Journal of Educational Psychology
1990, Vol. 82, No. 1, 60–70

0022-0663/90/$00.75

Predictors of Math Anxiety and Its Influence on Young Adolescents' Course Enrollment Intentions and Performance in Mathematics

Judith L. Meece
School of Education
University of North Carolina at Chapel Hill

Allan Wigfield
Institute for Social Research
University of Michigan

Jacquelynne S. Eccles
Department of Psychology
University of Michigan

We used structural modeling procedures to assess the influence of past math grades, math ability perceptions, performance expectancies, and value perceptions on the level of math anxiety reported in a sample of 7th- through 9th-grade students (N = 250). A second set of analyses examined the relative influence of these performance, self-perception, and affect variables on students' subsequent grades and course enrollment intentions in mathematics. The findings indicated that math anxiety was most directly related to students' math ability perceptions, performance expectancies, and value perceptions. Students' performance expectancies predicted subsequent math grades, whereas their value perceptions predicted course enrollment intentions. Math anxiety did not have significant direct effects on either grades or intentions. The findings also suggested that the pattern of relations are similar for boys and girls. The results are discussed in relation to expectancy-value and self-efficacy theories of academic achievement.

A strong background in mathematics is critical for many career and job opportunities in today's increasingly technological society. However, many academically capable students prematurely restrict their educational and career options by discontinuing their mathematical training early in high school. Several recent surveys (National Assessment of Educational Progress [NAEP], 1988; National Center for Educational Statistics [NCES], 1984) indicate that only half of all high school graduates enroll in mathematics courses beyond the 10th grade. These reports also indicate that fewer women than men enroll in the more advanced courses in high school mathematics (NAEP, 1988; NCES, 1984), although the "gender gap" is beginning to narrow (Chipman & Thomas, 1985; Eccles, 1987). Furthermore, students of both sexes, but particularly women, do not attain a high level of mathematical competency, even if they have completed 4 years of high school math (NAEP, 1988).

The writing of this article was supported, in part, by Grant BNS-8510504 from the National Science Foundation to Jacquelynne Eccles and Allan Wigfield. Data collection was supported by Grant R01-MH31724 from the National Institute of Mental Health to Jacquelynne Eccles. We are grateful to Carol Kaczala, Carol Midgley, and Terry Adler for their help in collecting and processing the data, to Blanche Arons and Jane Trexler for their assistance with the preparation of this article, and to Dale Schunk and two anonymous reviewers for their helpful comments on an earlier draft of this article.

Allan Wigfield is now in the Department of Human Development, at the University of Maryland, College Park, Maryland. Jacquelynne Eccles is in the Department of Psychology, at the University of Colorado, Boulder, Colorado.

Correspondence concerning this article should be addressed to Judith L. Meece, School of Education, CB-3500, 105E Peabody Hall, University of North Carolina, Chapel Hill, North Carolina 27599-3500.

The present study is a part of a 2-year longitudinal investigation of the cognitive motivational variables that influence high school students' decisions to enroll in advanced mathematics courses. This research is guided by a model of academic choice and achievement based on expectancy-value theories of motivation (Eccles, 1983). The model links achievement behavior to expectancies for success and to the incentive value of the task. It is our contention that this model, originally proposed as a general model of academic choice, is particularly useful in analyzing sex differences in mathematics (Meece, Parsons, Kaczala, Goff, & Futterman, 1982). Our previous research testing aspects of this model showed that self-concepts of math ability and the subjective value of mathematics were predictive of junior and senior high school students' course enrollment plans and performance in mathematics. We also found significant sex differences in students' self-concepts of math ability and task values (Eccles, 1983; Eccles [Parsons], 1984; Eccles [Parsons], Adler, & Meece, 1984).

In this study, we focus on the mediating influence of math anxiety on students' course enrollment plans and performance in mathematics. Research within the expectancy-value tradition has examined affective dispositions that can inhibit achievement striving, such as the motive to avoid failure in Atkinson's original model of achievement motivation (Atkinson, 1964) and the related construct of test anxiety (Hill, 1972; Sarason, 1980). Studies of mathematics achievement have primarily examined the negative effects of math anxiety. These studies have shown that math anxiety relates negatively to students' performance on standardized tests of mathematics achievement, grades in mathematics, plans to enroll in advanced high school mathematics courses, and selection of math-related college majors (Armstrong, 1985; Betz, 1978; Brush, 1980; Eccles [Parsons], 1984; Hackett, 1985; Hendel, 1980; Richardson & Woolfolk, 1980; Sherman & Fennema, 1977; Wigfield & Meece, 1988).

Math anxiety has also received considerable attention for its role in explaining sex-related differences in mathematics achievement and course enrollment patterns. Sex typically accounts for only a small proportion of the variance in students' responses on math anxiety measures (Betz, 1978; Dew, Galassi, & Galassi, 1983; Eccles [Parsons], 1984; Meece, 1981). However, high school and college women generally rate themselves as more math anxious than men (Armstrong, 1985; Betz, 1978; Brush, 1985; Meece, 1981; Richardson & Woolfolk, 1980; Wigfield & Meece, 1988).

The present study has several important goals. First, we identify important predictors of math anxiety. Correlational studies have shown that math anxiety is related negatively to measures of prior mathematics achievement and math ability perceptions (Fennema & Sherman, 1977; Hendel, 1980; Rounds & Hendel, 1980; Wigfield & Meece, 1988). Using path analysis procedures, Betz and Hackett (1983) and Hackett (1985) showed that a measure of math-related efficacy was a stronger predictor of college students' math anxiety than were achievement test scores in mathematics. In a previous study (Wigfield & Meece, 1988), we suggested that the value students attach to mathematics can moderate these relations. Students who have low perceptions of their math abilities and do not value mathematics may not report as much math anxiety as students who have low perceptions of their math abilities but think it is important to do well in mathematics. To extend previous research, we test a conceptual model that includes prior mathematics achievement, math efficacy-related perceptions, and the subjective value of math as predictors of math anxiety.

The second major goal of this study was to assess the relative predictive influence of math anxiety on students' mathematics course enrollment plans. Several studies have indicated that math anxiety appears to add little to the prediction of mathematics participation and achievement beyond that of previous math performance, general attitudes toward mathematics, and self-concepts of math ability. When the effects of these other variables also are examined, the relative influence of math anxiety is either substantially reduced or nonsignificant (Betz, 1978; Brush, 1980; Fennema & Sherman, 1977; Rounds & Hendel, 1980; Siegel, Galassi, & Ware, 1985).

Previously, we suggested that some of the ambiguity concerning the effects of math anxiety is due to its conceptualization (Wigfield & Meece, 1988). Some measures of math anxiety include items assessing math ability perceptions, which makes it difficult to distinguish the effects of math anxiety from the influence of other closely related motivational variables. We showed, however, that math ability perceptions and math anxiety are conceptually distinct, though related, constructs (Wigfield & Meece, 1988). In this study, we test the relative predictive influence of math anxiety, math efficacy-related perceptions, and the subjective value of mathematics on students' course enrollment plans and achievement in mathematics.

