COURSE ENROLLMENT AS SELF-REGULATORY BEHAVIOR: WHO TAKES OPTIONAL HIGH SCHOOL MATH COURSES?

KIMBERLY A. UPDEGRAFF

PENNSYLVANIA STATE UNIVERSITY

JACQUELYNNE S. ECCLES

UNIVERSITY OF MICHIGAN

BONNIE L. BARBER

UNIVERSITY OF ARIZONA

KATHRYN M. O'BRIEN

PENNSYLVANIA STATE UNIVERSITY

Course enrollment decisions are among the most influential self-regulatory behaviors students exercise in school because these decisions directly affect the opportunities students have to learn new material. A great deal of concern has been expressed lately about math course enrollment decisions in particular. Originally, this concern focused on the underrepresentation of women in advanced math courses. This work began with a report from Lucy Sells that female high school graduates in California had taken substantially fewer math courses than their male peers, and, as a result, were not eligible for over half of the undergrad-

Direct all correspondence to: Jacquelynne S. Eccles, Institute for Social Research, The University of Michigan, Box 1248, Ann Arbor, MI 48106-1248.

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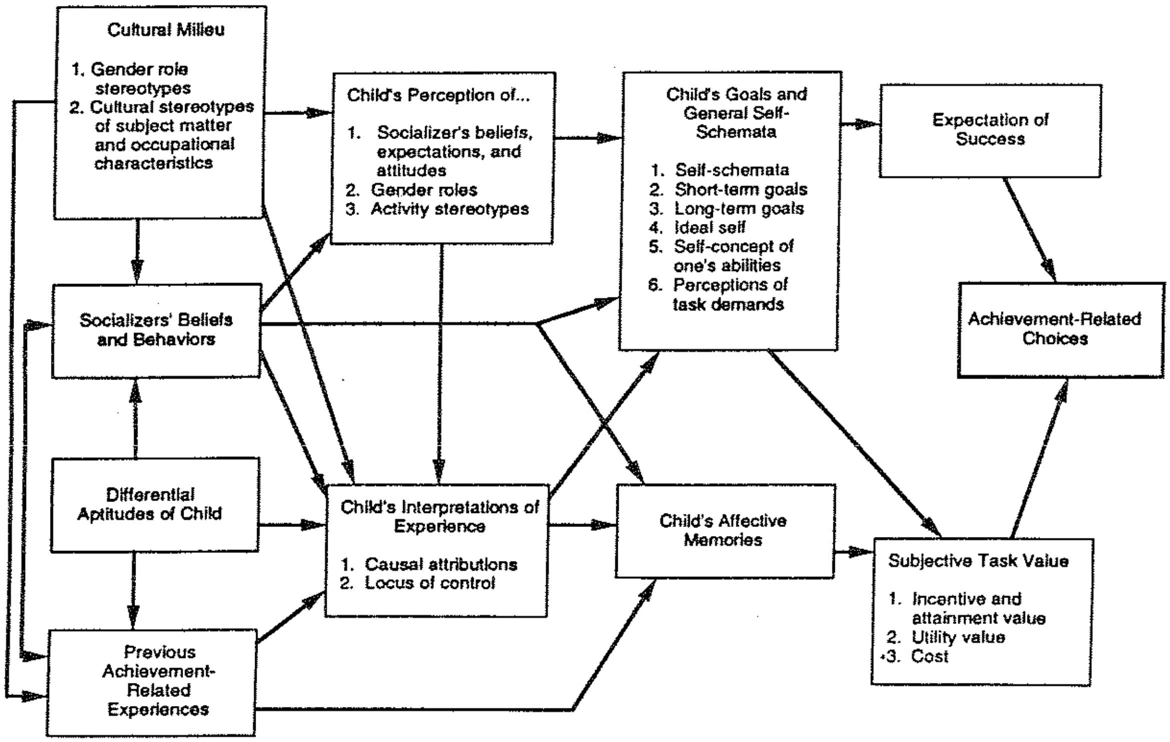
uate majors in the University of California system (Sells 1978; see also Chipman, Brush, & Wilson 1985). Based on these findings, Sells argued that high school math courses are the critical filter that keeps females out of math-related occupations and college majors (see also Fennema & Sherman 1978). Recent reports have extended the concern more broadly to both females and males (NSF 1994). Several reports of the educational status of American students point to relatively low levels of math proficiency at all grade levels. Decisions by both male and female students to take only the minimal number of high school math courses contribute to this problem among high school graduates (NSF 1994). Understanding the attitudinal predictors of these course enrollment decisions would provide a basis for intervention programs.

This article focuses on assessing the role of one such set of attitudinal predictors —the set derived from the Expectancy-Value Model of Achievement Choices proposed by Eccles and her colleagues (Eccles et al. 1983). This model focuses on the motivational and social factors influencing such long and short range achievement goals and behaviors as career aspirations, vocational and avocational choices, course selections, persistence on difficult tasks, and the allocation of effort across various achievement-related activities. Drawing upon the theoretical and empirical work associated with decision-making, expectancy-value theory, achievement theory, and attribution theory (Ajzen & Fishbein 1977; Atkinson 1964; Feather 1982, 1988; Fischoff, Goitein, & Shapira 1982; Weiner 1985), the model, depicted in Figure 1, links educational, vocational, and other activity choices most directly to two sets of beliefs: the individual's expectations for success and the importance or value the individual attaches to the various options perceived by the individual as available. The model also specifies the relation of these beliefs to cultural norms, experiences, aptitudes, and to those personal beliefs and attitudes that are commonly assumed to be associated with achievement-related activities by researchers in this field (Eccles et al. 1983). In particular, the model links achievement-related beliefs, outcomes, and goals to causal attributional patterns, to the input of socializers (primarily parents and teachers), to gender-role belief systems, to self perceptions and self-concepts, and to one's perceptions of the task itself. Each of these factors are assumed to influence both the expectations one holds for future success at the various achievement-related options and the subjective value one attaches to these various options. These expectations and the value attached to the various options, in turn, are assumed to influence choice among these options.

