19	— / —	[.28 / .49]
2. Parents' perception of importance of math for child	.11 / .25	.00 / -.13	.21 / .18	.09 / .02	-.06 / .12	.17 / .21
3. Mother's perception of task difficulty for child	-.57 / -.60	.49 / .46	-.27 / -.28	-.28 / -.34	-.37 / -.50	-.48 / -.43
4. Father's perception of task difficulty for child	-.49 / -.54	.46 / .42	-.26 / -.28	-.18 / -.22	-.27 / -.45	-.37 / -.44
5. Parents' perception of child's math ability	.31 / .35	-.20 / -.16	.23 / .28	.24 / .08	.49 / .42	.31 / .35
6. Teacher's perception of child's math ability	.44 / .59	-.36 / -.44	-.08 / .12	.21 / .20	.50 / .57	[.29 / .52]
7. Child's perception of socializers' perception of child's math ability	.72 / .78	-.41 / -.34	[.31 / .51]	.14 / .28	.21 / .33	.60 / .70
8. Child's perception of parental encouragement to continue taking math	.30 / .37	-.09 / -.20	.42 / .30	.09 / .15	-.11 / .05	.36 / .43
9. Child's perception of socializers' perception of task difficulty for child	-.52 / -.56	.58 / .58	[-.08 / -.27]	-.06 / -.19	-.13 / -.23	-.32 / -.40

Correlation for female is the upper figure, correlation for males is the lower figure.
$r > .19$ significant at $p < .05$; $r > .27$ significant at $p < .01$.
[ ] = Correlation is significantly different for girls and boys.

of selected variables for each year are presented in Table 4.4. We predicted that this link would be mediated by children's perceptions of their parents' and teachers' beliefs rather than affected directly by the socializers' beliefs or by the shared knowledge of the children's math aptitude. To assess these hypotheses, we performed a series of recursive path analyses on the teacher, parent, and child factor scale scores. Figure 4.4 depicts the relations between Year 1 socializer scores and Year 1 student scores. A second analysis, testing the long-range effects of Year 1 variables on the Year 2 measures of student attitudes, yielded similar results.

In support of our predictions, expectancies and goals of socializers were related (mostly indirectly) to children's math self-concept and directly to the children's perceptions of their parents' and teachers' beliefs about their math aptitude and potential. Thus, student perceptions acted as mediators between socializers' attitudes and children's self-concepts of ability (including expectancies), task difficulty, and the value of math. In addition, the child's previous math performances were only indirectly related to intent to study math. That is, measures of children's self-concept and expectancies were more directly related to course plans than either past objective measures of the children's performance or parents' actual attitudes. Much of the effect that these past objective measures have on the children's self-concept is mediated by their impact on the perceptions of teachers and parents.

In conclusion, parents had sex-differentiated perceptions of their children's math aptitude despite the similarity of the actual performance of boys and girls. This difference was most marked for parents' estimates of how hard their children have to try to do well in math. Parents also thought advanced math was more important for their sons than for their daughters. Parents' perceptions of and expectations for their children were related to both the children's perception of socializers' beliefs and to the children's self-concept, future expectations, and plans. Further, parents' beliefs and children's perceptions of these beliefs were more directly related to children's self-concepts, expectancies, and plans than were the children's own past performance in math. Finally, parents as role models of sex-differentiated math behaviors did *not* have a direct effect on their children's self-concepts, expectations, and course plans.

Socializers: Summary and Implications

Because parents' responses were predictive of student attitudes, it would seem that intervening with the parents would have significant impact. Unfortunately, parents are not an easy target group for intervention. Given the number of people and the diversity of opinions and values represented in parent groups, such interventions would be costly and high risk. Consequently, whereas the gain might be great, the cost-benefit ratio is probably low. Nevertheless, were such interventions designed, they should include the following components:

1. Both parents should be provided with information about the value of math for future jobs; stress should be placed on the opening fields of computer science and on the importance of math for careers in social sciences.

2. Parents should be made aware of the detrimental effects of feedback to their children that conveys the sense that math is a hard subject. Because their perceptions of the difficulty of math for their children are influential, parents should be cautioned about the effects of communicating these beliefs to their children.

3. Although seemingly benign, reinforcing girls' opinion that their successes are due to hard work appears to have a long range debilitating effect on girls' self-concept of ability and on their course enrollment plans. Parents should be made aware of this effect and cautioned against attributing their children's, especially their daughters', successes to hard work. Children's success and hard work should be attributed instead to their ability and interests.

One additional point should be made about parental influences. Parents do not have much influence as role models, thus, we do not have to worry about inducing major changes in parents' views about their own math abilities. Instead, we have to stress to them the importance of not projecting these beliefs, if negative, onto their children. Admittedly, this is not an easy task, yet it is certainly easier than convincing them that their own self-concepts of math ability are inaccurate.

Turning now to the school system, our data suggest that teachers also have some impact on students' math attitudes. They are a convenient target group and there are ameliorative behaviors available to them that were observed very infrequently in our classrooms. For example, teachers made few attributions. Teachers could use classroom interactions as an opportunity to model and reinforce beneficial attributional patterns for high ability girls. Similarly, we observed few incidences of the discussion of the importance of math for later careers; teachers could be giving this information to students at all grade levels. Finally, we observed few incidences of encouragement to continue taking math courses or to consider math-related careers. Whereas the variation in existing levels of encouragement was not predictive of plans, increasing the overall level of encouragement given to girls might have beneficial effects. In addition, given the importance of parental attitudes, teachers could work with parents in encouraging math-able girls to consider math-related careers. A well timed phone call letting parents know that their daughter is math-able and should consider one of the many lucrative fields

involving her math skills could do wonders. Providing teachers with information regarding the importance of each of these behavior clusters would be an inexpensive intervention. And, because most teachers we talked to wanted to do a good job, our intuition is that they would make use of such information as best they were able.

With regard to classroom interaction patterns, two effects emerged. Both democratic teaching styles and increased opportunity for interaction coupled with appropriate evaluative feedback were associated with high expectancies in "bright" girls. Consequently, teachers should be encouraged both to call on specific students rather than relying on student volunteers for answers and to provide these students with appropriate work praise and criticism.

One additional intervention strategy is suggested indirectly by our data. We found that interest and enjoyment of math was significantly related to other attitudinal variables, that boys and girls did not differ on these variables, and that interest in and enjoyment of math decreased with age. These data suggest that positive attitudes toward math might be maintained by activities designed to capitalize on the enjoyment of math expressed by the younger children. Further, because boys and girls did not differ in their enjoyment of math, it should be possible to design activities that appeal to both boys and girls. Involving children in such activities might maintain their interest and increase participation in advanced math courses.

ACKNOWLEDGMENT

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