FINAL REPORT

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SELF-PERCEPTIONS, TASK PERCEPTIONS AND ACADEMIC CHOICE: ORIGINS AND CHANGE

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ABSTRACT

A two year longitudinal/cross-sectional project investigated the determinants of students' decisions to enroll in advanced math courses, with particular attention to the determinants of sex-differentiated course participation. This study attempted to 1) plot developmental shifts on psychological variables related to achievement attitudes, 2) assess the relative importance of these variables for student decisions and 3) identify the developmental origins of individual differences on these variables. Questionnaires were administered to approximately 600 students in grades 5-12, their parents and their teachers. School record data and observational data were also gathered in the first year of the study.

Students' estimates of their math abilities, their estimates of the value of advanced math, and their perceptions of their parents' beliefs about their math ability decreased with age. Students' estimates of the difficulty of math increased with age. Plans to continue in math were facilitated by high expectancies, high self concept of math ability and low estimates of future course difficulty. Sex differences favoring boys were found on each of these scales. While teachers' expectancies did predict students' attitudes, teachers' expectancies were not sex-differentiated. However, in classrooms where students' expectancies showed the greatest sex differences, teachers provided less praise for, and interacted less with, "bright" girls than with "bright" boys. Parents had no role model effect on their children's attitudes, but parents' beliefs regarding their children's abilities did affect students' attitudes. Although parents did not state that their sons had more ability, they felt that their daughters had to try harder than

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 requirement. While 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 (Sherman & Fennema, 1977; Fennema, Note 1; Fox & Brody, Note 2; Sells, Note 3).

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 one year of high school math. While some of the factors influencing this decision might be impossible to change, such as parents' education or their careers, other factors might be modifiable. Identification of these modifiable factors could lay the foundation for the design of appropriate intervention programs aimed at increasing the likelihood of students continuing to take mathematics.

It is clear from the volume of research on this problem that sex differences in math achievement and course selection is of more than recent concern. Past research has proposed the following explanations for this problem:

Males outperform females on spatial problem-solving tasks and their sons to do well and believed that math was less important for their daughters. In general, mothers had the greatest influence and fathers had the least influence on students' attitudes regarding mathematics. Teachers' influences were intermediary.

on other mathematics aptitude measures. Consequently, they are more able to continue in math (Aiken,L., 1971; Astin, 1974; Maccoby & Jacklin, 1974; Wittig & Pedersen, 1979).

Males receive more encouragement than females from parents, teachers, and counselors to enroll in advanced mathematics courses or to pursue math-oriented careers (Haven, 1971; Fox, Tobin & Brody, 1979; Casserly, Note 4; Luchins, Note 5).

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 (Ernest, 1976; Fennema & Sherman, 1977; Fox, 1975, Nash, 1979; Sherman & Fennema, 1977; Stein & Smithells, 1960; Armstrong & Kahl, Note 6).

Males perceive themselves as more competent and report greater confidence in learning mathematics than females (Ernest, 1976; Fennema & Sherman, 1977; Fox, Tobin & Brody, 1979; Robitaille, 1978; Fox & Brody, Note 2).

Each of these bodies of research has provided insights into the mechanisms contributing to students' math achievement behaviors. But because researchers have approached this area of study from a variety of theoretical perspectives and consequently have focused their research on a subset of possible causes, there is no overriding theme linking together these disconnected findings. What is needed is a theoretical framework which acknowledges the complex interplay of these factors, takes into account the sociocultural context in which mathematics learning takes place and thus provides a more comprehensive approach to this problem.

Decision, achievement and attribution theorists (e.g., Atkinson, 1964; Edwards, 1954; Weiner, 1972) have all addressed the issue of choice behavior, linking it to one's expectancy for success and the incentive value of the task for the individual. Applying these theories of behavior to students' decisions to continue taking mathematics, we propose that enrollment decisions are a joint function of students' expectations for their performance in a particular math course and of students' perceptions of the importance or incentive value of taking mathematics. 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.

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Figure 1 presents such a model. Within 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 math ability 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 past history of math performance and 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 those events rather than the events themselves. For example, doing well in math is presumed to influence one's expectancies 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 nor are they as likely to go on in math. This apparent paradox is less puzzling if one acknowledges that it is the subjective meaning and interpretation of one's successes and failures which determine one'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 differential information relevant to these expectations might account, in part, for the observed sex differences in students' course selection in math.

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 in line 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 two year cross-sectional/longitudinal project was designed with the following specific goals:

a) 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;

b) the assessment of the relative importance of these factors in mediating differential participation in mathematics; and

c) the identification of the developmental origins of individual differences on these variables.

The selection of specific variables for study was guided by the theoretical model outlined above.

RESEARCH DESIGN AND METHODOLOGY

The project can be described as a longitudinal and cross-sectional study with the goal of identifying the developmental origins and the relative importance of various factors which may mediate differential participation rates in mathematics by boys and girls. Our design is based on Schaie's General Developmental Model (Schaie, 1965). Schaie stated that "a response is a function of the age of the organism, the cohort (total population of organisms born at the same point or interval in time) to which the organism belongs, and the time at which measurement occurs" (Schaie, 1965, p.93). Further, he suggested that in order to establish empirically the relative importance of each of these factors in producing change, one must make the following comparisons: 1) subjects of the same age born in different years must be compared in order to gauge the effects of historical change; 2) subjects of different ages must be compared to gauge the effects of age on development; and 3) subjects' behavior must be measured at two different points in time to gauge the effects of maturing one year. Our design is based on this reasoning.

The project was executed in two phases over two years and entailed the administration of questionnaires to 668 students, their parents and their teachers in grades five through twelve. Data were collected in several forms: student record data, a student questionnaire, a parent questionnaire, a teacher questionnaire and classroom observations. Information taken from each student's school record included final grades in mathematics for the past four years (1975-1979) 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 stereotyping of math as a male domain, perceived cost of success and causal attributional patterns. In addition, measures of the children's perceptions of their parents' and teachers' attitudes regarding the children's abilities were included. A copy of the questionnaire and major scales with alpha coefficients are included in Appendix E and Appendix A, respectively. In some cases these scales were factor analyzed using a maximum likelihood factor analytic procedure developed by Joreskog & Sorbom (1979). These factor scales were used primarily as summary variables for the path analyses. The items comprising each factor and the factor loadings are included in Appendix A. Several additional composite scores were formed for specific analyses. These are discussed where appropriate in the presentation of our findings. A summary of all major measures is displayed in Table 1.

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Parents completed a similar battery assessing attitudes for both themselves and their children. A copy of the questionnaire is included in Appendix E. A listing of the scales with alpha coefficients are included in Appendix A.

Teachers completed a brief questionnaire assessing their beliefs about the causes of the sex-differentiated participation rates and their judgments of each child's ability and performance. Copies of the teacher measures are included in Appendix E.

The observational system used was a modified version of Brophy and Good's (Note 7) and Dweck's (1978) systems. Observers coded interactions between teachers and individual students during ten classroom sessions. Classroom observations were designed both to describe the social milieu of the classroom and the teachers' behavior toward the class as a unit, and to look at specific interactions between mathematics teachers and student subjects. An overview of the observational system is included in Appendix A.

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 eighteen mathematics classes observed included two 5th grade classes, one 6th grade class, eight 7th grade classes and seven 9th grade classes.

During the second year, 94% of the first year sample was relocated. Slightly modified questionnaires were administered to the relocated students, their current mathematics teachers, and their parents. Of the parents relocated, 45% returned their second questionnaire. Because of this low parent return, the second year parent data were not analyzed. During the second year, an additional control group of 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 the comparisons outlined by Schaie, discussed earlier and in Appendix C. There were no classroom observations in Year 2.

The analyses based on the suggestions of Schaie (1965) and Nesselroade and Baltes (1974), outlined in more detail in Appendix C, indicated that the control sample and the main sample did not differ. 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; Year 1 and Year 2 data were analyzed separately, except for the longitudinal analyses.

In addition to the appendices already noted, tables detailing distributions of subjects and participation rates, a more detailed description of the general analytic procedures and a more complete discussion of variable selection and hypotheses are included in the appendices.

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 2 presents the means associated with these analyses for the Year 1 and Year 2 samples Table 3 summarizes the results of the analyses of variance.

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Descriptive analyses: Sex. Few sex differences emerged. Compared to girls, boys rated their math ability as higher and perceived their parents as having slightly higher estimates of their ability even though there had been no difference between the past math performances 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 and girls did not differ in their perceptions of their parents' expectancies for them nor in their perceptions of their parents' estimates of the difficulty of current math courses. In looking at the expectancies these students had for their performance in math, we found little or no sex differential in their expectancies for success in their current math courses; but boys did have higher expectancies than girls for success in future math courses. Both boys and girls might have based their current expectancies on recent objective evaluations of their performance, i.e., last year's math grade. But expectancies for the future may depend not only on these objective outcomes, but also on their more general perceptions of their own ability and the difficulty of math. As was mentioned earlier, boys and girls did perceive both of these factors differently. These differing perceptions should be reflected in the attributions assigned to success and failure experiences.