Much of the research on math anxiety has involved high school and college-aged students, and less information is available on the correlates and effects of math anxiety in younger populations. Therefore, this study focuses on a sample of junior high school students. Research has shown that students' reports of uneasiness, worry, and anxiety related to mathematics increase during the early adolescent years (Brush, 1985; Meece, 1981; Wigfield & Meece, 1988). A few studies have suggested further that achievement-related affect may play a particularly important role in determining the achievement outcomes of young adolescents (Brush, 1985; Harter & Connell, 1984).

Another important objective of this study was to examine differences in the relations among predictor and outcome variables for male and female students. Our previous work has documented sex-related differences in junior high school students' math-related expectancies, values, and anxiety (Eccles, 1983; Eccles [Parsons], 1984; Meece, 1981; Wigfield & Meece, 1988). Other evidence suggests that affective factors may play a more important role in explaining differences in the achievement patterns of female than of male students (Meyer & Fennema, 1986). Also, in our previous work, we found evidence that past performances in mathematics may have a stronger influence on the task expectancies and values of male students than on those of female students (Eccles, 1983, 1985; Eccles [Parsons] et al., 1984). None of these studies, however, used sophisticated group comparison analyses to examine these sex differences.

Theoretical Links Between Expectancy-Value and Self-Efficacy Achievement Models

Research on math anxiety has been limited by the lack of an integrative theoretical framework for conceptualizing relations among self-perception, affective, and performance variables (Reyes, 1984). We based our previous research on expectancy-value theories of achievement motivation. In the present study, we relate this research to the growing literature on self-efficacy approaches to academic achievement. Expectancy-value and self-efficacy theories stress the importance of conceptually similar constructs and processes. First, both approaches stress the important influence of individuals' judgments of their ability to perform or to succeed at a task as critical determinants of task choice, persistence, affective reactions, and performance in achievement situations. Second, both theories emphasize the critical role of cognitive and inferential processes in forming expectancy judgments. And third, both expectancy-value and self-efficacy approaches maintain that the incentive or reinforcement value of an outcome can mediate achievement-related behavior.

There are also some important distinctions between the two theories. Expectancy-value theories are concerned with the anticipated outcomes or consequences of an action. Expectancies are defined as the subjective probability of success on a task (Atkinson, 1964; Atkinson & Feather, 1966) or as the subject probability that a particular reinforcement will occur as a function of a particular action (Rotter, 1954). Self-efficacy theorists argue that expectancy judgments concerning the consequences of one's actions are distinct from efficacy judgments concerning one's ability to attain a certain level of performance (Bandura, 1986). Bandura points out that a person may feel certain that an action will lead to a particular outcome but may doubt his or her ability to successfully perform the action. This distinction is most appropriate for situations in which outcomes or reinforcers are loosely tied to actions because of environmental contingencies (Bandura, 1986). Schunk (1984) has argued that there may be less of a distinction between expectancy judgments and efficacy judgments in achievement situations.

Another important difference concerns the emphasis placed on the subjective value of the outcome in the two theories. Although self-efficacy theories stress the importance of this variable, much of the research in this area focuses on the impact of efficacy beliefs. Norwich (1987) recently concluded that researchers need to elaborate the incentive conditions under which efficacy judgments influence subsequent performance. In contrast, expectancy-value research has suggested that the perceived value of an achievement activity can be a stronger predictor of some achievement outcomes than efficacy-related beliefs (Eccles [Parsons], 1984; Eccles [Parsons] et al., 1984; Feather, 1988).

Model Specification

In this study, we test two models derived from expectancy-value and self-efficacy theories. The models share some general features. Expectancy-value and self-efficacy theories maintain that in forming efficacy or ability judgments, individuals rely on information about their past performances. Research has further shown that successful performances do not necessarily enhance efficacy-related perceptions; the impact of this information depends on how it is cognitively appraised and interpreted (Bandura, 1986; Eccles, 1983; Meece et al., 1982; Schunk, 1984; Weiner, 1979). On the basis of this research, the proposed models predict that students' efficacy-related beliefs mediate the effects of prior academic performance on anxiety, course enrollment plans, and performance in mathematics.

The models distinguish between two types of efficacy-related beliefs. Bandura (1981) has argued that self-concepts of ability are global estimates of efficacy. These assessments tend to be less predictive of achievement-related outcomes than domain- or task-specific measures of efficacy. This distinction is also consistent with expectancy-value models of achievement. In our model of academic choice and performance (Eccles, 1983; Meece et al., 1982), we hypothesized that students' math ability perceptions positively influence students' expectations for success in mathematics, and these, in turn, predict achievement-related outcomes. Correlational data supported the positive relation between these two types of efficacy beliefs; however, factor analysis findings suggested that they should be treated as a single construct (Eccles, 1983; Eccles, Wigfield, & Chambers, 1988). Consequently, we used a construct that includes both types of efficacy beliefs in much of our previous research. Although this strategy is statistically justifiable and theoretically appropriate, it obscures the distinction suggested by self-efficacy theorists, limits our ability to test micro-level associations among these efficacy-related perceptions, and possibly reduces the predictive power of our model.

In this study, we treat students' math ability perceptions and expectancies as separate constructs. However, because these two types of efficacy beliefs are closely associated, multicolinearity is a potential problem when both constructs are included in the models as distinct predictors. To handle this problem, we draw on our longitudinal data and use Year 1 indicators of math ability perceptions to predict Year 2 course performance expectancies in each of the models.

We include performance expectancies in the models as domain-specific measures of perceived efficacy. We operationally define this variable as students' ratings of how well they expect to do in their current mathematics course. This assessment is conceptually similar to a measure of perceived efficacy because it involves judgments concerning one's ability to attain a certain level of performance, rather than the anticipated consequences of a successful performance (Bandura, 1986; Schunk, 1984). However, the expectancy measure is different from self-efficacy measures that assess students' perceptions of their abilities to successfully perform certain mathematical tasks (Norwich, 1987) or to receive passing grades in a variety of math-related courses (Betz & Hackett, 1983; Hackett, 1985).

Last, both models contain a measure of the perceived importance of mathematics to test its relative predictive influence on anxiety, grades, and course enrollment plans in mathematics. We also specify a positive relationship between the efficacy and value measures used in this study. This addition to our model is based on previous cross-sectional research in which we found a positive relation linking students' prior math ability perceptions to their current perceptions of task value (Eccles, 1983) and on recent research indicating a reciprocal relation between math ability and math valence constructs (Feather, 1988).

Math Anxiety Model

In our first model, we tested two sets of causal relations. First, on the basis of previous research (Eccles [Parsons], 1984; Hackett, 1985; Meece, 1981; Wigfield & Meece, 1988), we predicted that students' anxiety about math would be directly and negatively related to how well students expect to do in their current mathematics course. To extend previous research, we tested whether the importance students attach to math would contribute directly to the prediction of math anxiety. We also examined the possibility that expectancies and values interact to influence anxiety (Wigfield & Meece, 1988).