For example, let us consider course enrollment decisions. The model predicts that people will be most likely to enroll in courses that they think they will do well in and that have high task value for them. Expectations for success depend on the confidence the individual has in his/her intellectual abilities and on the individual's estimations of the difficulty of the course. These beliefs have been shaped over time by the individual's experiences with the subject matter and by the individual's subjective interpretation of those experiences (e.g. does the person think that her/his successes are a consequence of high ability or lots of hard work?). The value of a particular course is also influenced by other concerns as well, such as: Does the person like doing the subject material?; Is the course required?; Is the course seen as instrumental in meeting one of the individual's long or short range

FIGURE 1
General model of achievement choices



goals?; Have the individual's parents or counselors insisted that the course be taken or, conversely, have other people tried to discourage the individual from taking the course?; Is the person afraid of the material to be covered in the course?

In summary, according to the Eccles et al. expectancy-value model, achievement-related choices, whether made consciously or nonconsciously, are guided by the following: (a) one's expectations for success on the various options, and (b) the value the individual attaches to the various options. Expectations are assumed to be influenced most directly by one's history of previous performances (e.g., course grades) and aptitude. The value is assumed to be most directly influenced by (a) the relation of the options both to one's short and long range goals and to one's core self identity and basic psychological needs, (b) the pleasure one experiences when doing various activities, and (c) by the potential cost of investing time in one activity rather than another. All of these psychological variables are influenced by one's experiences, one's interpretative frameworks, cultural norms, gender-role beliefs, and the behaviors and goals of one's socializers and peers. The model has now been used to predict individual differences within gender, as well as gender differences, in behavioral choices ranging from participation in athletic activities, to occupational aspirations, and early marriage and parenting. In this paper, we focus on its utility in predicting high school math enrollment decisions.

Eccles and her colleagues have reviewed the evidence supporting the significance of many of these links (e.g. Eccles et al., 1983; Eccles et al. 1984; Eccles 1994; Eccles & Wigfield 1995; Meece et al. 1982). This evidence is particularly strong for the link between expectations for success (or efficacy beliefs) and achievement (e.g., see Bandura 1994; Eccles & Wigfield 1995; Marsh 1990; Meece et al. 1982; Meece, Wigfield, & Eccles 1990; Schunk 1991 for review). There is also substantial evidence that gender differences in math expectations help to explain the under-representation of women in math-related professions. For example, females from mid elementary school on report lower expectations for their performance and less confidence in their ability in mathematics than boys (e.g., Bandura 1994; Betz & Fitzgerald 1987; Dweck & Licht 1980; Eccles 1993; Eccles et al. 1993) In addition, these differences in self-perception have been found to mediate gender differences in occupational decisions.

Although there is much less work on the task value-related beliefs and course enrollment, Eccles (1984) documented both the importance of subjective task value for predicting math course enrollment and the importance of gender differences in subjective task value for accounting for the gender differences in twelfth grade math enrollment among high ability students. Similar differences emerge in studies of the interest patterns of gifted girls and boys. Gifted girls typically rate the value of English, foreign languages, composition, music, and drama higher than the boys; in contrast gifted boys rate the value the physical sciences, physical training, U.S. history, and sometimes mathematics higher than girls (e.g., Benbow & Stanley 1984; Terman 1930). Although the gender differences in interest in mathematics are typically quite weak, the gender differences in interest in physics and applied mathematical fields like engineering are quite consistent and fairly large (Benbow & Minor 1986; Benbow 1988).

Similarly, when asked their occupational interests and/or anticipated college major, gifted girls rate domestic, secretarial, artistic, biological science, and both medical and social service occupations and training higher than the boys while the gifted boys express more interest than the girls in both higher-status and business-related occupations in general, and in the physical sciences, engineering, and the military in particular (Benbow & Stanley 1984; Fox, Pasternak, & Peiser 1976; Terman 1930). Thus even among mathematically gifted and talented adolescents, there is evidence of gender stereotypic differences in value-related beliefs that appear to mediate gender differences in later college majors and career aspirations. These studies, however, did not assess the link of these values to high school math course enrollment.

In this article, we test the utility of expectancy-value components of the Eccles et al. model for predicting high school math course enrollment. The project differs from most other studies of math course enrollment in two ways: First, it is both longitudinal and prospective. We are using beliefs from early in the high school years to predict to cumulative course enrollment decisions across the entire high school period. Second, it includes measures of both expectancy-related beliefs and subjective task values as well as measures of previous performance history assessed in terms of both a standardized test of quantitative reasoning and math course grades, thus allowing us to assess the predictive strength of expectancies and values independent of their association with prior achievement and aptitude as well as to assess the relative importance of these two sets of psychological beliefs as predictors of course enrollment. Although previous studies have linked expectations to achievement and both expectancy-related beliefs and values to occupational choice, few studies have also included indicators of both expectancy-related beliefs and subjective task value and fewer still have used course enrollment as the predicted outcome. Finally, we are extending the work that has been done primarily with highly able and gifted samples to a normative sample of adolescents in several midwestern school districts.

METHODS

DESIGN AND SAMPLE

This study has two broad goals: (1) to describe in as concise a manner as possible the math course taking profiles of a large random sample of students in 10 different school districts in southeastern Michigan, and (2) to test prospectively the utility of expectancy- and task value- related beliefs in explaining variation in cumulative course enrollment decisions. In order to do a prospective test of the predictive power of expectancy and task value-related beliefs for high school math course enrollment decisions, we are using information from several time points drawn from an on-going longitudinal study—the Michigan Study of Adolescent Life Transitions (MSALT). We use a standardized indicator of numerical aptitude gathered during the ninth grade as one control for ability; we use tenth math GPA as our second control for math ability / performance. We use tenth grade indicators of the students' expectancy- and task-value related beliefs so that the individual differences in these beliefs precede, in time, individual differences in math course enrollment decisions (virtually all of the youth were taking math in the tenth grade). Finally, we use these predictor and control variables to explain the variance in total number of courses taken during one's entire high school career (a cumulative picture of enrollment decisions across four years). This design provides the strongest longitudinal test of our hypotheses.

The sample is part of an on-going longitudinal investigation designed to examine participants' normative and non-normative life transitions from early adolescence through adulthood. Participants were initially recruited from 10 predominantly white middle- and lower-middle-class school districts in Southeastern Michigan through letters sent home in their sixth grade math classes in 1983 (see Eccles, Wigfield, Flanagan, Miller, Reuman, & Yee 1989 for recruitment and attrition information).