Boys and girls differed in their attributional patterns for success and failure in math achievement situations. 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: $X^2 = 9.77$, $p < .05$) and boys attributed success more to ability than girls did (Year 1: $X^2 = 7.99$, $p < .05$; Year 2: $X^2 = 16.0$, $p < .05$). In addition, girls attributed success more to consistent effort than did boys (Year 1: $X^2 = 8.80$, $p < .05$; Year 2: $X^2 = 5.733$, $p = .016$). When students in the Year 1 sample were divided into expectancy groups (low, medium or high), this difference between boys' and girls' attributions was especially marked for the high expectancy students. Within the high expectancy group, girls attributed their failure more to lack of ability and their success less to ability than did boys ($X^2 = 6.95$, $p < .05$). High expectancy girls also attributed their success more to consistent effort than did boys ($X^2 = 11.03$, $p < .05$).

These differences in attributional patterns reflect very different perceptions of the task demands of math which may, in turn, affect a student's expectations for future success. The girl for whom consistent effort is seen as a more important cause of her successes than ability could have low future expectancies because future courses are considered more difficult, demanding even more effort. The amount of effort she can or is willing to expend 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. The same dynamics would not apply to a boy who views his ability rather than his effor hists as the more important cause for success in math. He might assume that his ability will allow him to continue performing well with little or no additional effort.

Descriptive analyses: Grade. Grade effects were both more numerous and, in general, stronger than sex effects. What emerges from an inspection of Table 3 is a sense that children become more pessimistic and negative about math as they grow older. The older children had lower expectancies for both their current and future 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 preceeding the boys. No consistent grade by sex interactions emerged.

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

All students rated math as more useful for males (Year 1, M=5.60; Year 2, M=5.03) than for females (Year 1, M=2.98; Year 2, M=4.22; $p<.0001$ in each year). Students did not, however, rate males as having more math ability. The stereotyping of math as exclusively useful for males (calculated by subtracting the usefulness for women score from the usefulness for men score and 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 10th-12th 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 their 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 encouraged the students. 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 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 a mediating role for the stereotyping of math as a male domain. 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. These correlations are displayed in Tables 4-7.

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Femininity as measured by the PAQ did not relate to any of the student measures in either Year 1 or Year 2. Masculinity related consistently and positively to measures of expectancy and self-concept of math ability for both boys and girls but did not relate to girls' intention to continue in math. The fact that masculinity was so consistently related to self-concept of math ability in both boys and girls suggests that it is actually measuring a form of self-confidence or self esteem rather than sex-role typing. This conclusion, which is in line with recent suggestion of several other researchers in the field of androgyny, e.g., Locksley & Colton (1979), makes the use of the PAQ or other personality inventories as measures of sex-role identity suspect.

Further support for this 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 masculine 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. This finding, in conjunction with the correlational findings reported above, suggests that it is _only_ the responses to the "masculine" items that are related to self-concept. 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 psychological meaning of a high score on the masculine PAQ items needs reconceptualization.

Responses to the usefulness items yielded several interesting findings. First, while math was seen as more useful to men, the magnitude of this stereotype decreased over the two 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. The zero-order correlations within year (Year 1 with Year 1 and Year 2 with Year 2) are displayed in Tables 4-7. The correlations of Year 1 stereotypes with selected Year 2 student measures are summarized here.

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 ($\underline{r}$=.38), importance of doing well in math ($\underline{r}$=.44), and the utility of advanced math ($\underline{r}$=.38). 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 Year 2 data revealed some interesting changes in these relations.

What is striking about the results of Year 2 is that, for both boys and girls, the stereotyping of math as useful for <u>either</u> men or women yielded identical patterns of relations: the higher the rating of usefulness, the higher the students ratings of future expectancy, 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 was still influencing attitudes even if 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 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 the Year 2 variables.

This strange set of findings led us to question the validity of the responses of the Year 2 sample to our sex-stereotyped questions and left us with one major conclusion: stereotyping math as a masculine domain did not 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-typing 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-typing 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 by correlational and multivariate contingency table analyses. The zero-order correlation matrices for each year are presented in Tables 4-7. As predicted, in each year self-concept items were positively correlated with each other, with future expectancies and with intent to continue in math; they were negatively correlated with ratings of task difficulty. Self-concept items were also related positively to the value of math items and negatively to the cost of math participation items. Generally, these relations were true for both boys and girls.

To assess the origin of these attitudes we correlated the student attitudinal measures to teacher behavior, parents' attitudes and beliefs, and to a composite score reflecting both past math grades and performance on either the CAT or MAT (CHMAAPT). The analyses relating the student measures to the socializer measures will be 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.

Relational analyses: Path analyses. Path analyses were done separately for the Year 1 and Year 2 samples. These paths are depicted in Figures 2 and 3. Since the Year 2 sample included over 90% of the Year 1 students, and since the questionnaire had been improved based on Year 1 data, only the Year 2 data are discussed here. In addition, since 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 to emerge 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 2 represents a reduced path model for Year 1. For a more complete picture of relations, all paths significant at $p<.05$ were included. Figure 3, depicting Year 2 data, 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. These omitted paths paralleled the effects depicted in Figure 2.

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As predicted, intentions to continue taking math were most directly influenced by a student's concept of the value of math and his/her combined expectancies (current and future). These concepts, in turn, were related to the student's self-concept of math ability and his/her estimate of parents' and teachers' beliefs regarding his/her math ability. Past history of math grades and performance on math achievement tests did not have a direct effect on the student's plans, expectancies, self-concepts of math abilities or estimates of the difficulty of math. In addition, as predicted, stereotyping of math as a male domain increased the value of math. Among the 10th-12th graders seeking a career requiring math also increased math's value. To our knowledge, these data provide some of the strongest support available for a cognitive mediational model of achievement attitudes and course plans.

In summary, the proposed model provides an adequate explanation of these data. The variables included in the model explain 32-36% of the variance in intentions to take math. The path diagrams show graphically that intentions to continue in math are indeed affected by one's expectancies for success and one's assessment of the personal value of math. These, in turn, are mediated by one's perceptions of one's ability and task difficulty. This pattern suggests that to be effective, an intervention program designed to promote higher math participation should focus on heightening girls' expectancies for success in math achievement situations, promoting more realistic estimates of task difficulty, providing the girls with accurate information regarding the utility of math for their futures and working to increase the intrinsic interest value of math. Since 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 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 to our study is that teachers were found to treat girls for whom they have high expectancies in ways that were less facilitative of achievement than the way they treated comparable groups of boys.

Another mechanism that might explain girls' lower expectancies for success has been proposed by Dweck and her colleagues (Dweck, Davidson, Nelson, and Enna, 1978). Their model emphasized 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 argued 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, they suggested criticism cannot be discounted as easily by the girls. A similar though reversed pattern was proposed for praise. In addition, they suggested 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 made 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 directed 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 the 51 classroom variables listed in Table 8. Of the 51 variables, significant effects ($p < .01$) were found on only 3, each of which was a main effect due to sex. Girls received consistently less criticism than did boys.

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Insert Table 8
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Contrary to our predictions, 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. 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. 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 while 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 reanaylzed 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 reponses of both the teacher and the student, e.g., total dyadics). These differences are summarized in Tables 9 and 10. Clearly, these classroom types differed in the dynamics we observed (see Table 9). Teachers in high sex-differentiated classrooms were more critical were more likely to use a public teaching style and less likely to rely on more private dyadic interactions, and were more likely to rely on student volunteers for answers rather than directing the class participation by calling on specific children.

Insert Tables 9 & 10

Table 10 summarizes the effects of student sex on classroom interactions as a function of classroom type. Girls interacted more, received more praise and had higher expectancies in the low sex-differentiated classrooms. Boys, on the other hand, interacted more and received more praise in the high sex-differentiated classrooms but had equal expectancies in both classrooms.

These data suggest that teacher praise is facilitative of girls' expectancies for success in math. To test this hypothesis, we correlated teacher praise and the other teacher-style variables which discriminated the low from the high sex-differentiated classrooms with the following students' attitudinal variables: future expectancy, current expectancies, self-rated ability, interest in math, plans to go on in math, utility of advanced math, ratings of the difficulty of their present and future math courses and their stereotypes of the sex-linkage. The correlations are presented in Table 11. Few correlations were significant. As was true with the whole sample analyses, teacher's expectancies had the most significant effects. Variables discriminating the class types did not predict girls' expectancies, plans or estimates of their own abilities. Response opportunities and number of open questions did, however, relate positively and consistently to items tapping positive affective reactions to math in general and to this class in particular.

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Insert Table 11
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We next 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. The results of these analyses are summarized in Tables 12 and 13. In general we found that both "bright" males and "bright" females were treated differently in each of the two classroom types. "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 <u>least</u> amount of praise of <u>any</u> of the eight groups in the high sex-differentiated classrooms.

- - - - - - - - - - -
Insert Tables 12 & 13
- - - - - - - - - - -

Since "bright" girls were treated so differently in these two classroom types, we redid the correlational analyses outlined above for the samples of "bright" and less "bright" girls. The correlations are presented in Table 14. A few interesting relations emerged: amounts of both praise and work criticism were predictive of perceptions of current and future math difficulty. In addition, the total number of interactions was predictive of both perceptions of future difficulty and plans to continue taking math. Apparently "bright" girls who have a large number of teacher initiated interactions followed by evaluative feedback see math as easier, and "bright" girls who have a large number of teacher initiated interactions, regardless of the feedback, are more likely to plan to continue taking math. This pattern was not evident for girls considered less bright by their teachers.

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Insert Table 14
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In concluding, these additional points are important to stress: first, the frequency rates of all these interactive variables are quite low (see Table 13). Second, interactional variables are not as predictive of students' expectancies as are other variables we measured, e.g., students' sex and teachers' expectancies. Third, the effects 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, while 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. But, to the extent that teachers can be induced to cooperate, classroom effects should be modifiable.