Second, we tested longitudinal links of previous math grades and math ability perceptions to math expectancies, importance ratings, and anxiety. On the basis of earlier research (Eccles, 1983; Eccles [Parson], 1984; Wigfield & Meece, 1988), we predicted that math ability perceptions would relate positively to both expectancies and importance ratings and negatively to anxiety. The effects of prior achievement on these variables would be indirect. We also tested the bidirectional relation of expectancies and importance ratings. We predicted a positive link between the two variables based on the two recent studies (Eccles, et al., 1988; Feather, 1988).

Model of Course Performance and Enrollment Intentions

In this model, we examined the relative influence of expectancy, value, and anxiety constructs on students' subsequent math grades and intentions to enroll in mathematics courses. On the basis of our previous work (Eccles, 1983; Eccles [Parsons], 1984; Eccles [Parsons], et al., 1984) and studies of self-efficacy (Schunk, 1984), we predicted that students' performance expectancies in math would have the strongest positive direct effect on their subsequent grades. We predicted that the importance students attached to math would have the strongest direct effects on their intentions to enroll in math. We expected anxiety to have direct, negative effects on both subsequent grades and intentions (Wigfield & Meece, 1988). We also predicted that anxiety would mediate relations between expectancies and grades and between math values and intentions.

Second, we looked at longitudinal relations of math grades and ability perceptions to the other variables. As before, we predicted that math ability perceptions would directly influence performance expectancies, importance ratings, and anxiety. On the basis of previous research (Eccles, 1983; Schunk, 1984), we predicted that math ability perceptions would have indirect effects on subsequent math grades and intentions and that its effects would be mediated through performance expectancies and importance ratings. We expected previous grades to have direct links only to the subsequent year's grades.

Summary

The present study draws on expectancy-value and self-efficacy theories of achievement motivation to identify predictors of math anxiety and to conceptualize the mediating influence of math anxiety on young adolescents' course enrollment plans and performance in mathematics. We extend previous research in several important ways. First, we attempt to replicate our earlier findings with a different sample of adolescents. The socioeconomic composition of this sample is more diverse than that of the sample used in our previous investigations. Second, we test longitudinal relations between math performance and the critical self-perception variable identified in our model of academic achievement and choice (Eccles, 1983; Meece et al., 1982). To date, tests of the model have used cross-sectional data. We test relations between predictor variables and their causal links to outcome variables using more sophisticated structural equation modeling techniques than were used in the previous studies. We also used sophisticated group comparison procedures to assess possible sex-related differences in the predictive influence of performance and self-perception variables. Last, we limit our analyses to a sample of junior high school students to control for possible developmental differences.

Method

Sample

This study is part of a 2-year longitudinal research project involving approximately 860 students in 5th through 12th grade (see Eccles, Wigfield, Meece, Kaczala, & Jayarante, 1986, for a description of the full study). Because we were interested most in the junior high school years, the sample we used in this study consists of 250 students (131 girls and 119 boys) who were in Grades 7 through 9 during the second year of the study. The students are from two predominantly White middle-class suburban communities.

We used the mathematics classroom as an intermediate sampling unit and selected four classrooms at each grade level from among the classrooms whose teachers volunteered to participate in the study. Within each of the selected classrooms, 85–95% of the students agreed to participate. In seventh and eighth grade, all students were enrolled in math courses of an approximately equivalent level of difficulty. In ninth grade, most students were enrolled in either regular algebra (25 girls and 28 boys) or advanced algebra (20 girls and 13 boys). Seven students (4 girls and 3 boys) were enrolled in a slow-paced ninth-grade algebra class.

Project staff members administered questionnaires to students who had returned slips indicating parental consent. We group administered all questionnaires during the spring of Year 1 and Year 2.

Measures

Student attitudes. The Student Attitude Questionnaire (SAQ) has been used and refined in two major studies of children's beliefs and attitudes about mathematics (see Eccles, 1983; Eccles et al., 1986, for detailed descriptions of the SAQ). The questionnaire contains items to assess student's expectancies for success, perceived values, perceived ability, perceived effort, and perceived task difficulty in both math and English, and many other constructs, such as sex-role identity, sex stereotyping of math as a male domain, causal attributions, and children's perceptions of their parents' and teachers' attitudes regarding the students' abilities in math. Most of these constructs are assessed by two or more 7-point Likert-type items.

In this study we used three factor-derived scales (Eccles et al., 1988) from this questionnaire as predictor variables. The perceived math ability measure consists of three items tapping students' sense of their math ability and how well they were doing in math (α = .86 for overall, .83 for boys, .89 for girls). The expectancies measure consists of two items asking students to rate how well they expected to do in their current math course (α = .79 overall, .78 for boys, .81 for girls). The importance measure consists of two items asking students to rate how important it was to them to be good at math and to get good grades in math (α = .67 overall, .57 for boys, and .62 for girls). Table 1 lists these scales of items.[1] We scored each scale so that a higher scale would indicate a stronger endorsement of the items contained in it.

[1] The scales used in the present study are slightly different from the ones used in our previous investigations. The current scales are based on our most recent factor analysis of this data set and represent a more differentiated set of constructs. One of the items contained in the Ability Perception scale asked students to evaluate how well they were doing in mathematics. The wording of this item may appear similar to items that ask students to rate how well they expected to do in mathematics. The overlap in the content of these items could result in a spurious inflation of the association between the perceived ability and performance expectancy constructs. The use of ability perceptions from the previous year should help to alleviate this problem. We used only the Current Expectancies scale in this study because we wanted a course-specific measure of students' perceived efficacy in mathematics. Also, we found sex differences in this variable, which we did not find in the sample used in earlier studies. We recognize that these modifications can affect the replicability of our earlier findings.

The SAQ also includes an item asking students to indicate whether they would take more math in the future if they no longer had to. A high score on this item indicates that students planned to take more math.

Math anxiety. We included a measure of math anxiety in the SAQ during the second year of the larger study. This measure contains 19 items to assess the cognitive and affective dimensions of math anxiety. In a previous study, we deleted eight of these items because of their overlap with ability and value constructs (see Wigfield & Meece, 1988, for an elaboration of these procedures). Confirmatory factor analyses of the remaining 11 items produced two factors, the first representing concerns about doing well in math and the second representing strong negative affective reactions to math. In this study, we used five items with high factor loadings on the Negative Affective Reactions scale because that scale seemed to represent a form of debilitating math anxiety. We also found significant gender differences in this component of math anxiety (Wigfield & Meece, 1988). Table 1 lists the math anxiety items. The alphas for this sample are .77 overall, .71 for boys, and .80 for girls.

Math achievement. We collected achievement information on each student for both years of the study from school records. The present study used Year 1 and Year 2 final math grades as measures of students' previous and current math performance. We coded grades so that higher scores meant higher grades. Scores ranged from 2 for *E* (failure) to 14 for *A*+.