The questionnaire data used in this paper come from the fifth wave of data when the adolescents were in the tenth grade. At that wave, surveys were administered to 1,492 adolescents at school. The longitudinal regression analyses were run on the 1,039 students (548 girls and 491 boys) who responded to the survey at wave five, had information in their school record for the ninth grade numerical aptitude test and for whom we could find complete high school course enrollment information at the end of their twelfth grade year. This sample was predominantly white and of working or middle class socio-economic background. In order to provide as accurate a picture as possible of the course taking patterns in this cohort of students, we used all adolescents with complete course enrollment information regardless of whether they had filled out surveys in the tenth grade in describing the math course taking patterns (N = 1,761).

PROCEDURE

The questionnaire data were collected in Spring, 1988; students were excused from their regularly scheduled classes to complete the survey in their school cafeteria or auditorium. Students were allotted 90 minutes to respond to questionnaires with researchers present to answer questions. In addition, information about prior and subsequent course work, grades, and standardized test scores was gathered from school records.

MEASURES

Measures were obtained from student questionnaires and school record data. Self-concept of ability in math, utility of math, and interest in math were measured via questionnaires. These scales have been used and validated extensively by Eccles and her colleagues (e.g., Eccles [Parsons] 1983; Eccles et al. 1984; Eccles & Wigfield 1995). They have excellent internal consistency and test-retest reliabilities, and quite good predictive, face, convergent and discriminate validity.

Grades in math, math aptitude (based on standardized test scores), specific course enrollment choices, and the number of math classes taken throughout high school were gathered from school record data.

Self-Concept of Ability in Math. Our expectancy and ability self-concept items always load on a single factor and, thus, should be not broken into independent scales (Eccles & Wigfield, 1995). Consequently, we used a combined measure as our indicator for the students' expectancy-related beliefs. For this measure, the students rated their math ability on three items using a seven point Likert-type response scale with higher scores indicating more positive self-concepts of ability. Sample items include "How good are you at math?" (1=not at all good to 7=very good) and "If you were to rank all the students in your math class from the worst to the best in math, where would you put yourself?" (1=the worst to 7=the best). Cronbach's alpha was .87.

Utility of Math. Utility of math was assessed by the following two items rated on seven point scales: "For me, being good at math is . . . ? (1=not at all important to 7=very important) and "How useful do you think high school math will be for what you want to do after you graduate and go to work?" (1=not at all useful to 7=very useful). Alpha reliability was .76.

Interest in Math. Students' responded to the following two items rated on seven point scales: "I find working on math assignments. . . (1=very boring to 7=very interesting)" and "How much do you like doing math?" (1=a little to 7=a lot). Higher scores indicate more interest in math. For this scale, Cronbach's alpha was .92.

Math Ability. We used the Numerical Ability Subscale of the Differential Aptitudes Test administered in the ninth grade as an objective, standardized indicator of math ability.

Tenth Grade Math GPA. Students' math grades (based on school record data) were averaged for math classes taken during first and second semester of their sophomore year.

Math Course Enrollment Patterns. We used two different techniques to describe math course enrollment patterns. The first, which we labeled *"Track,"* reflects our best judgment of the level of the sequence of courses the students took across their four years of high school. We inspected individual course enrollment patterns, which were quite diverse across individuals within schools. Many students followed what we considered to be somewhat unusual patterns; for example, they would drop out of math for year and return the following year, or they would take a math course from a different sequence one year and then return to their original sequence pattern (i.e., taking algebra in ninth grade, business math in tenth grade, and then geometry in the eleventh grade). But, most of the students followed the sequences recommended in their high school handbooks—that is, sequences linked to either their math ability level or their post high school occupational trajectories. We were able to classify most of the students into one of following four "tracks" based on their ninth grade math course and information in their high school handbook: honors, college, regular, and basic. Students in the "honors" group typically studied Geometry in the ninth grade, Algebra or Trigonometry in the tenth grade, Pre-calculus in the eleventh grade, and Calculus in the twelfth grade. Students in the "college" tracking group commonly chose Algebra 1, Geometry, Algebra 2 or Trigonometry, and Pre-calculus or no math course in the ninth, tenth, eleventh, and twelve grades, respectively. The "regular" tracking group was enrolled in Pre-Algebra in the ninth grade, Algebra 1 in the tenth grade, Geometry in the eleventh grade, and no math class in the twelfth grade. Finally, students in the "basic" tracking group were commonly enrolled in General Math in the ninth grade, General Math, Pre-Algebra, or Algebra 1 in the tenth grade, and no math classes in the eleventh or twelfth grades. Given the variability in these tracks and the close association of track level with entering math ability level rather than student choice, we include this information only for descriptive purposes.

Number of Math Classes. The second indicator was much more straightforward—the total number of semesters of math courses. We use this indicator in our regression analyses because it is a better indicator of choice than the "track" or highest level of math course taken. Both of the latter two possible indicators are closely linked to performance histories and school policies that are less under the students own control than the number of courses taken. Students in all four "tracks" can take between 4 and 8 semesters of math courses. The specific courses taken are limited by the courses they have taken before, which are limited by such factors as the seventh grade math course they were assigned to, the quality of their math instruction during elementary school, their parents intervention on their behalf during middle school math course assignment, and their math aptitude. In previous studies, investigators have often focused on the college and honors tracks (see Chipman et al. 1985) . Within these tracks it makes sense to use the highest level of math course taken as the dependent variable since the students have similar choices to make. But in this study, we have intentionally focused on the entire range of students so that our results are relevant to the broader issue of math illiteracy in this country.

RESULTS

Overview. Descriptive analyses were conducted first to examine the characteristics of our "tracking" groups. Gender distribution in the "tracking" groups was tested using a chi-squared analysis. Next, "tracking" group and gender differences in number of math courses taken were examined using two-way analysis of variance.