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 which children come to imitate and later adopt as part of their own behavioral repertoire. If female models exhibit different behavior patterns than male models, then, it is argued, girls and boys will acquire sex-differentiated behavioral patterns. With regard to math expectancies in particular, it is hypothesized that girls exhibit more math avoidance and have lower math expectancies than boys because mothers are more likely than are 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 summarized in Table 15.

Insert Table 15

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. 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 performance higher than did fathers.

In line with the modeling hypothesis, one might conclude at this point that we had 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 past performance scale, as measured in Year 1. None of the more than 100 correlations were significant. Thus, while parents' self concepts do differ in the predicted direction, the influence of these differences on children's math self-concept is minimal.

An additional source of influence, however, might be parents' expressed sex-differentiated beliefs about either the math abilities of their children or the importance of math for their children. To assess this possibility, 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 data are summarized in Table 16.

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Insert Table 16
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The sex of the child had a definite effect on parents' perceptions of their child's math ability and on the parents' perceptions of the relative importance of various high school courses. While 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 since they don't believe math is that important for their daughters' futures. Similarly, as it is seen as relatively easier and more important for their sons than for their daughters, parents would 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 zero-order correlation for these analyses are presented in Tables 4-7. The children's plans, future expectancies, current expectancies and perceptions of the importance and value of math were related consistently 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. Parents' beliefs about their children's ability to do well in math were predictive of their children's course plans. Despite the greater sex-typing by fathers, however, their beliefs were not the stronger predictors of their children's self-concepts, expectancies or plans.

Socializers: General Findings.

As hypothesized, we found that parents' and teachers' beliefs are related to children's expectancies and plans. 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 recursive path analysis on the teacher, parent and child factor scale scores. These paths are displayed in Figures 4 - 6. Figure 4 depicts the analysis of the relations between Year 1 socializer scores and Year 1 student scores. Paths with a probability of less than .05 are depicted. Figures 5 & 6 depict the analyses of the relations between Year 1 socializer scores and Year 2 student scores. To provide greater clarity, only paths with a probability of less than .01 are depicted. Figure 6 includes only 10th-12th graders.

Insert Figures 4 - 6

In support of our predictions, expectancies and plans were related most directly to children's math self-concept and to their perceptions of their parents' and teachers' beliefs about their math aptitude and potential. Furthermore, the influences of socializers' attitudes on children's math self-concepts, expectancies and plans were mediated by the children's perceptions of these attitudes. Finally, while the zero-order correlations of children's math aptitude measure to the criterion measures were occasionally significant (see Tables 4 - 7), the path coefficients, when other cognitive mediators are partialled out, are not significant. Thus, children's cognitive constructs were more directly related to course plans and expectancies than either past objective measures of the children's performance or parents' actual attitudes. Any effect that these past objective measures might have had on the children's self-concept was mediated by their impact on the perceptions of teachers and parents, rather than by their direct effect on the children's estimate of their own ability. These results were characteristic of both analyses.

With regard to the differential effectiveness of various socializers, mothers appear to have the strongest influence on children's beliefs and attitudes; fathers had no significant independent effect over and above that which they shared with mothers. Teachers, especially last year's teachers, had less effect than either mothers or parents in general.

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 are 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.

Since parents' responses, especially mothers' were the most predictive of student attitudes, it would seem that intervening with the parents would have maximal 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, while the gain might be maximal, 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 which conveys the sense that math is a hard subject. Since their perceptions of the difficulty of math for their children are the most influential, mothers, especially, should be cautioned about the effects of communicating these beliefs to their children. 3) While 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 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.

Since parents do not have much influence as role models, 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. While admittedly not an easy task, 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, on the average, do not have a large impact on students' math attitudes. They are, however, a more convenient target group and there are ameliorative behvaiors available to them which 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. Girls' responses suggested that teachers had given them less encouragement to continue than they had given the boys. While 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. Providing teachers with information regarding the importance of each of these behavior clusters would be an inexpensive intervention. And, since 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.

An additional intervention strategy is suggested 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, since 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.

Longitudinal Analyses.

Our longitudinal analyses included a series of ANOVAS, comparing various sample groups, and a series of cross-lagged panel analyses. Each set of analyses is discussed in this section.

Analyses of Variance. In accordance with Schaie's General Developmental Model we computed a series of ANOVA analyses examining the effects of sex, time of measurement and birth cohort on students' attitudes. Included in these analyses are all students who took the questionnaire in both the first and second years of the data collection. The analyses are summarized in Table 17.

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Insert Table 17
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In these analyses time differences can be interpreted as the "true" longitudinal, cohort specific age changes occurring over the period of one year. However, when evaluating the relative impact of ontogenetic (age-related) versus historical change, you would expect cohort effects to dominate the outcome if indeed grade level is the crucial variable, since the seven cohort groups (1963, 1969) cover average grade level differences amounting to six years (5-6 vs. 6-6 vs. 7-6 vs. 8-6 vs. 9-6 vs. 10-6 vs. 11-6). Conversely, if historical or cultural change effects of the 1978-1979 period are more salient, one would expect time of measurement effects to dominate since time effects involve less confounded age variance (one year) (Nesselroade & Baltes, 1974).

Significant cohort effects were found for the majority of the student attitude scales with the exception of the effort and cost scales. These cohort effects represent the influence of grade on the various dependent measures. The general pattern of results indicates that students in higher grades had more negative attitudes toward mathematics than younger students. These results parallel the descriptive analyses reported earlier.

Time of measurement effects were less frequent than cohort effects. Time effects in these analyses may be thought of as developmental or longitudinal effects; that is, differences in responses attributable to the passage of one year. Scales reflecting the value of math to the student (utility, liking and cost) and perception of the amount of effort needed to do well showed significant effects for time. In each case, the students' attitudes dropped from 1978 to 1979. They liked their math teachers less, rated the utility of advanced math as lower, and rated the amount of effort required to do well in their current math course and its cost to them as lower. No significant effects of student sex were found in any of these analyses.

Cross-lagged Panel Analyses. Cross-lagged panel correlation 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. Having met the assumptions for the use of this technique, it was applied to our data.

Insert Figure 7

The results of these analyses are illustrated in Figure 7. In support of our predictions, future expectancy was causally influenced by self-concept ability and perceptions of task difficulty; self-concept of ability was causally influenced by perceptions of task difficulty and of the amount of effort needed to do well; both the utility and intrinsic value of math were causally influenced by perceptions of the worthwhileness of the effort needed to do well; and the estimates of the difficulty of future math courses was causally influenced by one's perceptions of the future difficulty estimates held by parents and teachers. Contrary to our predictions, however, perceptions of parents and teachers estimates of one's ability did not have a causal influence on students' self-concept or task variables. In support of the findings of Calsyn and Kenny (1977), we found instead, that self-concept variables and perceptions of task difficulty had a causal influence on students' perceptions of the attitudes of parents and teachers.

What then can we conclude? These analyses provide partial support for our model. As was the case with the path analytic results, we appear to understand the determinants of self-concept of ability and expectancies better than we understand the determinants of task value. This could, however, be a consequence of the measures we used in these analyses. Not all measures hypothesized to predict value were included in these analyses. For example, neither attributions nor math anxiety measures were included. Future analyses including these variables may provide additional support for our model.

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TABLE 1

GLOSSARY

Summary of Scales Used in Analyses

Description of Scale	Scale Label
<u>Student Scales</u>	
<u>Self-concept items</u>:	
-Math ability	ABIL, ABILITY
-Current expectancies	CUREX,CRNTEXP
-Performance in math	PERFORM,PERF
-Minimum standards for performance in math	MINSTAN
-Future expectancies for math	FUTEXP
-Combined (current and future) expectancies	COMBEX
<u>Task Relevant Items</u>	
-Difficulty of current math course	CURDIF,CRNTDIFF
-Required effort to do well in math	REQEF
-Actual effort	ACTEF
-Anticipated difficulty of future math	FUTDIF
-Combined (required and actual): effort	COMBEFF
<u>Value Items</u>:	
-Utility of advanced math	ADVUSE,UTIL.AD,FUT.UTIL
-Importance of math	IMPORT
-Interest in and liking for math	INTEREST
-Liking of teacher	LIKE.TCHR
-Cost of effort to do well in math	COST,COST.CUR,COST.ADV
-Utility of math	BAS.USE,BAS.UTIL
<u>Sex-Role Items</u>:	
-Femininity score from PAQ	FEM,PAQ FEM
-Masculinity score from PAQ	MASC,PAQ MASC
-Stereotyping of math utility for females	ST.USE.F
-Stereotyping of math utility for males	ST.USE.M
-Stereotyping of math ability	ST.ABIL,STABIL2
-Stereotyping of math as a male domain	MATH.MAL

TABLE 1 (cont'd.)