Design

We used structural equation modeling procedures to assess the two structured models and their associated measurement models. We used the LISREL VI program (Jöreskog & Sörbom, 1981) for these analyses. In using these procedures, researchers must clearly specify the assumptions made in formulating both the measurement and structural models (Jöreskog & Sörbom, 1981; Long, 1983). In our measurement model, we assumed that each observed variable would have a nonzero loading on only one latent variable, the one it was presumed to measure. For the structural model of the relations among the latent variables, we assumed that causal relations would be recursive. We further assumed that there would be noncausal relations between the self-perceptions variables posited to be at the same step in a causal sequence, so we estimated those relations. Finally, for items with quite similar wording, we allowed for correlated errors of measurement.

We used several different indices of the goodness-of-fit for the models, including chi-square, chi-square divided by its degree of freedom, Bentler and Bonett's (1980) normed fit index, and Jöreskog and Sörbom's (1981) Goodness-of-Fit (GFI). Bentler and Bonett's normed fit index involves comparing the chi-square value of the hypothesized model with that of a "null" model that assumes no covariances among the variables. This index has a maximum value of 1, and Bentler and Bonett suggested that values of .9 or above indicate reasonable fit. Similarly, for Joreskog and Sorbom's GFI, values of .9 or above should indicate a good fit.

Jöreskog and Sörbom (1981) outlined a series of steps by which researchers can test for the structural invariance of models in different groups. The most rigorous procedure involves testing the invariance of the covariance matrix structure for each group. We performed this test for the matrices for boys and girls. In addition to this test, we also examined the relations among latent variables to determine if they differed for boys and girls.

Results

Descriptive Statistics

Table 1 presents the means and standard deviations for the different variables included in the study for the whole sample and for boys and girls.[2] Table 2 presents the correlations among the items for the seventh- to ninth-grade students. Because the patterns of relations are similar across groups, we only present the correlations for the whole sample. As Table 2 indicates, all the correlations between the mathematics anxiety items and the other self-perceptions items and math grades are negative. Items tapping ability perceptions, current performance expectancies, and importance relate positively. Mathematics ability perceptions, performance expectancies, and importance ratings all relate positively to grades in math at Year 1 and Year 2. At each year, the relations between ability perceptions and grades and between performance expectancies and grades are stronger than the relations between the importance of doing well in math and math grades.

To test for possible sex-related differences in children's self-perceptions concerning mathematics and math grades, we performed one-way analysis of variance (ANOVAS) on the scales created using the items listed in Table 1. Compared with girls, boys have higher perceptions of their own math ability ($M = 5.31$ for boys, 4.95 for girls), $F(1, 276) = 8.09$, $MS_e = 1.23$, $p < .01$; higher performance expectancies in math ($M = 5.28$ for boys, 4.97 for girls), $F(1, 248) = 5.03$, $MS_e = 1.22$, $p < .05$; and stronger intentions to keep taking math ($M = 5.99$ for boys, 5.57 for girls), $F(1, 248) = 4.98$, $MS_e = 2.20$, $p < .05$. Girls ($M = 3.80$) express more anxiety about math than boys ($M = 3.27$), $F(1, 248) = 12.56$, $MS_e = 1.39$, $p < .01$. Sex of the student accounts for 2–5% of the variance in these self-perception variables. There are no sex differences in the importance students assign to doing well in math or in students' math grades for either year of the study.

Model 1: Math anxiety model. In the first model, we assessed how students' Year 1 math ability perceptions and math grades influenced their Year 2 math performance expectancies and ratings of the importance of doing well in math, and in turn how all these variables affected their math anxiety. Before testing this model, we first tested for possible interaction effects of expectancies and values on math anxiety with path analyses (using multiple regression procedures) that included expectancies, values, and their product as predictors of math anxiety. Results of these analyses showed that the interaction term was not significant; hence, in the LISREL modeling, we examined only main effects. We estimated the correlation between expectancies and importance in the model, but did not specify a causal link between these two variables.

Figure 1 depicts the final structural models for the whole sample. The significant maximum likelihood and standardized (in parentheses) parameter estimates are presented in the figure. Table 3 presents the goodness-of-fit indices for the models tested. As the table indicates, all of the indices show that the models fit quite well. For each model, the chi-squares divided by their degree of freedom are close to two or less.

[2] Table 1 presents individual items rather than scales because these items were used in the structural equation modeling analyses. Items 1–3 formed the Ability Perception scale, Items 4–5 formed the Current Expectancies scale, Items 6–7 formed the Importance scale, Items 8–12 formed the Anxiety scale, and Items 13–15 were entered as single-item indicators in the model.

Table 1
Means and Standard Deviations for the Items Included in the Modeling Analyses

Item	7th–9th grade (n = 250)		Boys (n = 119)		Girls (n = 131)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Math ability perceptions						
1. How good at math are you	5.22	1.24	5.41	1.13	5.06	1.26
2. Ability in math, compared to other students	4.88	1.38	5.11	1.05	4.64	1.16
3. How have you been doing at math this year	5.24	1.45	5.38	1.47	5.16	1.38
Performance expectancies						
4. Expectancy in math compared to other students	4.91	1.22	5.12	1.22	4.72	1.1
5. How well do you expect to do in math this year	5.32	1.18	5.43	1.23	5.22	1.1
Importance						
6. Being good at math is important	5.44	1.21	5.54	1.10	5.35	1.2
7. Importance of good grades in math	6.12	1.13	6.19	1.07	6.05	1.1
Math anxiety						
8. Nervousness about math tests	4.32	1.65	4.04	1.67	4.56	1.5
9. Scared of math tests	3.56	1.73	3.10	1.65	3.98	1.6
10. Dread doing math	3.26	1.65	3.02	1.60	3.47	1.6
11. Scared of advanced math	3.30	1.79	2.97	1.78	3.59	1.7
12. Nervous about math	3.29	1.51	3.19	1.45	3.37	1.5
13. Intentions to take more math	5.77	1.49	5.99	1.23	5.57	1.6
14. Math grades Year 1	10.31	2.29	10.14	2.48	10.46	2.1
15. Math grades Year 2	10.08	2.47	9.83	2.69	10.31	2.2

Note. Items 1–13 were scored on 1–7 scales, and Items 14 and 15 on 2–14 scales.

The normed fit indices (except for boys) are above .9, as are Jöreskog and Sörbom's (1981) GFIs. The individual parameters are quite large in relation to their standard errors, and all the normalized residuals are less than two. The squared multiple correlations for anxiety are .51 in the model for the whole sample, .40 for boys, and .48 for girls, which indicates that the models account for about half of the variance in students' anxiety scores.

Examination of the parameter estimates of the model for the whole sample shows that students' Year 1 ability perceptions and grades are strongly related. As hypothesized, students' Year 1 math ability perceptions directly and positively predict students' Year 2 performance expectancies and importance ratings. Also as hypothesized, students' Year 1 math ability perceptions have both a direct negative effect on Year 2 anxiety ratings and an indirect effect mediated through the expectancies and importance ratings. Math ability perceptions mediate the effects of students' Year 1 math grades on the expectancy, importance, and anxiety variables.