Path analyses were used to test the expectancy-value model. A series of regression analyses were performed. First, gender, ninth grade math aptitude, and tenth grade math GPA were entered as exogenous predictors of three math-related beliefs: students' interest, self-concept of ability, and utility of math. Second, the total number of math classes taken throughout high school was predicted with all three beliefs, controlling for gender, math ability, and tenth grade math GPA. Finally, the beliefs were each entered separately with the three exogenous predictors to examine their individual relation to number of courses taken. As you will see, the three predictors are highly intercorrelated, introducing the problem of multicollinearity into our analyses. Multicollinearity can lead one to underestimate the influence of some of the predictors because they share so much variance with other predictors. Slight variations in the relative size of each predictor with the dependent measures can have a major impact on the size of each coefficient in the multivariate regression equation when all predictors are entered simultaneously. Consequently, to provide as full a picture as possible, we ran several different analyses so that we could report the regression coefficients for each of the beliefs both independent of one another and separate from each other. This allows researchers interested in the total predictive power of each of the beliefs to relate their findings to the findings reported in this article.

GENDER COMPOSITION OF "TRACKING" GROUPS

The chi-squared analyses examining the difference between "tracking" groups in terms of gender composition approached significance (see Table 1). The honors "track" had fewer girls than would be expected, based on the proportion of girls in the sample. In contrast, girls were to be over-represented in the regular "tracking" group.

NUMBER OF MATH CLASSES TAKEN BY "TRACKING" GROUP

Two-way analysis of variance revealed significant group differences in the number of math classes taken by the students in each of the four "tracking" groups. Main effects were found for gender and "tracking" group: boys took more math classes than girls ($F(1, 1753)=11.91$, $p < .01$) and students in the "honors" track took the most math courses while students in the basic "tracking" group took the least number of math classes ($F(3, 1753)=65.21$, $p < .01$) (See Table 2). In addition, the interaction between gender and tracking group was significant ($F(3, 1753)=2.55$, $p < .05$). To examine the nature of the interaction, one-way analyses of variance by gender were conducted separately for each of the four "tracking" groups. Results indicated that girls took significantly fewer semesters of math than boys only in the honors "tracking" group ($p < .001$). The difference approached significance in the basic "tracking" group ($p < .07$), with girls in that group also taking fewer semesters of math than boys. No significant gender differences were found in the College and Regular tracks.

PREDICTING NUMBER OF MATH CLASSES

The number of semesters of math courses taken by the students was selected as the outcome in these path models because this number reflects students' self-regulatory choices better than the level of the courses taken. After the required four semesters of high school math, students have more control over whether or not to continue taking math than they do over what level math course to take. Thus, in terms of the role of expectancies and values, one would expect greater impact of these beliefs on number of courses rather that tracking level of the courses.

TABLE 1
Gender Composition of Tracking Groups
(n = 1761)

Tracking Group	*Gender (by percent)*		*Total Sample*
	Girls	*Boys*	
Honors	138(47)	154(53)	292
College	351(52)	322(48)	673
Regular	228(58)	167(42)	395
Basic	211(53)	190(47)	401
Total	928(53)	833(47)	1761

Note: $\chi^2 = 7.54$, $p < .06$

TABLE 2
Number of Math Classes by Gender and Tracking Groups
(n = 1761)

Tracking Group	*Gender*		
	Girls	*Boys*	*Group*
Honors	6.4 (1.7)	7.0 (1.5)	6.7
College	6.5 (1.5)	6.5 (1.5)	6.5
Regular	6.1 (1.8)	6.1 (1.8)	6.1
Basic	5.0 (1.8)	5.4 (1.9)	5.2
Total	6.0	6.3	

Notes: Main effect for tracking group F (3, 1753)=65.21, $p < .01$.
Main effect for gender F (1, 1753)=11.91, $p <.01$.
Interaction F (3, 1753)=2.55, $p < .05$.

Zero-order correlations between all variables in the model are reported in Table 3. As Table 3 indicates, the three exogenous variables are all significantly related to each of the three psychological variables, with the exception of gender and interest in math. The three psychological predictors were also significantly correlated to each other. Utility was related to interest (r=.59) and self-concept of ability (r=.50). Self-concept of ability and interest also were correlated (r=.64). Thus, path analyses were conducted in two steps. First, the combined effect of utility, self-concept of ability, and interest on the number of math classes taken was examined. Second, utility, interest, and self-concept of ability in math were each included separately in the path analyses to reduce the threat of losing significant paths because of the multicollinearity between the three psychological predictors. Gender, math aptitude, and tenth grade math GPA were entered into all regression analyses.

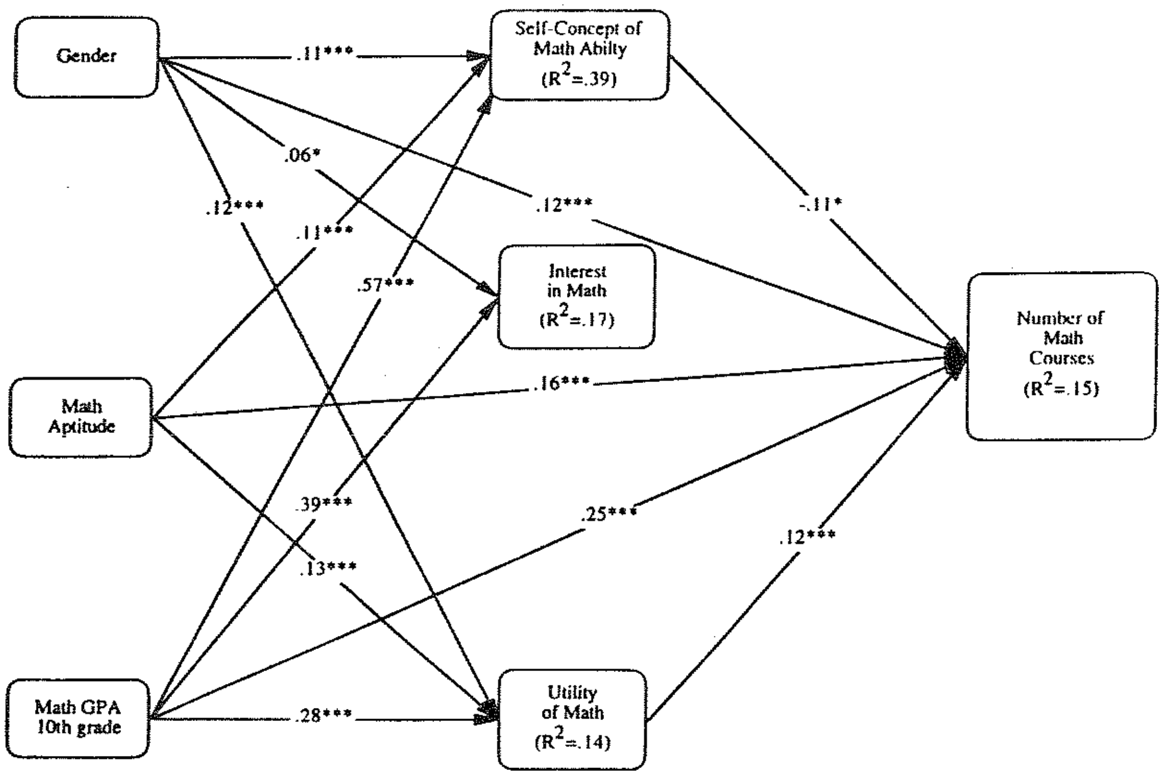
Figure 2 illustrates the full path model. The first three regressions examined the relationship between the exogenous variables and the beliefs. Self-concept of ability was predicted by gender (males higher), ninth grade math aptitude, and tenth grade Math GPA. Interest in math was predicted by gender (males more interested) and GPA. Utility of math was predicted by gender (males higher), math aptitude, and GPA. The fourth regression tested the combined effect of self-con-