Description of Scale	Scale Label
<u>Perceptions of related socializers scales</u>	
-Perceived math ability	PERABIL, PERCABIL
-Perceived expectancies for math	PAREXP, PERCEXP
-Perceived importance of math to parents	IMPFORPA, PAR.IMPT
-Encouragement to continue in math	ENCRG
-Perceived difficulty of current and future math	PARDIFF
-Perceptions of mother's of math	MPARUSE
<u>Parent Scales</u>	
-Parent's perception of the importance of math for child	PARIMPCH
-Parent's perception of child's ability	PARABCH
-Parent's perception of child's effort needed to do well	PAREFFCH
-Parent's future expectancy for child	PAREXCH
-Parent's perception of task difficulty for the child	PARTDCH
<u>Teacher Scales</u>	
-Teacher's perception of child's ability	TEACHABCH
-Teacher's future expectancy for child	TEACHEXCH
-Teacher's concept of child's ability (Sum: above 2)	TABCH
<u>Other Variables</u>	
-Student's intention to take more math	INTENT
-Student's Sex	SEX
-Student's math aptitude score (Comprised of student's previous math grade and most recent CAT or MAT score)	CHMAAPT
-Student's attributions for failure in math	FAILURE
-Student's attributions for success in math	SUCCESS
-Student's career plans	CAREER
-Student's perception of the amount of math necessary for his/her career plans	MATH.NEC

TABLE 1 (cont'd)

Factor Scales		Scale Composition
Description of Scale	Label	
<u>Student's Perception for Self</u>		
-Self-concept of math ability	CABCN	ABIL,PERF,CUREX,CURDIF,FUTEXP
-Self-concept of math value	CVALCN	IMPORT, BAS.USE INTEREST,UTIL.ADV,COST.ADV
-Perception of task difficulty for self	CTSKCN	REQEF, ACTEF, CRDIF
<u>Student's perceptions of socializer's attitude</u>		
-Student perception of socializers perception of task difficulty	PERDIF	PARDIFF, TEACHDIFF
-Student perception of socializers perception of math ability	PERABCN	PARABL,PAREXP,TEACHEXP
-Student perception of parental encouragement	PERENCRG	ENCRG
<u>Parent Factor Scales</u>		
-Perceived importance of math	BPARIMP	PARIMPCH (Mother and Father combined)
-Father's perception of task difficulty	FATHTD	PAREFFPA,PARTDPA
-Mother's perception of task difficulty	MOTHTD	PARABCH, PAREFTCH, PARTDCH
-Perceived math ability of child	BPARABCN	PARABCH, PARFEXCH, (mother and father combined)

TABLE 3

SUMMARY OF SIGNIFICANT RESULTS FROM ANALYSES OF VARIANCE: YEARS 1 AND 2

Variables yielding significant sex effects	Effect	F
Year 1		
COMBEFT	F>M	.01
ST.USE.F	M>F	.01
MATH.MAL	F>M	.05
FEM	F>M	.0001
MASC	M>F	.0001
CABCN	M>F	.05
CTSKCN	F>M	.05
EPARIMP	M>F	.01
FATHTD	F>M	.01
MOTHTD	F>M	.01
FUTEXP	M>F	.01
CRNTDIFF	F>M	.01
FUTDIFF	F>M	.01
Year 2		
ABILITY	M>F	.01
COMBEFT	F>M	.01
UTIL.ADV	M>F	.001
ST.USE.F	F>M	.05
ST.ABIL	F>M	.05
FEM	F>M	.0001
MASC	M>F	.0001
CABCN	M>F	.05
UTIL	M>F	.01
FUTEXP	F<M	.01
CURNTEXP	F<M	.04

TABLE 3 (cont'd.)

Variables yielding significant grade effects	Effect	F
Year 1		
ST.USE.M	CURV. U[1]	.01
ST.ABIL	CURV. U	.05
CHMAAPT	O>Y[2]	.01
CABCN	Y>O[3]	.001
CTSKCN	O>Y	.0001
CVALCN	CURV. U	.01
PERDIFCR	O>Y	.01
PERABCN	Y>O	.0001
TABCH	Y>O	.0001
MOTHTD	O>Y	.05
IMPORT	5th>O	.01
CRNTEXP	Y>O	.01
ABIL	Y>O	.01
CURDIF	O>Y	.001
UTIL.AV	Y>O	.001
INTEREST	Y>O	.01
LIKETCHR	Y>O	.01
PERF	Y>O	.01
PERCEXP	Y>O	.01
Year 2		
ST.USE.F	Y>O	.0001
ST.USE.M	Y>O	.0001
ST.ABIL	Y>O	.001
MASC	CURV. U	.0001
CABCN	Y>O	.0001
PERDIFCR	O>Y	.0001
PERABCN	Y>O	.0001
CUREX	Y>O	.001
ABILITY	Y>O	.01
CRNTDIF	O>Y	.001
UTIL.ADV	Y>O	.001
INTEREST	Y>O	.01
LIKETCHR	Y>O	.0001
PERF	Y>O	.0001
FUTDIF	O>Y	.0001
PERCEXP	Y>O	.0001

1 CURV. U=curvilinear relationship with age, decreasing and then increasing

2 O>Y=linear trend increasing with age

3 Y>O=linear trend decreasing with age

TABLE 4

Intercorrelation Matrix of Course Plans and Its Predictors

	Course Plans	Sex	Grade Level	Past Grades	Parent Expectancy	Parent Difficulty	Parent Ability	Future Difficulty	Current Difficulty	Perceived Ability	Current Expectancy	Future Expectancy
Course Plans	1.00											
Sex (1-Female, 2-Male)	.05	1.00										
Grade Level (7,9)	.34	.00	1.00									
Past Grades	-.00	-.07	-.29	1.00								
Parent Expectancy	.29	-.02	-.03	.10	1.00							
Parent Difficulty	-.22	-.07	.02	-.17	-.28	1.00						
Parent Ability	.35	.11	.06	.21	.52	-.41	1.00					
Future Difficulty	-.16	-.17	.19	-.10	-.22	.31	-.21	1.00				
Current Difficulty	-.28	-.17	.10	-.20	-.30	.49	-.51	.58	1.00			
Perceived Ability	.37	.11	.07	.24	.44	-.41	.72	-.37	-.69	1.00		
Current Expectancy	.37	.08	-.08	.22	.48	-.35	.63	-.34	-.60	.80	1.00	
Future Expectancy	.52	.17	.01	.14	.54	-.32	.57	-.38	-.52	.67	.62	1.00

APPENDICES

APPENDIX A

INSTRUMENTATION

Instrumentation

Student Questionnaire: Year 1.

The student questionnaire, composed of several different measures, was designed to assess those variables suggested as predictors of students' behaviors by the expectancy/value theory. The measures currently employed in the project have been developed in several steps summarized below.

Bipolar rating scales anchored at the extremes with short verbal descriptors, e.g.:

How much do you like math?

Not at all						Very much
1	2	3	4	5	6	7

were selected for the following reasons. First, it was necessary to employ a rating method appropriate for the entire age range of subjects (5th-12th grade). Changes in the wording of the items from grade to grade could have resulted in increased measurement error. For example, the fifth graders could have understood an item differently than tenth graders, resulting in spurious developmental findings. This format, a visualized rating scale, is easily understood, even by the youngest subjects. Secondly, since response alternatives are not written out, as in the traditional Likert scale, the amount of reading by the subjects was minimized thus reducing time involved in questionnaire administration. Thirdly, the psychometric properties of the interval scales derived from these data are superior to ordinal or categorical/nominal responses for data-analytic purposes.

With these practical and theoretical considerations in mind, items assessing a number of constructs were written. Whenever possible, these were framed as nine point bipolar scales. Items thus generated were piloted on school children in a nearby area, comparable in most respects to the intended sampling area.

The questionnaire was revised in light of results from the pilot sample. The pilot sample was instructed to mark items that were difficult to understand and to alert questionnaire administrators to problems or questions concerning any questionnaire items. Because students indicated difficulty in making such fine discriminations, the nine point scale was reduced to a seven point scale. Students' comments also enabled us to eliminate or reword items which were difficult to understand. Standard instructions were developed for questionnaire administration.

The revised questionnaire was distributed to students in the Ann Arbor school system in spring 1978. The following scales were incorporated into the questionnaire:

a) Perceived difficulty of math: absolute and comparative ratings of current and advanced mathematics courses

b) Expectancies: ratings of students' expected performance in current and advanced mathematics courses

c) Incentive value of mathematics: ratings of attractiveness of math courses and positive and negative outcomes in math

d) Utility: ratings of the perceived usefulness of current and advanced mathematics courses for self

e) Sex-typing of the utility of math: ratings of the perceived usefulness of current and advanced mathematics courses for men and women

f) Perceived effort: ratings of the effort perceived to be necessary to do well in math

g) Cost of effort: ratings of the degree to which effort expended in math has negative consequences

h) Encouragement: ratings of the degree to which parents and teachers have encouraged the student to continue taking advanced math

i) Ability: ratings of ability in current and advanced mathematics

The following constructs were not measured with a seven-point rating scale: plans, attributions, sex-role identity, sex-stereotyping of math. Students indicated their plans for taking mathematics courses from a number of prepared response alternatives. Measures of attributions for success and failure situations employed a forced ranking procedure. Students ranked a set of eight statements in terms of their typicality as explanations for success and failure outcomes on math tests. In addition, open-ended questions elicited responses about students' attributions for success and failure outcomes on math tests.

The model we are testing presumes that sex-role values are important influences on behavior. To measure sex-role values, we employed one original and one standardized test. The original measure of sex-role values derives sex-role scores for each subject as a function of differences among scales. Students rated both the importance of twelve sex-typed behaviors for boys and girls, and rated the frequency with which they engage in those activities. Values are scored as the difference between perception of self and perceived appropriateness of the same behavior for each sex. The standardized test is the Personality Attributes Questionnaire (PAQ) (Spence, Helmreich, and Stapp, 1974). The PAQ incorporates eighteen semantic-differential-type items. This scale was shortened and slightly modified for use with 5th through 8th graders.