As expected, the relation between expectancies and importance is positive; both expectancies and importance have strong, negative, direct effects on students' anxiety about math, which indicates that students who have more positive expectancies about math are less anxious about math. The negative coefficients for the paths between expectancies and anxiety are stronger than those for the paths between importance and anxiety.

In comparing the responses of boys and girls, we first tested the invariance of the covariance matrices for boys and girls. We used the most rigorous test proposed by Jöreskog and

Table 2
Correlations Between Items Included in the Modeling Analyses

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	—														
2	.69	—													
3	.70	.65	—												
4	.31	.34	.31	—											
5	.19	.23	.26	.65	—										
6	.30	.25	.21	.30	.22	—									
7	.25	.21	.26	.30	.32	.46	—								
8	−.21	−.20	−.21	−.44	−.36	−.18	−.18	—							
9	−.29	−.21	−.24	−.46	−.34	−.18	−.12	.65	—						
10	−.41	−.26	−.31	−.37	−.36	−.38	−.25	.33	.48	—					
11	−.36	−.28	−.20	−.27	−.22	−.30	−.22	.33	.47	.51	—				
12	−.20	−.11	−.17	−.37	−.32	−.20	−.23	.36	.31	.41	.20	—			
13	.38	.23	.28	.23	.23	.38	.39	−.16	−.16	−.24	−.24	−.07	—		
14	.57	.44	.66	.23	.25	.18	.17	−.12	−.13	−.25	−.19	−.06	.30	—	
15	.36	.33	.41	.52	.47	.16	.18	−.24	−.29	−.26	−.17	−.20	.18	.55	

Note. n = 250. All correlations greater than .16 are significant at the .01 level. Table 1 lists item names.

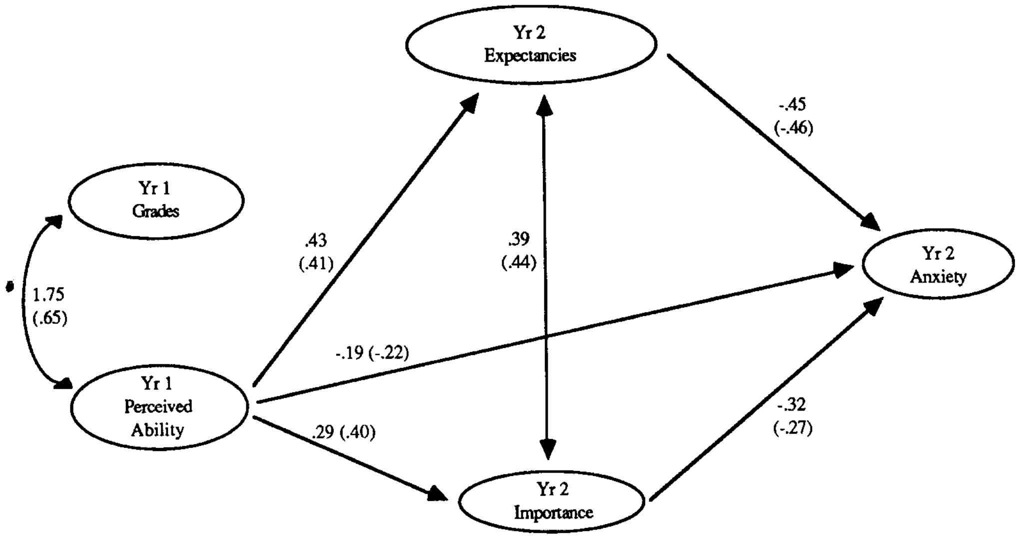

Figure 1. Predictors of mathematics in the 7th–9th grade group (Yr = year).

Sörbom (1981) for testing invariance across groups. We analyzed the matrices containing all 15 items included in either the first set of models or the second set of models. The chi-square for this test is 86.45, and with 78 degrees of freedom, the test is nonsignificant, which indicates that the covariance matrices are invariant.

Though the covariance matrices are invariant, the parameter estimates of the models indicate some differences in the relations among the latent variables for boys and girls. Perceived ability is a significant predictor of performance expectancies for boys but not girls. Perceived ability has a direct effect on girls' anxiety ratings; in contrast, the effects of perceived ability on math anxiety are primarily indirect in the male sample. Thus, students' prior perceptions of their math ability appear to have a slightly different impact on boys' and girls' subsequent self-perceptions. Although there are differences in the magnitude of some causal relations, the overall model specifications fit the male and female sample data equally well, which suggests that these differences reflect weak and chance variations.

Table 3
Goodness-of-Fit Indices for the Structural Models

Index	*df*	χ^2	Normed fit index	GFI
Model Set 1				
7th–9th grade null model[a]	78	1,316.04	—	.42
7th–9th grade model[a]	51	104.63	.92	.94
7th–9th grade boys null model[b]	78	565.87	—	.46
7th–9th grade boys model[b]	51	31.93**	.87	.92
7th–9th grade girls null model[c]	78	801.12	—	.39
7th–9th grade girls model[c]	51	77.38**	.90	.92
Model Set 2				
7th–9th grade null model[a]	105	1,564.44	—	.40
7th–9th grade model[a]	72	125.93	.92	.94
7th–9th grade boys null model[b]	105	702.10	—	.42
7th–9th grade boys model[b]	72	88.36*	.88	.92
7th–9th grade girls null model[c]	105	943.74	—	.38
7th–9th grade girls model[c]	72	100.12**	.89	.91

Note. GFI = Joreskog and Sorbom's (1981) Goodness of Fit Index.
[a] $n = 243$. [b] $n = 116$. [c] $n = 127$.
* $p < .10$. ** $p < .05$.

Model 2: Predicting Year 2 grades and intentions. In the second model, we assessed how the self-perception variables and previous math performance related to two outcome variables, students' grades and intentions to enroll in mathematics courses at the end of the second year. Again, we first used path analyses to test for possible interaction effects of expectancy and value on Year 2 grades and enrollment intentions; none of the interaction terms was significant. We next specified models in which expectancies and importance both predicted to anxiety which, in turn, predicted Year 2 grades and intentions to determine if anxiety mediated the effects of expectancies and importance on grades and intentions. Contrary to our predictions, anxiety did not have a direct effect on either of these outcome variables. Because of this result and the relatively strong relations among anxiety, importance, and expectancies (which makes colinearity a possible problem), we did not specify causal links from expectancies and importance to anxiety in the second set of models. Instead, we included expectancies, importance ratings, and anxiety at the same point in the model's causal sequence and specified noncausal relations among these variables. We then tested their relation to grades and intentions (see Figure 2). We also specified a causal relation between Year 1 and Year 2 grades because there was likely to be some relationship between grades across time that was not mediated by the cognitive motivational variables included in the model.