TABLE 3
Zero-Order Correlations between All Variables in the Path Model

	2	*3*	*4*	*5*	*6*	*7*
1. Gender	.11***	–.06+	.09**	.04	.12***	.13***
2. Math aptitude		.46***	.38***	.24***	.27***	.29***
3. Math GPA			.61***	.41***	.64***	.31***
4. Self-concept of math ability				.64***	.50***	.21***
5. Interest in math					.59***	.20***
6. Utility of math						.24***
7. # of math courses						

Note: $+p < .10$; $*p < .05$; $***p < .001$.

FIGURE 2
Full model predicitng number of math courses taken in high school



cept of ability, interest, and utility of math, and gender, math aptitude, and tenth grade Math GPA on the number of math courses taken. Gender, ninth grade math aptitude, tenth grade Math GPA, and utility of math were significantly directly related to the number of math classes. In addition, as predicted, gender, aptitude, and GPA had indirect effects on course taking, through their effect on math utility. Interestingly, self-concept of math ability has a direct, but negative path. It is likely this represents a repressor effect due to the multicollinearity of the six predictors, as the zero-order relationship between self-concept of ability and number of courses is positive (r=.24). Together, these variables accounted for 15% of the variance in the number of math courses.

Next, regressions were conducted separately for self-concept of ability, utility, and interest in math. In the first regression of self-concept of ability in math, gender, math aptitude, and tenth grade Math GPA on number of courses only the three exogenous variables were significantly associated with the number of math classes; indicating that self-concept of math ability does not have a significant impact on course taking once gender, aptitude, and GPA are controlled (see Figure 3). Fourteen percent of the variance was accounted for in this model.

In the analyses including gender, math aptitude, tenth grade Math GPA, and interest in math the three exogenous variables had significant direct effects on the number of math classes, and interest in math approached significance ($p < .06$) as a predictor of courses taken. Again, 14% of the variance in the number of courses taken was accounted for in this model (see Figure 4).

FIGURE 3
Predicting number of math courses with self-concept of math ability, gender, math aptitude, and math GPA

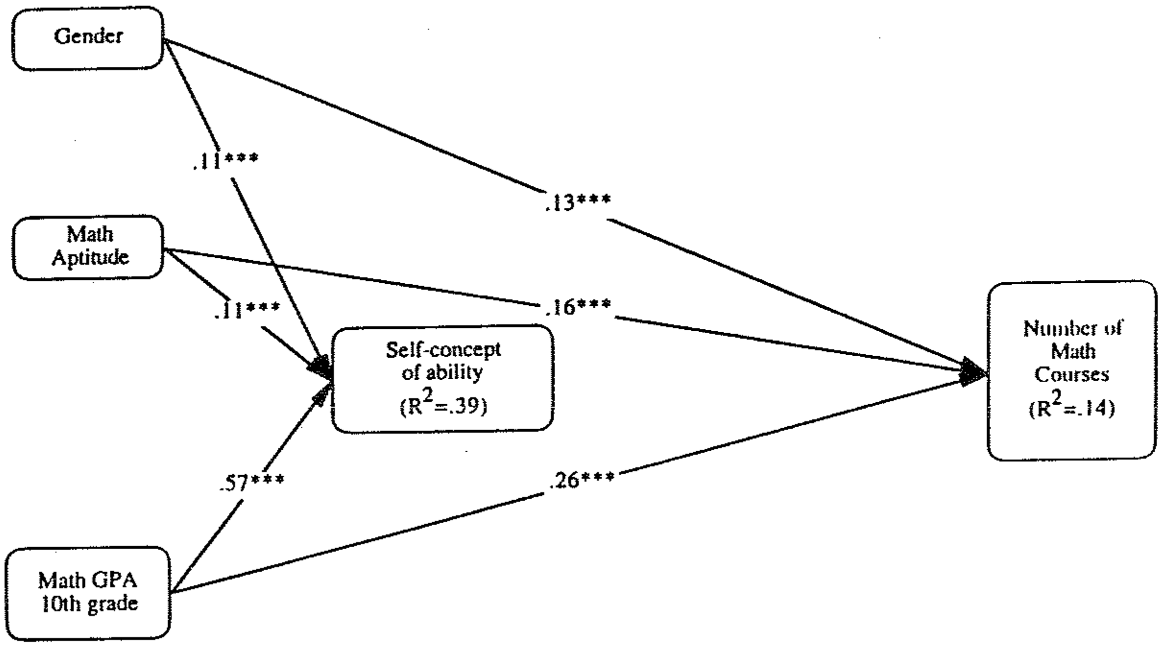
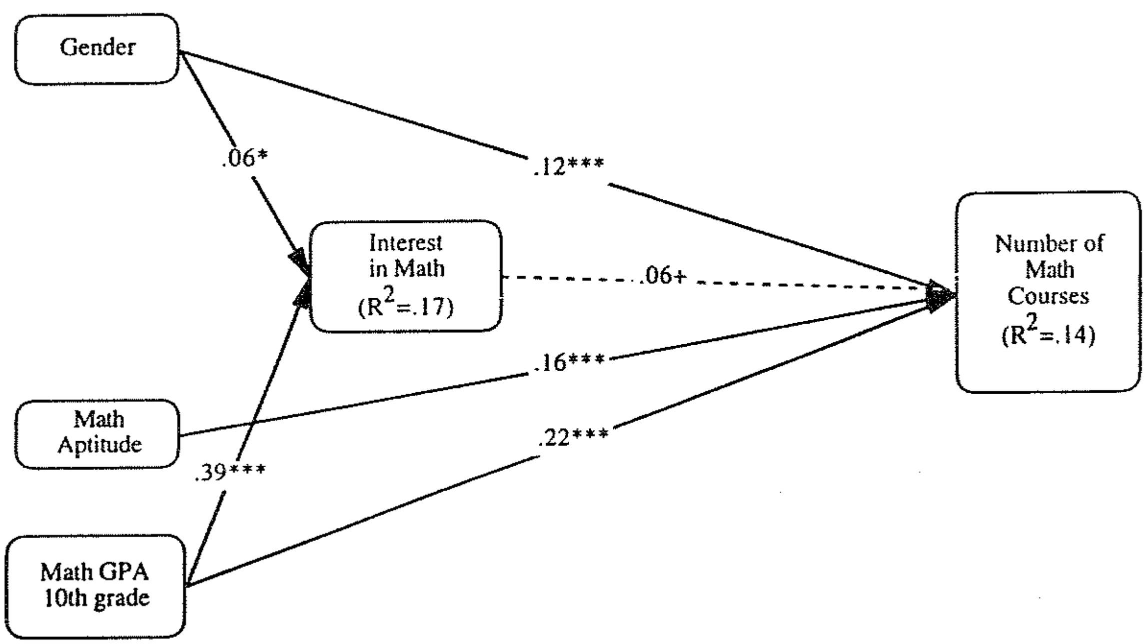