Student Questionnaire: Year 2.

The slightly modified version of the student questionnaire was administered to students in the Ann Arbor sample in Year 2. The final version was arrived at by 1) examination of the results from year one, and 2) interviews with non math-taking and math-taking high school students. Items with extremely low variance in the previous year's data were eliminated since they do not contribute to behavioral prediction. Open-ended questions with low variability were also eliminated.

In addition, sections of the questionnaire were expanded. Important influences on students' decisions to take math had been elicited in interviews with high school students. Based on these interviews, a rating scale was developed asking students to rate the influence of a number of persons on these decisions. Questions asking students to rate and rank a list of reasons describing why they are currently taking math, and questions about tracking experiences, were added.

Theoretical and conceptual issues received special attention when the questionnaire was refined/revised in Fall/Winter 1978. Most important was the issue of reliability of scales formed from the individual items. Scales were formed by taking the mean value of several items all presumably measuring the same construct, e.g., self-concept of ability. The alpha coefficient is a measure of test reliability which represents the expected correlation of a test with an alternative test the same items in length. Based on the reliability figures, scales were revised. Scales were constructed so that redundant items, as well as those items correlating lower than .25, were dropped from the scales. Reliability values were examined as each revision was accomplished. Scale revision was successful, in that the majority of scales had values of approximately .80 with a range of coefficient α from -.2943 to .83. Scales with less than .60 will not be used in data analysis. These scales are summarized in Table A. These scales were factor analyzed. The factor scales and their factor loadings are presented in Table B. A final form of the student questionnaire may be found in Appendix E.

Parent Questionnaire

A questionnaire was employed to assess parent attitudes and expectancies. This instrument was designed for the acquisition of three categories of information: 1) the parents' self-reported experiences in math and attitudes regarding mathematics 2) parents' beliefs about their child's attitudes toward math, and 3) parents' beliefs about their children's math abilities and their child's math experiences. Information about several aspects of each category was sought. Parent scales were constructed in a manner similar to that used in constructing student scales. The scales reflected the categories discussed in each of the next three paragraphs. The scales used in final analyses are presented in Table C. These scales were factor analyzed. The factor scales and their factor loadins are presented in Table B. A copy of the parent questionnaire is included in Appendix E.

Referring first to parental attitudes about mathematics, parents were asked to reflect back upon their experiences in high school and to report on their experiences and cognitions at that time. Given the inaccuracies often associated with retrospection, this information was intended not so much to inform us about past conditions as to inform us how these parents currently view their past high school experiences with mathematics. Current parental attitudes were then assessed. Similar items and scales were used to measure both the "retrospective" and current attitudes. Several items were constructed which parallel items on the student questionnaire. Thus parents were asked about: a) utility of math (e.g. How useful is the math you learned in high school for you or your job?) b) importance or incentive value of math (e.g. How enjoyable was high school math? How important was it to you to get good grades in high school math?) c) ability (e.g. How good were you in advanced high school math?) d) effort (e.g. How hard did you have to try to do well in high school math?) e) difficulty of math (e.g. Compared to other subjects that you took in high school, how difficult was mathematics?). In addition, parents were asked to report the number of math courses they had taken in high school and college, their level of education, and their occupation.

Referring next to parental perceptions of their children's math attitudes, parents were asked to report what they thought were their children's attitudes about math and about themselves as math learners. Items in this section were developed to parallel the items and scales in the student questionnaire. In particular, the parents' perceptions of the following children's responses were assessed: a) incentive value of math for the child, b) importance to the child of receiving good grades, c) child's self-concept of math ability, d) child's perceptions of the difficulty of math, e) child's perceptions of the effort required to do well in math.

A final section of the parent questionnaire inquired about parental attitudes toward the child's ability and math education. Parental expectancies for their child's performance in math were elicited. Additionally, parents rated their own and the math teacher's influence on the child's attitudes, indicated their minimal level of aspiration for their child, rated the utility of the math the child had acquired in school and rated their child's ability and the reasons the parents feel are responsible for their child's performance. Finally, three items assessed parental sex-typing of the domain of mathematics.

Teacher Questionnaire

Teachers were asked to complete two questionnaires, one asking for their opinions of mathematics, and another rating each participating student in their math class on a six question scale.

The first questionnaire is labeled "Teacher's Math Survey". It consists of four open-ended questions which ask the teachers to give their opinions regarding: why boys outnumber girls in high school math classes; which factors are most important in determining boys' and girls' attitudes toward math; and reasons for poor performance in math by some students. Finally, they are asked to rate, on a seven point scale, how much they enjoy teaching mathematics. On the second questionnaire, for each student, teachers were asked to rate: how well she/he expects this student to do in advanced high school math course, how well the student is doing this year, how hard the student is trying, how much ability the teacher perceives the student has, and how well the student is doing in math compared to how well he/she could do. If a teacher indicated that a student was not performing to the best of his or her ability, the teacher was asked to explain why this might be happening.

Teachers were given these questionnaires to complete at the time of administration of the student questionnaires. All teachers agreed to complete these forms therefore these data are complete for all participating students in grades five through eleven.

Observational Procedure

The observational system used in this study is a modified version of two other systems: Brophy and Good's Teacher-Child dyadic interaction system and Dweck et. al's observational procedure used to code evaluative feedback. Appropriate modifications were made following pilot observations in a variety of classrooms. Important considerations in modifying these existing observational systems were their relevance to the research goals of this project and their administrative ease. Care was taken to include recording of behaviors assumed to be related to teachers' expectancies and teachers' attributions for students' performances.

The observational system focused on dyadic interactions between teachers and individual students; thus, only occasions in which the teacher was interacting with a single student were recorded. The recording of each interaction included the following: who initiated the interaction, the context of the interaction, student response to teacher, and teacher feedback to student. In addition, the setting in which the interaction took place was coded, i.e., whether the interaction was public and monitored by the class or a private interaction between student and teacher. Special effort was made to pick up two types of teacher statements we felt critical for our study: explicit statements made by teachers to a student regarding how well the student can or should do on an assignment or test (expectancy statements), and explicit statements regarding the teacher's assessment of which factors explained the quality of the student's work (attributional statements). We recorded these statements verbatim. Table D summarizes our coding system. The coding manual, which gives a detailed explanation of the system, and a copy of a coding sheet, is included in Appendix E.

Observers completed a three week training program before observing began in the sample classrooms. Training included discussing the manual, coding written transcripts and videotapes of classroom interactions and coding in classrooms not included in the sample. In the training classrooms, observers independently coded four one hour sessions with a criterion coder. Only after obtaining a .75 agreement did the observer begin to collect data in the sample classrooms. Because much of the data involved sequential coding, teacher-student interactions were scored as agreements only if the entire sequence was coded identically. For example, during response opportunities, both coders had to agree on type of question, level of question, student response, and teacher feedback for the interaction to be counted as an agreement. The percentages of agreement for each observer are shown in Table E. The mean percentages of agreement ranged from 75% to 86% for the five observers.

The observer spent at least three sessions in the classroom before beginning to collect data. These sessions were used by observers to acquaint themselves with the students so that interactions could be assigned reliably to the student involved. These sessions also helped in making the students and teachers feel comfortable with the observer's presence. After these practice sessions, ten classroom sessions were observed. These sessions were sequential when possible. Data were not collected on days with atypical events, e.g., films, tests or teacher absence.

In Fall 1978, teachers were offered a profile of their classrooms. The frequency and proportion of differing types of interactions in their classroom were compared to that observed in classrooms of the same and different grade levels. See Appendix F for a copy of the text and tables given to teachers. These reports were presented to the teachers individually so that questions could be answered immediately.

TABLE A

MATHEMATICS ATTITUDE SCALES INCLUDED IN THE STUDENT QUESTIONNAIRE

Future Expectancies for Math:FUTEXP

How successful do you think you'd be in a career which required mathematical ability? (not very successful/very successful) (V=18)

How well do you think you'll do in your mathematics course next year? (not at all well/very well) (V=182)

How well do you think you'll do in advanced high school mathematics courses (like Algebra II, Trigonometry, or Calculus)? (not at all well/very well) (V=186)

How well would you expect to do in Trigonometry and Pre-Calculus? (not at all well/very well) (V=232)

How well would you expect to do in this course (Calculus)? (not at all well/very well) (V=234)

How well do you think you'll do in your mathematics course next year? (not at all well/very well) (V=273)

How well do you think you would do in your mathematics course next year? (not at all well/very well) (V=292)

alpha=.7899

Current Expectancies for Math:CUR, CRNTEXP

Compared to other students in your class, how well do you expect to do in mathematics this year? (much worse than other students/much better than other students) (V=17)

How well do you expect to do on your next math test? (not at all well/very well) (V=60)

How well do you think you will do in your math course this year? (very poorly/very well)

alpha=.8341

TABLE A (cont'd.)