Table 3 presents the goodness-of-fit indices for the models tested. As before, all of the overall indices show that the models fit well. Furthermore, the parameter estimates are

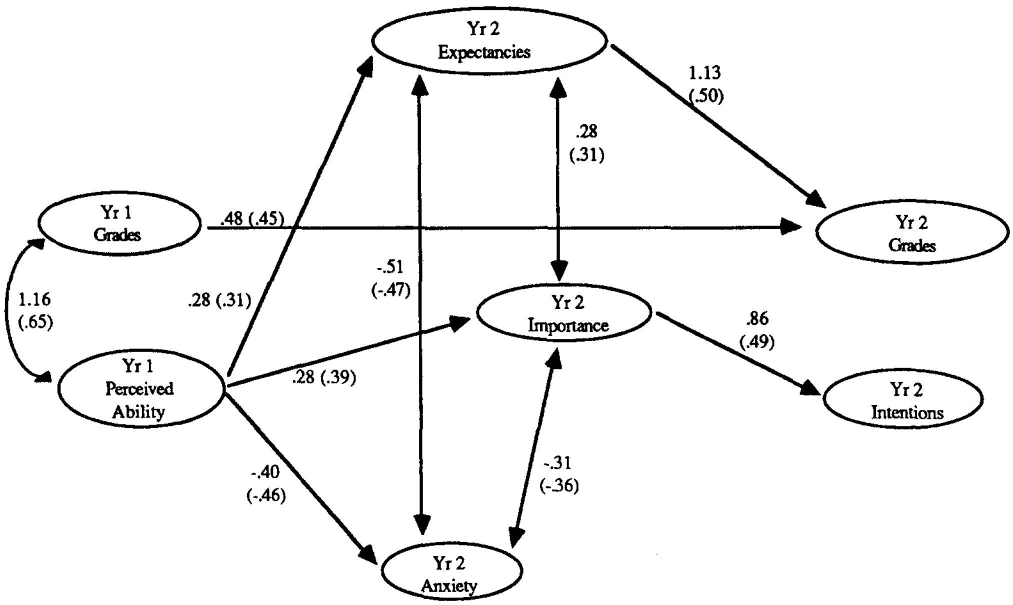

Figure 2. Predictors of mathematics grades and intentions to keep taking mathematics in the 7th–9th grade group (Yr = year).

large, relative to their standard errors, and the normalized residuals are less than two. Figure 2 shows the models for the total sample, with the significant maximum likelihood and standardized parameter estimates.

As in the anxiety model, Year 1 math ability perceptions have direct positive effects on the current performance expectancies and importance and direct negative effects on the anxiety variables. The effects of Year 1 grades on these self-perception variables are all indirect, mediated through their association with Year 1 ability perceptions. Year 1 grades have a significant direct effect only on Year 2 grades. Current performance expectancies and importance ratings are positively related; both of these variables relate negatively to anxiety.

The direct links between expectancies and Year 2 math grades are strong and positive, which indicates that students with higher performance expectancies in math have higher Year 2 grades. This direct effect is stronger than the direct effect from Year 1 grades to Year 2 grades, which suggests that performance expectancies mediated, to some extent, the longitudinal link between grades in mathematics. Current performance expectancies do not directly relate to intentions to enroll in mathematics courses; instead, the importance students assign to doing well in math has a strong, direct, positive effect on their intentions to continue taking mathematics. This link is much stronger than the direct link of past grades to intention, which again suggests that the importance-ratings act as a mediating variable between Year 1 grades and students' course enrollment intentions. As noted above, anxiety does not have a direct effect on Year 2 grades or intentions.

We have already reported that the structure of the covariance matrix for these items did not differ for boys and girls. Nonetheless, in terms of differences in the relations among the latent variables for boys and girls in these models, the direct link between Year 1 grades and performance expectancies is not significant for girls. The coefficient for the direct path between expectancies and Year 2 grades is somewhat stronger for boys than for girls, and the coefficient for the path between importance and intentions is stronger for girls than for boys.

The squared multiple correlations are .50 for Year 2 grades and .33 for intentions to enroll in mathematics courses in the overall model; .57 for Year 2 grades and .18 for intentions in the model for boys; and .43 for Year 2 grades and .39 for intentions in the model for girls. Thus, the model accounts for more variance in boys' than in girls' Year 2 grades; in contrast, it accounts for more variance in girls' than in boys' course enrollment intentions. In general, the model accounts for more variance in math grades than in course enrollment intentions, for both boys and girls.

In summary, the results suggest that students' efficacy-related beliefs influence students' performances and academic choices in mathematics, as hypothesized. In addition, students' ability perceptions have strong direct effects on Year 2 performance expectancies, importance-ratings, and anxiety, but they have only indirect effects on Year 2 grades and intentions. Students' performance expectancies strongly and directly predict subsequent grades but not course enrollment intentions. Students' ratings of the importance of math predict their course enrollment intentions but not grades. Students' anxiety about math have no direct effect on either subsequent grades or course enrollment intentions. Sex differences are few and difficult to interpret because the covariance matrices did not differ across these two groups.

Discussion

Several interesting findings emerged in this study. First, we replicated and extended our previous research on the longitudinal relations specified in the Eccles model (Eccles, 1983; Eccles [Parsons], 1984; Eccles [Parsons] et al., 1984). The results indicate that the relations identified previously in cross-sectional analyses emerge in longitudinal tests as well. In particular, math ability perceptions have strong longitudinal effects (both direct and indirect) on future efficacy-related beliefs and value perceptions. As hypothesized in the Eccles model, math ability perceptions directly affect students' valuing of math as well as their expectancies for success in math. Second, we demonstrated that the bidirectional relationship between expectancies and values is positive. We also demonstrated that when relations with other predictor variables are specified in a model, math anxiety has only indirect effects on subsequent performance and enrollment intentions. And last, we showed that boys' and girls' efficacy-related and value perceptions link to subsequent performance and enrollment patterns in similar ways.

Concerning predictors of math anxiety, we found that students' current performance expectancies in math and, to a somewhat lesser extent, the perceived importance of mathematics have the strongest direct effects on their anxiety. Consistent with previous research (Betz & Hackett, 1983; Hackett, 1985), efficacy-related judgments significantly predict math anxiety in students. As expected, students' perceptions of their math ability mediate the effects of past performance on anxiety. Hence, in support of cognitive mediation models of achievement (Bandura, 1986; Eccles, 1983; Harter & Connell, 1984; Weiner, 1979), it is students' interpretations of their achievement outcomes and not the outcomes themselves that have the strongest effects on students' affective reactions to achievement.

Interestingly, the importance students assigned to mathematics achievement does not moderate the effects of expectancies on anxiety. Instead, importance-ratings have a direct negative effect on math anxiety. Students who assigned more importance to achievement in mathematics reported less math anxiety. Without longitudinal data to disentangle causal relations between the value and anxiety variables, it is difficult to interpret this finding. This particular finding reaffirms our earlier suggestion that exploring the causal links between anxiety and value constructs should be a high priority in future research on math anxiety (Wigfield & Meece, 1988).