FIGURE 4
Predicting number of math courses with interest in math, gender, math aptitude, and math GPA



Finally, analyses including utility of math, gender, math aptitude, and tenth grade Math GPA revealed the predicted pattern of relationships. Each variable had a significant direct effect, all three exogenous predictors had an additional indirect effect through utility. Fifteen percent of the variance in the number of courses taken was accounted for by the model (see Figure 5).

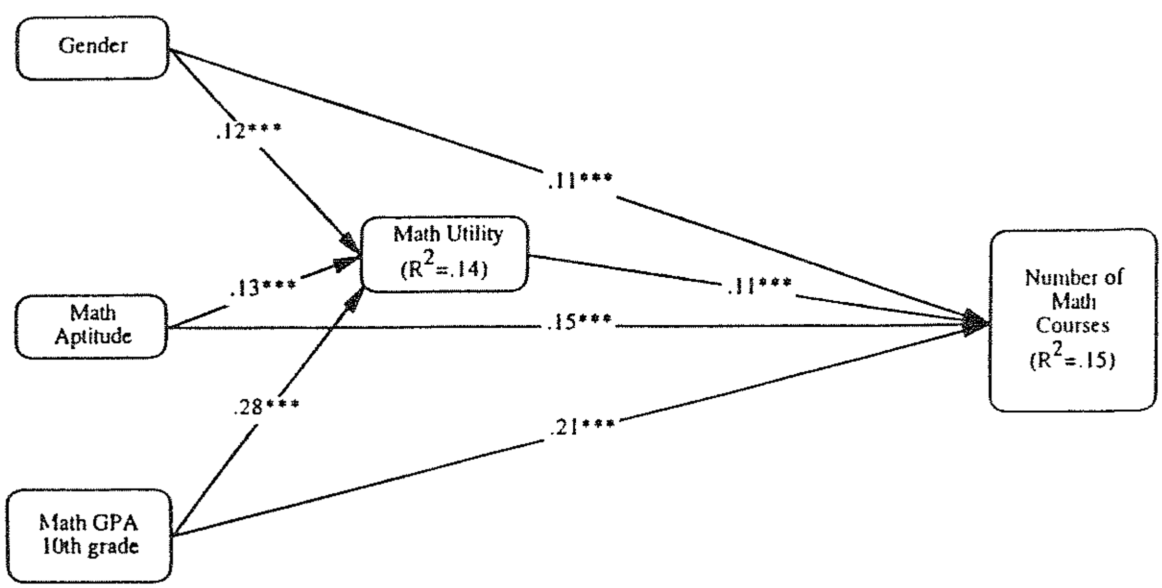
DISCUSSION

We had two primary goals in this paper: (1) to provide a description of high school math course enrollment patterns and their association with student gender, and (2) to test the utility of the Eccles et al. Expectancy-Value Model for predicting individual differences in cumulative math course enrollment. By and large, the results are consistent with our hypotheses for each of these sets of analyses.

PATTERNS OF MATH COURSE ENROLLMENT

The descriptive goal of the article had two components: to summarize the nature of high school course taking trajectories and to examine the relation of gender to

FIGURE 5
Predicting number of math courses with utility of math, gender, math aptitude, and math GPA



math "tracking" group membership and course taking. We were able to classify the students into the following four "tracking" groups based on course catalogues and ninth grade math course: honors, college, regular, and basic. Gender differences were found only in the honors "track": in this track females were both underrepresented in terms of membership and stopped their math education earlier than their male peers in this track. More specifically, honors math students typically took Geometry in ninth grade, and then proceeded up to Calculus in twelfth grade, averaging 6.7 semesters of math courses. The girls in this track, however, took approximately 1/2 semester less math than the boys (6.4 versus 7 semesters). These results are consistent with other research showing that gender differences in math course taking are most apparent among the most able students (Chipman et al. 1985; Eccles 1984; Eccles & Harold 1992; Phillips 1984).

The most common explanation for this difference is the gender difference favoring males on measures of math expectations/self-efficacy/ability self-concepts (see Bandura 1994; Betz & Fitzgerald 1987; Chipman et al. 1985; Meece et al. 1982). We also obtained this gender difference for our indicator of math self-concept. However, this gender difference did not mediate the gender difference in number of math courses taken. Instead, the gender difference in course taking was mediated in part by the gender difference in the perceived utility of math. This finding is discussed later, along with a consideration of the most likely intervention strategies for increasing the number of math courses taken by these math able females.