Math Ability:ABIL, ABILITY

How good at math are you? (not at all good/very good) (V=12)

If you were to order all the students in your math class from the worst to the best in math, where would you put yourself? (the worst/the best) (V=26)

In comparison to most of your other academic subjects, how good are you at math? (much worse/much better) (V=48)

alpha=.7974

Perceived Math Ability:PERABIL, PERCABIL

How good at math does your mother think you are? (not at all good/ very good) (V=23)

How good at math does your father think you are? (not at all good/ very good) (V=32)

How good at math does your teacher think you are? (not at all good/very good) (V=29)

alpha=.8164

Difficulty of Current Math:CURDIFF, CRNTDIF

In general, how hard is math for you? (very easy/very hard) (V=14)

Compared to most other students in your class, how hard is math for you? (much easier/much harder) (V=28)

Compared to most other school subjects that you have taken or are taking, how hard is math for you? (my easiest course/my hardest course) (V=38)

alpha=.8118

TABLE A (cont'd)

Perceived Difficulty of Current Math:PERDIF

How hard does your mother think math is for you? (very easy/very hard) (V=53)

How had does your father think math is for you? (very easy/very hard) (V=56)

How hard does your teacher think math is for you? (very easy/very hard) (V=59)

alpha=.7370

Effort:COMBEFF

How hard do you have to try to get good grades in math? (a little/ a lot) (V=13)

How hard do you have to study for math tests to get a good grade? (a little/a lot) (V=45)

To do well in math I have to work. . . (Check one)
1) much harder in math than in other subjects.
2) somewhat harder in math than in other subjects.
3) a little harder in math than in other subjects.
4) the same as in other subjects.
5) a little harder in other subjects than in math.
6) somewhat harder in other subjects than in math.
7) much harder in other subjects than in math. (V=49) hard) (V=67)

How much time do you spend on math homework? Check one.
a) an hour or more a day

b) 30 minutes a day
c) 15-30 minutes a day
d) about 1 hour a week
e) about 30 minutes a week
f) about 30 minutes every two weeks
g) I rarely do any math homework.

How hard do you try in math? (a little/a lot) (V=27)

Compared to most other students you know, how much time do you have to spend working on your math assignments? (much less time than other students/a lot more time than other students) (V=37)

alpha=.7595

TABLE A (cont'd.)

Utility of Basic Math:BAS.USE, BAS.UTIL(Year 1)*

How useful is learning basic math (like adding and dividing) for what you want to do after you graduate and go to work? (not at all useful/very useful)

How useful do you think the things you have learned in basic math are for your other school courses? (not very useful/very useful)

alpha = .6137 *Included in Year 1 only

Utility of Advanced Math:ADVUSE, UTIL.AV, FUT.UTIL

How useful is what you would learn in high school math (like Algebra II, Trigonometry, or Calculus) for what you want to do when you finish school and go to work? (Not very important/very important) (V=19)

How useful is what you would learn in advanced high school math (like Algebra II, Trigonometry, or Calculus) for your daily life outside of school? (not at all useful/very useful) (V=30) (V=271)

alpha=.7522

Importance of Math:IMPORT

I feel that, to me, being good at solving problems which involve math or reasoning mathematically is: (not at all important/very important) (V=33)

How important is it to you to get good grades in math? (not at all important/very important) (V=46)

How upset would you be if you got a low mark in math? (not at all upset/very upset) (V=50)

alpha=.7353

Interest in Math:INTEREST

In general, I find working on math assignments (very boring/very interesting) (V=11)

In general, I find working on math games ...(boring/interesting)

How much do you like doing math? (not very much/very much) (V=41)

alpha=.8004

TABLE A (cont'd.)

Liking for Math Teacher:LIKE.TCHR

How much do you like your math teacher? (not very much/very much) (V=61)

alpha unavailable

Perceived Importance of Math to Parent:IMPFORPA

How upset do you think your mother would be if you got a low mark in math? (not very much/very much) (V=25)

How upset do you think your father would be if you got a low mark in math? (not very much/very much) (V=34)

alpha=.7763

Performance in Math:PERF, PERFORM

In math, most of the time, how well do you do in each of the following things?

a) when the teacher calls on you for an answer in class (very poorly/very well) (V=42)
b) when taking a test I have studied for (very poorly/very well) (V=43)
c) when doing math homework problems (very poorly/very well) (V=44)

How have you been doing in math this year? (very poorly/very well) (V=64)

alpha=.7614

Minimum Standards For Performance in Math:MINSTAN (Year 2)*

What is the lowest grade or evaluation mark you would be satisfied with in your present math course? (V=15)

alpha is unavailable

*Included in Year 2 only

TABLE A (Cont'd.)

Anticipated Difficulty of Future Math:FUTDIF

How difficult do you think next year's math will be for you? (much easier than this year/much harder than this year) (V=183) (NOTE: V183 used in scale only for 9th graders)

How hard do you think advanced high school math will be for you? (very easy/very hard) (V=187)

Compared to most other school subjects you may take in high school, how hard do you think advanced high school math will be for you? (my easiest course/my most difficult course) (V=188)

If you took Trigonometry and Pre-Calculus, how hard do you think it would be for you? (not at all hard/very hard) (V=231)

If you took Calculus, how hard do you think it would be for you? (not at all hard/very hard) (V=233)

alpha=.7732

Perceived Expectancies for Math:PERCEXP, PAREXP

How well do you think your father expects you to do in math this year? (not very well/very well) (V=57)

How well do you think your mother expects you to do in math this year? (not very well/very well) (V=69)

How well do you think your teacher expects you to do in math this year? (not very well/very well) (V=54)

alpha=.8672

Cost of Effort To Do Well in Math:COST*

Is the amount of effort it will take to do well in your math course this year worthwhile to you? (not very worthwhile/very worthwhile) (V=52)

Is the amount of effort it would take to do well in advanced high school math courses (like Algebra II, Trigonometry, or Calculus) worthwhile to you? (not very worthwhile/very worthwhile) (V=66)

How much does the amount of time you spend on math keep you from doing other things you would like to do? (takes away no time/takes away alot of time) *V(52) included in Year 2 only

alpha=.719

TABLE A (cont'd.)

Parent Encouragement to Continue in Math:ENCRG

Rate on a scale of 1 to 7 how much each of the following people have encouraged or discouraged you:

Mother (strongly discouraged me/strongly encouraged me) (V=221)
Father (strongly discouraged me/strongly encouraged me) (V=222)

alpha=.7091

Plans for Future Math Courses:INTENT (Year 1)

Would you take more math if you didn't have to? (Check one)
a) I very definitely would take more math
b) I probably would take more math
c) maybe I would take more math
d) I'm not sure
e) maybe, but not that likely
f) I probably would not take any more math
g) I very definitely would not take any more math (V=543)
How much more math would you take? (V=739)

Do you plan to take any math courses in high school? Yes_____ No_____ how many?
a) Three years of math
b) Two years of math
c) One year of math
d) None
Which math courses do you plan to take?

TABLE A (cont'd.)

<u>Plans and Future Choices in Math</u>:INTENT (Year 2)

Would you take more math <u>if you didn't have to</u>: (Check one)
1) I very definitely would take more math
2) I probably would take more math
3) maybe I would take more math
4) I'm not sure
5) maybe, but not that likely
6) I probably would not take any more math
7) I very definitely would not take any more math (V=184)

How much more math would you take if you did <u>not</u> have to?
1) I would not take any more math
2) I would take one or two years of junior high school math
3) I would take math through ninth grade
4) I would take math through ninth grade, plus one more year of high school math
5) I would take math through ninth grade, plus two more years of high school math
6) I would take math all the way through high school (V=185)

What math courses, if any, do you plan to take in the 11th grade? (Please be as specific as you can, for example, Trigonometry and Pre-Calculus, Calculus, etc.)
a) first semester (V=275)
b) second semester (V=276)
c) I do not plan to take math in the 11th grade (V=277)

What math courses, if any, do you plan to take in the 12th grade?
a) first semester (V=278)
b) second semester (V=279)
c) I do not plan to take math in the 12th grade (V=280)

TABLE A (cont'd.)

Parents' Use of Math:MPARUSE*

How much does your mother use math? (not very much/very much)

Sex Stereotyping of the Utility of Math for Women:ST.USE.F

How useful do you think women find basic math in their jobs? (not at all useful/very useful)

How useful do you think that women find advanced high school math in their jobs? (not at all useful/very useful)

How useful do you think women find basic math (like adding and dividing) in their everyday activities? (not at all useful/very useful)

alpha = .742

Sex Stereotyping of the Utility of Math for Men:ST.USE.M

How useful do you think men find basic math (like adding and dividing) in their jobs? (not at all useful/very useful)

How useful do you think men find basic math in their everyday activities? (not at all useful/very useful)

How useful do you think men find advanced high school math (like Advanced Algebra and Calculus) in their jobs? (not at all useful/very useful)

alpha = .6850

Sex Stereotyping of Math Ability:ST.ABIL,ST.ABIL2*

In general, I think boys are...

a) much better than girls at math, b)somewhat better than girls at math, c) a little better than girls at math, d) the same as girls at math, e) a little worse than girls at math, f) somewhat worse than girls at math, g) much worse than girls at math. Why?______

* Alpha coefficient not available for single item scales.

TABLE A (cont'd.)

Math Aptitude and Past History:CHMAAPT

Average of standardized scores on most recent MAT, CAT, and past math grades plus the constant 4.

Math as a Male Domain:MATH.MAL

ST.USE.M minus ST.USE.F scales

Sex Role Identity

Personality attribute questionnaire.

1. Scored as Neutral (Low masculine, Low feminine)
   Masculine (High masculine, Low feminine)
   Feminine (Low masculine, High feminine)
   Androgynous (High masculine, High feminine)

2. Scored as Masculine (MASC)
   Feminine (FEM).

Career Plans

In this section we would like to ask you some questions about your future plans. Please indicate which of the following you plan to do after you graduate from high school.