Several important findings emerge from our analyses of the prediction of mathematics performance and course enrollment intentions. First, although previous performance has direct effects on subsequent grades, it also has indirect effects mediated through students' ability perceptions, performance expectancies, and importance-ratings, and this provides further support for the cognitive mediation models of achievement behavior. Second, performance expectancies predict subsequent math grades, whereas the perceived importance of mathematics predicts course enrollment intentions. This pattern is consistent with earlier findings (Eccles [Parsons], 1984; Eccles [Parsons] et al., 1984). It is important to point out that we specified a reciprocal relation between expectancy and value constructs in this study. Thus, if efficacy-related judgments influence the perceived importance of mathematics, as the results suggest, they can have an indirect influence on course enrollment plans. Similarly, value judgments can influence performance outcomes, although they may do so indirectly through the influence they have on efficacy-related judgments. These findings emphasize the importance of examining both the direct and indirect effects of efficacy-related beliefs and value constructs on achievement outcomes.

Contrary to our prediction, math anxiety does not mediate the influence of performance expectancies in math and ratings of its importance on subsequent math grades and intentions. In addition, math anxiety does not have significant direct effects either on subsequent performance or on intentions to continue taking math; rather, the effects of math anxiety are indirect. These results suggest that expectancy and importance ratings are stronger determinants of subsequent performance and intentions than is math anxiety; however, we need to look at these relations longitudinally to fully assess this hypothesis. It does appear that it may be misleading to examine the influence of math anxiety on mathematics performance without looking at the effects of other self-perceptions such as expectancies and values.

An important finding of this study is that expectancy and value judgments are positively related (see also Eccles et al., 1988). In his initial formulations of expectancy-value theory, Atkinson (1957) posited that the two constructs had an inverse relation, so that highly valued tasks were those for which the individual had low expectancies for success. Our results suggest that in real-world achievement settings, the relations between the two constructs are positive. Highly valued tasks are those for which students have high expectancies for success. In further support of this position, Feather (1988) found a similar positive relation between subject matter ability perceptions and valences in his study of college students' course enrollment decisions. Similar to Feather, we did not specify the direction of causal influence in our models. The perceived value of mathematics may lead students to develop their mathematical skills and abilities, or students may come to value those skills and tasks they perform well. Alternatively, as Feather suggested, a reciprocal process may explain the causal relation between expectancy and value constructs.

Another set of interesting findings concerns the patterns of relations for the male and female samples. Contrary to the suggestions of previous research (Meyer & Fennema, 1986), math anxiety does not differentially predict achievement outcomes for girls and boys, even though girls and boys differed in the amount of anxiety they report. Instead, the results suggest that the underlying structure of the relations between variables are the same for boys and girls. Thus, it seems likely that the sex differences we find in course enrollment and performance patterns are due more to the mean differences in boys' and girls' achievement-related perceptions than to differences in the pattern of relationships among the variables used in this study.

We suggest that researchers pursue some questions regarding math anxiety left unresolved in this study. One shortcoming of our analyses is that the effects of anxiety were assumed to be linear. Test anxiety research (Heinrich & Spielberger, 1982; Wine, 1980) suggests that its effects may depend on the amount of anxiety experienced. Moderate levels of math anxiety may facilitate achievement striving, whereas more extreme levels appear to be more disruptive of cognitive and attentional processes, especially on tasks involving higher order thinking skills. Another important question concerns the effects of the individual differences in how students experience their anxiety. The students in our sample had a fairly restricted range of math ability. Wigfield and Eccles (1989) point out that low and high achieving students can experience test anxiety for different reasons and may respond to similar levels of anxiety in different ways. These interactional and individual effects need further examination in future research.

The results of this study have important implications for educational intervention. Treatment programs for math anxiety have generally involved helping students manage their emotional stress (for review, see Richardson & Woolfolk, 1980). Although programs that help eliminate emotional arousal can increase students' sense of efficacy and reduce anxiety (Bandura, 1986), for many math-anxious students, skill development should also be a critical component of these programs. Schunk and his colleagues have shown that it is possible to enhance self-perceptions of efficacy in students who have cognitive skill deficits, through direct or self-directed strategy training (for review, see Schunk, 1984). Findings from Schunk's research indicate that as students acquire and master cognitive skills, they develop a greater sense of self-efficacy, which leads to increased persistence, higher levels of performance, and more intrinsic interest in the activity. For students with a history of poor achievement in mathematics, skill development with training to reshape negative motivation patterns might be the most effective approach (Borkowski, Weyhing, & Carr, 1988).

The results of this study also confirm the predictions we have made elsewhere (Eccles, 1983; Eccles [Parsons], 1984; Eccles [Parsons] et al., 1984; Meece et al., 1982) regarding the critical role (especially for girls) that value perceptions play in determining students' intentions to enroll in advanced mathematics courses. Teachers can help enhance students' valuing of math in several ways, including explicitly relating the value of math to students' everyday lives, making math personally meaningful, and counseling students about the importance of mathematics for various careers (see Casserly, 1980; Eccles et al., 1986). Unfortunately, in over 400 hours of classroom observation, Eccles and her colleagues (1986) observed fewer than a dozen instances of these instructional behaviors. Clearly, greater attention needs to be given to this aspect of mathematics education.

In conclusion, this study demonstrates the utility of integrating self-efficacy and expectancy-value approaches to better understand achievement behavior in school settings. Both approaches stress the importance of conceptually similar constructs. By developing models that draw on the strengths of each approach, researchers can begin to build more comprehensive models of achievement behavior. Our findings highlight the importance of formulating achievement models that examine reciprocal relations among math anxiety, efficacy beliefs about math, and math achievement values, and their causal links to academic performance and choices. Future research should assess the generality of our findings to other age groups, to students differing in mathematics ability, and to students in different kinds of mathematics curricula.

References

Armstrong, J. (1985). A national assessment of participation and achievement in women in mathematics. In S. Chipman, L. Brush, & D. Wilson (Eds.), *Women and mathematics: Balancing the equation* (pp. 59–94). Hillsdale, NJ: Erlbaum.

Atkinson, J. W. (1957). Motivational determinants of risk-taking behavior. *Psychological Review, 64,* 359–372.

Atkinson, J. W. (1964). *An introduction to motivation.* Princeton, NJ: Van Nostrand.

Atkinson, J. W., & Feather, N. T. (1966). *A theory of achievement motivation.* New York: Wiley.

Bandura, A. (1981). Self-referent thought: A developmental analysis of self-efficacy. In J. Flavell & L. Ross (Eds.), *Social cognitive development: Frontiers and possible futures* (pp. 200–239). New York: Cambridge.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice-Hall.

Bentler, P. M., & Bonett, D. G. (1980). Significance tests and goodness-of-fit in the analysis of covariance structures. *Psychological Bulletin, 88,* 588–606.

Betz, N. (1978). Prevalence, distribution and correlates of math anxiety in college students. *Journal of Counseling Psychology, 24,* 551–558.

Betz, N. E., & Hackett, G. (1983). The relationship of mathematics self-efficacy expectations to the selection of science-based college majors. *Journal of Vocational Behavior, 23,* 329–345.

Borkowski, J., Weyhing, R., & Carr, M. (1988). Effects of attributional retraining on strategy-based reading comprehension in learning-disabled students. *Journal of Educational Psychology, 80,* 46–53.

Brush, L. (1980). *Encouraging girls in math.* Cambridge, MA: Abt Books.