The most important other finding relates to the differences in number and type of math courses taken across the different "tracks." The college track students take similar math courses as the students in the honors "track," but since they take these courses approximately one year later than the honors students, they end up finishing with Pre-Calculus instead of calculus and math analysis if they take math during all four years of high school. But the majority did not take four years of math; the average for this group was 6.5 semesters of math. Consequently, most ended their math education with less than one of year of advanced math training beyond introductory algebra and geometry—less training than many educators would recommend for adequate college preparation.

This differences in both the number and the type of math courses taken by the honors "track" versus the college preparatory "track" is troubling. In many schools, the distinction between these two groups of students is fairly arbitrary, often depending more on school policies regarding how many honors courses will be offered than on more objective indicators of the students' ability to master the material being taught (Dornbusch 1994, Oakes 1985). Although the consequences of not being exposed to either analytic math or calculus during high school for subsequent difficulties in college math and science courses have not been adequately studied, it is reasonable to assume that greater exposure would provide a cushion of familiarity with higher level mathematical reasoning that, in turn, could ease the anxiety many college students, particularly female college students, have about college math, science, economic, and statistics courses (see Chipman et al. 1985).

Furthermore, the fact that there was no difference in the number of courses taken by females in these top two "tracks" is consistent with other studies suggesting that neither counselors nor math teachers provide as much support and encouragement for these girls, compared to their male peers, to take as much math as possible in high school (Chipman et al. 1985; Eccles & Harold 1992). For both of these groups, the girls appear to be allowed to select themselves out of math after their junior year. In contrast, boys in the honors "track" stay in math through the middle of their senior year while the boys in the college "track" show the same pattern as the girls in both of these tracks. Evidence from other sources suggests that the honors boys take more math courses both because they want to and because they are actively discouraged from dropping out of math too early (see Chipman et al. 1985). There is also ample evidence to suggest that both the boys and girls in the college "track" would take more math if they were actively encouraged to do so (see Chipman et al. 1985; Eccles & Harold 1992).

But even more troubling is the limited math training the students in the basic "track" are allowed to get. This group of students took only 5.2 semesters of high school math, beginning with General Math in ninth grade. Few took any abstract math such as algebra. As a result, many of these students leave high school with less training in mathematical reasoning than needed for the types of jobs they hope to enter (NSF 1994). Evidence from Catholic schools demonstrates that almost all high school students can learn abstract mathematical reasoning if they are given adequate instruction and the opportunity to enroll in the proper courses (Bryk et al. 1993). Apparently, the students in these school districts, like the students in many public school districts around the country, are being given neither of these opportunities.

ASSESSING THE ECCLES ET AL. EXPECTANCY-VALUE MODEL

We had two sub-goals for this set of analyses. First, we tested whether the exogenous variables of gender, math aptitude and GPA predicted variation in our three psychological constructs. Second, we tested whether these psychological constructs predicted the number of math courses taken after controlling for our three exogenous variables.

As expected, both ninth grade math aptitude and tenth grade math GPA predicted self-concept of math ability, interest in math and the perceived utility of math. The strongest associations occurred for self-concept of ability, suggesting that self-concept of math ability is a very accurate reflection of one's performance history in mathematics. In addition, also as one might expect, interest was more strongly related to GPA than to performance on the DAT. These results on consistent with those studies indicating that expectancy-related beliefs are highly correlated with previous performance (e.g., Eccles [Parsons] et al. 1983; Marsh 1990).

The pattern for gender is particularly interesting. Gender is related to self-concept of math ability both at the zero-order level and after grades and aptitude are controlled. The latter finding indicates that males report higher than expected self-concept of math ability after GPA and Math Aptitude were controlled. Girls in this population received higher grades than the males while they were in junior high school (Frome & Eccles 1995). They also received slightly higher math grades in tenth grade. Consequently, given the strong association between GPA and self-concept of ability one would expect the girls to report higher ability self-concepts than the boys. They do not. Other researchers have found a similar discrepancy in the direction of gender effects for grades and ability self-concepts. In most of these studies, the boys report higher ability self-concepts even though the girls are receiving higher grades. One might conclude, however, that the boys higher self-concepts reflect the fact that they earn higher scores on standardized aptitude tests like the DAT. However, we find a significant gender effect even when DAT scores are controlled. There has been some speculation as to whether this discrepancy reflects boys' over-estimation or girls' underestimation. Results across studies on this question are mixed. For example, both Crandall (1969) and Phillips (1984) concluded that girls, particularly the most able girls, are underestimating their ability. In contrast, other analyses on this same population suggest that during the seventh grade the females in the top quartile of this population in terms of math performance are more accurate than the boys in their math ability self-concepts with the boys overestimating their math ability (Frome & Eccles 1995). But regardless of which group is more accurate, the boys' higher self-concepts are likely to have beneficial effects for them in the long run since high ability self-concepts and high efficacy (even if unrealistically high) have been shown to facilitate performance, particularly in high anxiety-provoking contexts, such as on difficult, standardized timed tests and in advanced, abstract courses (Dweck & Licht 1980; Eccles et al. 1984; Steele & Aronson 1996).

As expected, we also found a gender difference in the perceived utility of math: Consistent with gender-role stereotypes, males rated the utility of math higher than females. Why might this be so? Sex differences have been found on many of the psychological processes proposed by Eccles and her colleagues to underlie sex differences in subjective task value. For example, Eccles-Parsons et al. (1983) predicted that the value of particular tasks would be linked to: (a) conceptions of one's personality and capabilities, (b) long range goals and plans, (c) schema regarding the proper roles of men and women, (d) instrumental and terminal values (Rokeach, 1973), (e) ideal images of what one should be like; and (f) social scripts regarding proper behavior in a variety of situations. If gender-role socialization leads males and females to differ on these core self and role related beliefs, then related activities will have differential value for males and females. For example, both boys and girls stereotype mathematicians and scientists as loners who have little time for their families or friends because they work long hours in a laboratory on abstract problems that typically have limited immediate social implications (Boswell 1979). If females place a lot of value on having time to spend with their future families then becoming a scientist or mathematician should hold little appeal to them given this stereotype. Similarly, in a study of linking personal values and college major, Dunteman, Wisenbaker, and Taylor (1978) identified two sets of values that both predicted major and differentiated the sexes: the first set (labeled thing-orientation) reflected an interest in manipulating objects and understanding the physical world; the second set (labeled person-orientation) reflected an interest in understanding human social interaction and a concern with helping people. Not surprisingly, the females had higher person-orientation than the males and the males reported higher thing-orientation than the females. Furthermore, consistent with the course enrollment gender differences in the present sample, the students in Dunteman et al. (1978) with high thing-orientation and low person-orientation were more likely than other students to select a math or a science major. And finally, the females were more likely than the males to major in something other than math or science because of their higher person-oriented values.