1.---Continue your education (college, vocational training, etc.). Please indicate what you plan to study in college or the type of vocational training you are interested in. -----

2.---Look for a job. Please indicate the type of job you are interested in.

3.---Other plans (please describe).

Attributions

People use different reasons to explain why they have done things well or poorly. Think of the last math test you did not do so well on (one you did poorly on). Why do you think you did so poorly? ---

People use different reasons to explain why they have done things well or poorly. Think of the last math test you did well on. Why do you think you did so well? ---

TABLE B

FACTOR SCALES

Student Attitudes

Self concept of math ability		Concept of math value		Perception of task difficulty	
Scale	Factor score	Scale	Factor score	Scale	Factor score
Ability	.84	Importance	.53	Required effort	.81
Performance	.80	Basic utility	.56	Actual effort	.63
Current expectancies	.91	Interest	.42	Current difficulty	.57
Current difficulty	.60	Util.adv	.88		
Future expectancy	.70	Cost.adv	.73		

TABLE B (cont'd)

Perceptions of Related Socializers

Socializers' perception of task difficulty		Socializers' perception of math ability		Parental encouragement	
Scale	Factor score	Scale	Factor score	Scale	Factor score
Parents' perception of current/future math difficulty	.67	Parents' perception of math ability	.80	Father encouragement	.60
Teacher's perception of current/future math difficulty	1.4	Parents' expectancies	.76	Mother encouragement	1.0
		Teacher's expectancies	.64		

Factor loadings not standardized

TABLE B (cont'd)

Parent's Attitudes

Perceived importance of math for child		Father's perception of task difficulty		Mother's perception of task difficulty		Perceived math ability of child	
Scale	Factor score	Scale	Factor score	Scale	Factor score	Scale	Factor score
PARIMPCH (Mother)	1.7	PAREFFCH	1.4	PAREFFCH	2.4	PARABCH (Mother)	1.0
PARIMPCH (Father)	.51	PARTDCH	2.3	PARTDCH	2.4	PAREXCH (Mother)	1.6
						PARABCH (Father)	1.5
						PAREXCH (Father)	2.3

Factor loadings not standardized.

TABLE D

OVERVIEW OF OBSERVATIONAL SYSTEM

I. Response Opportunities: Situation in which teacher publicly questions students in class
  - A. Type of Question
    - 1.) Discipline -- teacher calls on student to redirect student's attention
    - 2.) Direct -- teacher calls on student who has not volunteered
    - 3.) Open -- teacher calls on student who has raised his/her hand
    - 4.) Call-out -- student calls out the answer without permission
  - B. Level of Question
    - 1.) Response -- questions that have a right or wrong answer
    - 2.) Self-reference -- questions that ask for opinion or prediction
  - C. Type of Student Response
    - 1.) Answer
    - 2.) Don't know
    - 3.) No response at all
  - D. Teacher's Feedback
    - 1.) Praise or criticism directed to quality of the work
    - 2.) Praise or criticism directed to the form of the work
    - 3.) Praise or criticism directed to conduct
    - 4.) Affirm
    - 5.) Negate
    - 6.) No feedback
    - 7.) Give answer
    - 8.) Ask other -- calls on another student to answer the question
    - 9.) Sustaining feedback -- gives the student another opportunity to answer the question
    - 10.) Attributions to ability, effort and task difficulty

II. Student-Initiated Questions
  - A. Type of Questions
    - 1.) Content
    - 2.) Procedural
  - B. Teacher's Feedback

III. Dyadic Interactions: Situations in which teacher interacts privately with student
  - A. Initiation of interaction
    - 1.) Teacher
    - 2.) Student
  - B. Feedback

APPENDIX B

SAMPLE

SAMPLE

School Selection

The study was conducted in Ann Arbor, Michigan. The schools selected within this community have predominantly white middle class populations. Students were sampled from one of the two high schools in the community. Elementary and junior high schools were then chosen from schools which feed into this high school. The sample included three elementary schools, five junior high schools and one high school.

Subject Selection

Year 1. The Year 1 sample consisted of students from grade levels 5th to 11th inclusive. The sample was drawn using the mathematics classroom as an intermediate sampling unit. Classrooms at each grade level were chosen randomly from among the classrooms whose teachers volunteered to participate in this study. Within each classroom all students were asked to participate. However, only students who returned a signed letter of permission from a parent could participate in the study. A larger number of 7th and 9th grade classes than other grade classes were chosen since past research has indicated that these might be critical times for student attitude change.

Table A summarizes the number of classrooms sampled at each grade level and the participation rates within schools, grades and classes. The total sample included approximately the same number of boys and girls; girls making up 53% of the sample (see Table B).

The parent sample included the mothers and fathers of the student subjects in the Year 1 sample. Both parents of 62% of the participating students completed the questionnaire (see Table C). For another 18% of the subjects, a questionnaire was received from only one parent. Only one parent completing a questionnaire may reflect the existence of either a single parent family or the cooperation of only one of two parents. Since we did not have access to information on family make-up, we cannot distinguish between these two cases.

The teacher sample included all teachers in the selected classrooms. A subset of these classrooms was observed. All teachers completed the questionnaire.

At the beginning of the second year of this study (Fall 1978) students and their parents were administered a questionnaire similar to the one they had completed in the first year. Each student's current mathematics teacher was asked to complete a rating scale. Table D shows the number of students in each grade level who completed questionnaires in both years of the study. Ninety-four percent of the students were relocated in the second year and completed the questionnaire. In contrast, as is shown in Table E, the return rate of parent questionnaires in the second year was low (45%). Thus, a longitudinal analysis of the parent data was not completed.

Control. The control sample consisted of a sample of students from grade levels 5th to 12th inclusive. The sample was drawn during the second year from the same schools and one additional high school. In grades five through nine, mathematics classrooms served as the intermediate sampling unit. Classrooms at each grade level were randomly chosen from the sample schools and from among the classrooms whose teachers volunteered to participate in the study. Some of these teachers had participated in the project in the first year. All students, within each classroom, were asked to participate. Students who returned a signed letter of permission from a parent participated in the study. Table F lists numbers of students by school, grade and class. In grades ten through twelve students were chosen directly from student lists. Only students who were enrolled in college preparatory mathematics classes were chosen for the high school math sample, i.e., 10th graders who were enrolled in geometry or accelerated geometry, 11th graders who were enrolled in second year algebra, pre-calculus or advanced placement pre-calculus and 12th graders who were enrolled in math analysis or calculus.

Control sample data were first compared to Year 2 data of the original sample to assess test-retest effects. No significant effects were found. Therefore, these two data sets were combined for purposes of all analyses, except the longitudinal analyses.

The parent sample included the mother and father of all control student subjects. Both parents of 59% of the students in this sample completed questionnaires; 13% of the students had data from one parent only (see Table G). Data were also gathered from the mathematics teachers of all students in grades five through nine. High school teachers were not asked to participate since students were not sampled by class.

TABLE A

PARTICIPATION RATE[1] OF YEAR 1 SAMPLE WITHIN SCHOOLS, GRADES, AND TEACHERS

School	Teacher	Grade 5	6	7	8	9	10	11	
A	1[2]	27% (7)							27% (7)
B	1[2]	59% (17)							59% (17)
C	1[2]		80% (20)						80% (20)
D	1[2]			59% (13)					
D	2[2]			59% (11)					
D	3[2,3]				100% (1)	97% (29)			
D	4[2]					64% (17)			
D	Total								79% (72)
E	1[2]			55% (16)					55% (16)
F	1[2]			53% (16)					
F	2[2]			69% (20)					
F	3[2]			51% (15)					
F	4				22% (5)				
F	5				32% (9)				
F	1				36% (10)				

TABLE A (cont'd.)

PARTICIPATION RATE[1] OF YEAR 1 SAMPLE WITHIN SCHOOLS, GRADES, AND TEACHERS

School	Teacher	Grade 5	6	7	8	9	10	11	
F	5[2,3]				82% (9)	71% (12)			
F	6[2,3]				86% (6)	74% (14)			
F	7[2]					70% (22)			
F	Total								54% (138)
G	1[2]			52% (14)					
G	2[2]					66% (19)			
G	Total								59% (33)
H	1[2]			38% (10)					38% (10)
I	1						54% (13)		
I	2							54% (14)	
I	Total								54% (27)
	Overall	44% (24)	80% (20)	54% (115)	40% (40)	72% (113)	54% (13)	54% (14)	57% (339)

[1]Percentage of students volunteering to participate.

Number of students volunteering in parentheses.

[2]These classrooms were observed

[3]First-year algebra classes with both 8th and 9th grade

TABLE B

DISTRIBUTION OF SEX WITHIN GRADE LEVELS IN YEAR 1 SAMPLE

Sex	Grade							
	5	6	7	8	9	10	11	
Female	46%	53%	55%	48%	55%	43%	46%	53%
Male	54%	47%	45%	52%	45%	57%	54%	47%

TABLE C

NUMBER OF PARENTS IN YEAR 1 SAMPLE

Student's Sex	Mother Only	Father Only	Both Parents	Neither Parent
Female	26	9	118	28
Male	20	8	94	36
Total	46	17	212	64
Percentage of Total	13%	5%	62%	20%

TABLE D

RELOCATION OF SAMPLE IN YEAR 2

Grade	Year 1	Year 2	%Relocated
5	24	23	96%
6	20	20	100%
7	116	108	93%
8	40	35	88%
9	113	107	95%
10	13	13	100%
11	14	11	79%
Total	339	317	94%

TABLE E

NUMBER OF PARENTS IN YEAR 2 SAMPLE

Student's Sex	Mother Only	Father Only	Both Parents	Neither Parent
Female	6	0	75	100
Male	10	3	57	89
Total	16	3	132	189
Percentage of Total	5%	1%	39%	55%

TABLE F

PARTICIPATION RATES[1] OF CONTROL SAMPLE

School	Teacher	Grade 5	6	7	8	9	10	11 Math	11 Non Math	12 Math	12 Non Math	
A	1	24% (7)										24% (7)
B	1	37% (10)										
B	2	56% (15)										
Total												46% (25)
C	1		33% (8)									
C	2		71% (17)									
C	3	90% (26)										
Total												65% (51)
D	3					97% (29)						97% (29)
E	1			77% (24)								77% (24)
F	1			43% (12)								
F	3				21% (4)							
F	4			39% (9)								
F	62				75% (6)	22% (2)						
F	6					30% (6)						
F	7					65% (11)						

TABLE F (cont'd.)