Brush, L. (1985). Cognitive and affective determinants of course preference and plans. In S. Chipman, L. Brush, & D. Wilson (Eds.), *Women and mathematics: Balancing the equation* (pp. 123–150). Hillsdale, NJ: Erlbaum.

Casserly, P. (1980). Factors affecting female participation in advanced placement programs in mathematics, chemistry and physics. In L. Fox, L. Brody, & D. Tobin (Eds.), *Women and the mathematical mystique* (pp. 138–163). Baltimore, MD: Johns Hopkins University Press.

Chipman, S. J., & Thomas, V. G. (1985). Women's participation in mathematics: Outlining the problems. In S. F. Chipman, L. R. Brush, & D. M. Wilson (Eds.), *Women and mathematics: Balancing the equation* (pp. 1–24). Hillsdale, NJ: Erlbaum.

Dew, K. M. H., Galassi, J. P., & Galassi, M. D. (1983). Mathematics anxiety: Some basic issues. *Journal of Counseling Psychology, 30,* 443–446.

Eccles, J. S. (1983). Expectancies, values, and academic behavior. In J. T. Spencer (Ed.), *Achievement and achievement motivation* (pp. 75–146). San Francisco: W. H. Freeman.

Eccles, J. S. (1985). Sex differences in achievement patterns. In T. B. Sonderegger (Ed.), *Nebraska symposium on motivation* (pp. 97–132). Lincoln: University of Nebraska Press.

Eccles, J. S. (1987). Gender roles and women's achievement-related decisions. *Psychology of Women Quarterly, 11,* 135–172.

Eccles, J. S., Wigfield, A., & Chambers, B. (1988). *Modeling relationships of achievement expectancies, task values, and ability perceptions.* Unpublished manuscript, University of Michigan.

Eccles, J. S., Wigfield, A., Meece, J. Kaczala, C, Jayarante, T. (1986). *Sex differences in attitudes and performance in math.* Unpublished manuscript, University of Michigan.

Eccles (Parsons), J. S. (1984). Sex differences in mathematics participation. In M. Steinkamp & M. Maehr (Eds.), *Advances in motivation and achievement: Women in science* (Vol. 2, pp. 93–137). Greenwich, CT: JAI.

Eccles (Parsons), J. S., Adler, T., & Meece, J. (1984). Sex differences in achievement: A test of alternative theories. *Journal of Personality and Social Psychology, 46,* 26–43.

Feather, N. T. (1988). Values, valences, and course enrollment:

Testing the role of personal values within an expectancy-valence framework. *Journal of Education and Psychology, 80,* 381–391.

Fennema, E., & Sherman, J. (1977). Sex-related differences in mathematics achievement, spatial visualization, and affective factors. *American Educational Research Journal, 14,* 51–71.

Hackett, G. (1985). Role of mathematics self-efficacy in the choice of math-related majors of college women and men: A path analysis. *Journal of Counseling Psychology, 32,* 47–56.

Harter, S., & Connell, R. (1984). A model of children's achievement and related self-perceptions of competence, control, and motivational orientation. In J. Nicholls (Ed.), *Advances in motivation and achievement* (Vol. 3, pp. 219–250). Greenwich, CT: JAI Press.

Heinrich, D., & Spielberger, C. D. (1982). Anxiety and complex learning. In H. W. Krohne & L. Laux (Eds.), *Achievement, stress, and anxiety* (pp. 145–165). New York: Hemisphere.

Hendel, D. (1980). Experiential and affective correlates of math anxiety in adult women. *Psychology of Women Quarterly, 52,* 219–230.

Hill, K. T. (1972). Anxiety in the evaluative context. In W. W. Hartup (Ed.), *The young child* (Vol. 2, pp. 225–263). Washington, DC: National Association for the Education of Young Children.

Jöreskog, K. G., & Sörbom, D. (1981). *LISREL VI: Analysis of linear structural relationships by maximum likelihood and least squares methods.* Chicago: National Education Resources.

Long, J. S. (1983). *Covariance structure models: An introduction to LISREL.* Beverly Hills, CA: Sage.

Meece, J. (1981). *Individual differences in the affective reactions of middle and high school students to mathematics: A social cognitive perspective.* Unpublished doctoral dissertation, University of Michigan.

Meece, J. L., Parsons, J., Kaczala, C. M., Goff, S. B., & Futterman, R. (1982). Sex differences in math achievement: Towards a model of academic choice. *Psychological Bulletin, 91,* 324–348.

Meyer, M., & Fennema, E. (1986, April). *Gender differences in the relationships between affective variables and mathematics achievement.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

National Assessment of Educational Progress. (1988). *The mathematics report card: Are we measuring up*? Princeton, NJ: Educational Testing Service.

National Center for Educational Statistics. (1984). *High school and beyond: A national longitudinal study for the 1980s.* Washington, DC: U.S. Government Printing Office.

Norwich, B. (1987). Self-efficacy and mathematics achievement: A study of their relationship. *Journal of Educational Psychology, 79,* 384–387.

Reyes, L. (1984). Affective variables and mathematics education. *The Elementary School Journal, 5,* 558–581.

Richardson, F. C., & Woolfolk, R. L. (1980). Mathematics anxiety. In I. G. Sarason (Ed.), *Test anxiety: Theory, research and application* (pp. 271–288). Hillsdale, NJ: Erlbaum.

Rotter, J. B. (1954). *Social learning and clinical psychology.* Englewood Cliffs, NJ: Prentice-Hall.

Rounds, J. B., & Hendel, D. D. (1980). Measurement and dimensionality of mathematics anxiety. *Journal of Counseling Psychology, 27,* 138–149.

Sarason, I. G. (1980). Introduction to the study of test anxiety. In I. G. Sarason (Ed.), *Test anxiety: Theory, research and application* (pp. 19–33). Hillsdale, NJ: Erlbaum.

Schunk, D. H. (1984). Self-efficacy perspective on achievement behavior. *Educational Psychologist, 19,* 45–58.

Sherman, J., & Fennema, E. (1977). The study of mathematics by high school girls and boys: Related variables. *American Educational Research Journal, 14,* 159–168.

Siegel, R. G., Galassi, J. P., & Ware, W. (1985). A comparison of two models for predicting mathematics performance: Social learning versus math aptitude-anxiety. *Journal of Counseling Psychology, 32,* 531–538.

Weiner, B. (1979). A theory of motivation for some classroom experiences. *Journal of Educational Psychology, 71,* 1–25.

Wigfield, A., & Eccles, J. S. (1989). Test anxiety in elementary and secondary school students. *Educational Psychologist, 24,* 159–186.

Wigfield, A., & Meece, J. (1988). Math anxiety in elementary and secondary school students. *Journal of Educational Psychology, 80,* 210–216.

Wine, J. D. (1980). Cognitive-attentional theory of test anxiety. In I. G. Sarason (Ed.), *Test anxiety: Theory, research and applications* (pp. 349–385). Hillsdale, NJ: Erlbaum.

Received July 29, 1988
Revision received October 2, 1989
Accepted October 3, 1989 ■