It is likely that similar differences in the population reported on this paper will be linked to gender differences in their career plans. The males in this population are more likely than the females to aspire to careers requiring four years of high school math (Eccles, 1994). In addition, at grade 12, these young women placed more value than their male peers on a variety of female-stereotyped career-related skills and interests such as doing work that directly helps people and meshes well with child-rearing responsibilities (Jozefowicz, Eccles, & Barber, 1993). These values, along with ability self-concepts, predicted the gender stereotyped career plans of both males and females.

With regard to our second sub-goal, of the three psychological predictors, perceived utility yielded the strongest and most consistent association with number of high school math courses taken. It was the only significant psychological predictor in the full model and it had the largest beta in the reduced models. Furthermore, perceived utility was the only psychological predictor through which gender had an indirect, as well as a direct, effect on number of math courses taken. These results are consistent the findings of Eccles (1984) and Eccles et al. (1984) but somewhat at odds with the burgeoning literature stressing the importance of efficacy-related constructs as both predictors of both individual differences and gender differences in achievement and achievement choices (e.g., Bandura 1995; Betz & Fitzgerald 1987).

Several investigators, including Eccles and her colleagues, have found the positive relation between self-concept of ability and performance indicators like grades. And there is considerable debate right now regarding the direction of the causal relation between performance and self-concept of ability. The safest conclusion seems to be that they are reciprocally related. But whatever the direction, by tenth grade, there is a very strong association between these two variables. By this age, ability self-concepts are a very accurate reflection of current competence. Thus, it should not be surprising that these self-concepts have little independent predictive power once indicators of current competence are entered into the equation, particularly for inherently difficult yet optional choices like advanced high school math courses. Consistent with this hypothesis, both Eccles et al. (1984) and Eccles (1984) found that, even though self-concept of ability was a powerful predictor of subsequent math grades, it was not a significant predictor of course enrollment plans and actual course enrollment once achievement level was controlled. In contrast, in both of the these studies, as well as in the current study, indicators of subjective task value are significant predictors of course enrollment even after current achievement levels are controlled. It is likely that values continue to predict course enrollment precisely because they are more independent of actual ability level.

These findings highlight a critical feature of the Eccles et al. (1983) perspective: namely, the explicit assumption that achievement-related decisions, such as the decision to enroll in an accelerated math program or to major in education rather than law or engineering, are made within the context of a complex social reality that presents each individual with a wide variety of choices; each of which has both long range and immediate consequences. Furthermore, the choice is often between two or more positive options or between two or more options that each have both positive and negative components. For example, the decision to enroll in an advanced math course is typically made in the context of other important decisions such as whether to take advanced English or a second foreign language, whether to take a course with one's best friend or not, whether it's more important to spend one's senior year working hard or having fun, etc. Too often theorists have focused attention on the reasons why capable women, for example, do not select the high status achievement options and have failed to ask why they select the options they do. This approach implicitly assumes that complex choices, such as career and course selection, are made in isolation of one another; for example, it is assumed that the decision to take advanced math is based primarily on variables related to math. Eccles and her colleagues explicitly reject this assumption, arguing instead that it is essential to understand the psychological meaning of the roads taken as well as the roads not taken if we are to understand the dynamics underlying both men's and women's achievement-related choices (Eccles 1994).

Consider, as an example, two junior high school students: Mary and Barbara. Both young women enjoy mathematics and have always done very well. Both have been identified as gifted in mathematics and have been offered the opportunity to participate in an accelerated math program at the local college during the next school year. Barbara hopes to major in journalism when she gets to college and has also been offered the opportunity to work part time on the city newspaper doing odd jobs and some copy editing. Mary hopes to major in biology in college and plans a career as a research scientist. Taking the accelerated math course involves driving to and from the college. Since the course is scheduled for the last period of the day, it will take the last two periods of the day as well as 1 hour of after-school time to take the course. What will the young women do? In all likelihood, Mary will enroll in the program because she both likes math and thinks that the effort required to both take the class and master the material is worthwhile and important for her long range career goals. Barbara's decision is more complex. She may want to take the class but may also think that the time required is too costly, especially given her alternative opportunity at the city paper. Whether she takes the college course or not will depend a lot on the advice she gets at home and from her counselors. If they stress the importance of the math course then its subjective worth to her will increase. If its subjective worth increases sufficiently to outweigh its subjective cost, then Barbara will probably take the course despite its cost in time and effort.

These results have interesting implications for intervention designed to get both females and males to take more high school math courses. Given the importance of the perceived utility of math as the critical attitudinal predictor of the number of math courses taken, interventions need to focus directly on increasing the perceived utility of high school math courses. Eccles and her colleagues have observed in numerous high school math courses. They reported rarely hearing the teachers explain why taking high school math courses might be important (Eccles-Parsons et al., 1982). Students often do not know how much math is required for different occupations and for entry into different types of post-secondary school education (Dornbusch 1994). Consequently it should not be surprising that they take little more than what is required for their high school graduation. As noted earlier, ample evidence now exists documenting the benefits of intervention programs focused both on perceived utility value and on self-efficacy (see Chipman et al. 1985). Furthermore, such programs are effective for both girls and boys.

In summary, we found good support for the Eccles et al. model particularly with regard to the power of subjective value beliefs in explaining both individual differences and gender differences in students' high school math course enrollment patterns. We are particularly struck by the strength of the importance/utility construct. Recall the example we gave about the two young women deciding whether to take the college course or not. We stressed the perceived utility of the course for the young women's future plans. These data support this emphasis. At this point in these students' lives, they must begin to chose between elective courses. These finding suggest that they weigh the utility of the course for their future educational and vocational goals heavily in making these choices.

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