PARTICIPATION RATES[1] OF CONTROL SAMPLE

School	Teacher	Grade 5	6	7	8	9	10	11 Math	11 Non Math	12 Math	12 Non Math	
F	7					43% (3)						
Total												39% (53)
G	2					75% (21)						75% (21)
H	1			40% (10)								40% (10)
I							25% (26)	13% (18)	64% (14)	34% (25)	24% (19)	24% (102)
J									21% (7)			21% (7)
Overall		52% (58)	52% (25)	52% (55)	37% (10)	59% (72)	25% (26)	13% (18)	38% (21)	34% (25)	24% (19)	38% (329)

[1]Percentage of students volunteering to participate. Number of students volunteering in parentheses.

[2]First-year algebra classes with both 8th and 9th grade students.

TABLE G

DISTRIBUTION OF SEX WITHIN GRADE LEVELS IN CONTROL SAMPLE

Sex	Grade										
	5	6	7	8	9	10	11		12		
							Math	Non Math	Math	Non Math	
Female	53%	56%	42%	50%	59%	69%	47%	81%	43%	63%	55%
Male	47%	44%	58%	50%	41%	31%	53%	19%	57%	37%	45%

TABLE H

NUMBER OF PARENTS IN CONTROL SAMPLE

Student's Sex	Mother Only	Father Only	Both Parents	Neither Parent
Female	19	4	105	49
Male	13	5	86	40
Total	32	9	191	89
Percentage of Total	10%	3%	59%	28%

APPENDIX C

GENERAL ANALYTIC PROCEDURES

General Analytic Procedures

Descriptive Analyses.

Data analysis proceeded in four distinct phases. The first phase included the descriptive analysis of the data. These analyses, in keeping with our interest in developmental trends and sex discrepancies, examined the distributions of variables in the population as a whole as well as within sex and age groups. Additional groups within the sample were compared. These comparison groups included mothers and fathers, parents of daughters and parents of sons, and students with high and low math expectancies

Relational Analyses.

In phase two, bivariate and multivariate relations were examined. Correlational, regression and multivariate contingency table analyses were used to assess relations of variables within and between testing times. Regression techniques allowed us to estimate the relative importance of variables in predicting our major dependent variables: expectancies, values and course choice. Multiple regression on the merged data sets allowed us to compare the relative power of classroom behaviors, parent attitudes and student attitudes in predicting student attitudes and plans.

A variant of multiple regression, linear discriminant function analysis, was planned for use in this phase of data analysis. Discriminant function analysis (DFA) is a multivariate technique that determines which linear combination of variables best discriminates between two or more groups. DFA was to be used to determine those variables which discriminated between the students planning to continue or actually continuing to take advanced math and those who were not continuing in math. These analyses could not be performed since 95% of our sample either planned to or did continue in their math studies.

To assess relations among ordinal and categorical variables in our data set, we used a multivariate contingency table analysis known as ECTA (Everyperson's Contingency Table Analysis). The ECTA program, prepared by Fay and Goodman, is one of the most widely used techniques arising from log-linear modelling procedures. Because ECTA makes no assumptions regarding the normality of the distribution and the absence of interaction, it is particularly well suited to the analysis of this type of data. Another advantage to the ECTA system lies in the analyst's ability to compare the goodness of fit to different patterns of relations within the data. Patterns of relations, or models, are specified by the analyst in an attempt to explain the "activity" within an n-way contingency table. The relations specified in a model are those variables which show a single or marginal effect, an association between two variables, or interactions among three or more variables. Any effects not specified are assumed to be contingent only upon the grand mean. The model fitting process is hierarchical in nature, thus lower order effects (e.g. single or marginal effects) are also estimated in the test of fit when a bivariate or trivariate relationship is specified. The maximun likelihood estimation process is then forced to fit all possible marginal totals. The likelihood-ratio chi square statistic (LRX^2) used in the estimation process tests the discrepancy between expected and observed frequencies. A non-significant LRX^2 indicates little discrepancy between expected and observed frequencies, and a model which fits the data. The significance of improvement a second model might offer over a first can be estimated by taking the difference in LRX^2 and degrees of freedom and looking for a significant LRX^2. In addition to model testing and comparison, ECTA also provides a Lambda statistic based on logs of odds ratios in the contingency table to pinpoint specific associations among levels of variables.

Longitudinal Analyses.

The collection of data at two points in time strengthens one's ability to make inferences regarding the causal direction of correlational relations. Our analysis plan included two longitudinal statistical techniques which strengthen causal inferences and test causal models: Cross-lagged panel analyses and Analyses of Variance.

Cross-lagged panel correlations (CLPC) is a technique used in evaluating the evidence for causal inference. The CLPC program examines the correlations between pairs of variables collected at a minimum of two points in time. Significant differences between the values of the cross lagged correlations (r_{x1y2} and r_{x2y1}) indicate that one variable of the pair is causally dependent upon the other. CLPC was used as a preliminary step to model testing. These analyses were used to clarify the causal relations between variables such as the students' perceptions of their parents' expectancies for them in math and the students' expectancies for math performance.

It was Schaie's contention that the application of analysis of variance techniques combined with the use of cross-sectional and longitudinal experimental designs would allow the researcher to assess the unconfounded effects of the three paramenters of his General Developmental Model (Schaie, 1965). Such analyses would, it was argued, result in separate estimates of the cohort, time of measurement and age parameters of the model. Schaie's contention was contested on conceptual ground by Baltes and others (see Nesselroade and Baltes, 1974). Adam (1978) has recently demonstrated that un-confouned estimates of the three parameters cannot be obtained. With this evidence in mind, we have accepted Baltes' position vis-a-vis the General Developmental Model. Baltes contended that a given design inevitably confounds two of the three effects. In our design we have chosen to counfound time of measurement with the other two effects.

We adopted the cohort-sequential model of data analysis for use in this investigation. The cohort-sequential model varies cohort and age while confounding time of measurement. In our design, cohort effects are identical to effects of grade in school. More concretely, the data analysis of the cohort-sequential model was performed as a cohort (7) x sex (2) x age (2) ANOVA with repeated measures on the factor of age. Each of the student attitude scales served as a dependent variable in these analyses. The results of these analyses are summarized in the text.

In addition, two series of control analyses were performed. These are summarized in Tables A and B. In each case, data from one year of the longitudinal sample was compared to a control sample of students tested only in the second year. In the first series of control analyses, data from the year one sample and control sample were examined for cohort, sex and time of measurement effects with a 8 x 2 x 2 fully crossed factorial ANOVA. The absence of time of measurement effects is evidence for the greater external validity of the study in terms of its replicability across time. The second series of control analyses used data from the second year and from the control samples. These data were examined for cohort, sex and testing effects. The lack of significant testing effects increases our confidence that practice effects did not bias our longitudinal findings.

Model Testing Analyses.

The final phase of analysis, that of model testing, integrates the knowledge obtained from prior analysis with our theoretical model in the conceptualization and evaluation of our model for predicting choice behavior. The theoretical model tested is presented in Figure 1 of the text. Standard path analytic procedures were used to evaluate the utility of this model.

TABLE A

ANALYSIS OF VARIANCE OF STUDENTS' ATTITUDES TOWARD MATH:
YEAR 1 AND CONTROL SAMPLES

Effect	Scale																
	FUT EXP	CRNT EXP	ABIL	PAR ABIL	CUR DIF	PER DIFF	COMB EFT	UTIL ADV	IMPORT	INT	LIKE TCHR	PAR. IMPT	PERF	FUT DIF	PERC EXP	COST	MIN STAN
Cohort (C)	**	**	**	**	**	**		**	**	**	**	**	**		**	**	
Sex (S)							**										
Time (T)								**									
CS																	
CT									*						*		
ST												**					

*$p \leq .05$

**$p \leq .01$

TABLE B

ANALYSIS OF VARIANCE OF STUDENTS' ATTITUDES TOWARD MATH:
YEAR 2 AND CONTROL SAMPLES

Effect	Scale																	
	FUT EXP	CUR EXP	ABILITY	PAR ABIL	CUR DIF	PER DIF	COMB EFT	UTIL. ADV	IMPORT	INTEREST	LIKE TCHR	PAR. IMPT	PERF	FUT DIF	PERC EXP	COST	CUR UTIL	MIN STAN
Sex (S)			*				**	**										
Cohort (C)	**	**	**	**	**	**		**		**	**		**		**		**	**
Practice (P)							*											
SC																	*	
SP																		
CP						*									*			

*$p \leq .05$

**$p \leq .01$