Course Enrollment as Self-Regulatory Behavior:

Who Takes Optional High School Math Courses?

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Without a doubt, course enrollment decisions lead to some of the most influential self-regulatory behaviors in terms of the opportunities students will have to learn new material. A great deal of concern has been expressed lately about math course enrollment decisions in particular. Several reports of the educational status of American students point to relatively low levels of math proficiency at all grade levels. Decisions to take only the minimal number of high school math courses contribute to this problem among high school graduates. Understanding the attitudinal predictors of these course enrollment decisions would provide a basis for intervention programs. This paper 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, originally proposed to help explain why fewer women than men enroll in advanced math and physics courses, 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), Eccles and her colleagues elaborated an expectancy-value model of achievement-related choices. This 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 beliefs, to self perceptions and self concept, 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 several factors including the following: 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 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?

This example should make clear an very important feature of our perspective: 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 gifted, 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? It 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.
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, and the behaviors and goals of one's socializers and peers.

In this paper, we test the utility of expectancy-value components of this model for predicting math course enrollment. The project differs from most other studies of math course enrollment in two ways: First, it is longitudinal. Second, it includes measures of both explicit expectations and subjective task values and of previous performance history assessed in terms of both a standardized test of quantitative reasoning and math course grades. Although many studies have documented 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), few of these studies have also included indicators of subjective task value. Eccles (1984) has 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. In this paper, we extend this work to a normative sample of adolescents in several midwestern school districts. By including indicators of both expectancy-related beliefs and subjective task values, we are able to test for the relative importance of these two sets of psychological beliefs as predictors of course enrollment. By including indicators of both aptitude and prior grades, we are able to test the independent
importance of these two sets of psychological beliefs, after controlling for their association with current ability and past performance.

Methods

Sample

The sample was drawn from the fifth wave of the Michigan Study of Adolescent Life Transitions (MSALT), a 10-year, 7-wave longitudinal investigation designed to examine participants' normative and non-normative life transitions from early adolescence through adulthood. Participants were 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 fifth wave of data was collected when adolescents were in the tenth grade.

Surveys were administered to 1,492 adolescents at wave five. The study focused on adolescents who responded to the survey at wave five and for whom complete record data was obtained through grade twelve (n=1,048). Of these participants, approximately equal numbers of girls and boys were represented (554 girls and 495 boys). The sample was predominantly white.

Procedure

The fifth wave of data was 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 course work, grades, and standardized test scores was gathered from school records. Researchers obtained this information for all students who completed questionnaires at wave five.

Measures

Measures were obtained from student questionnaires and school record data. Self-concept of ability in math, utility of math, and interest in math was measured by students'
responses to a series of items. 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.** Students' rated their math ability on a three item scale. Items were rated on a seven point Likert-type scale with higher scores indicating more positive self-concepts of ability. Sample items include "How good are you at math?" (1=Not very 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=Worst to 7=Best). Cronbach's alpha was .86.

**Utility of Math.** Utility of math was assessed by two items which students rated on a seven point scale with higher scores suggesting that math will be more useful in the future. Items were "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 .75.

**Interest in Math.** Students' responded to two items which tapped their interest in math. Questions were "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 .90.

**Math Ability.** Math ability was measured by standardized test scores on the Numerical Ability Subscale of the Differential Aptitudes Test administered in the ninth grade.

**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.

**Number of Math Classes.** Information regarding course enrollment patterns including the number of math classes was gathered from school record data. Students received a "1" for each semester of math taken during their high school years.

**Tracking Groups.** Course catalogues from each school district were used to identify tracking groups. Tracking groups were defined by students' math classes at the ninth grade.
Students were classified into one of four groups representing honors, college, regular, and basic course enrollment patterns.

Although there was considerable variability in course enrollment patterns, 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.

Results

Descriptive analyses were conducted first, to examine the characteristics of the 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 was 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, math aptitude, and 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.

Gender Composition of Tracking Groups

The chi-square 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 the regular tracking group, girls appeared to be over-represented.

**Number of Math Classes Taken by Tracking Group**

Two-way analysis of variance revealed significant group differences in the number of math classes taken. Main effects were found for gender and tracking group with boys taken more math classes than girls ($F(1, 1753)=11.91, p < .01$) and students in the honors track completing the most math courses and students in the basic tracking group completing 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 in the honors tracking group ($p < .001$). The difference approached significance in the Basic tracking group ($p < .07$), with girls in that group 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 included as the outcome in these path models because that number reflects student 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 than tracking level of the courses.

Zero-order correlations between utility, interest, and self-concept of ability in math were significant. Utility was related to interest ($r=.49, p < .01$) and self-concept of ability ($r=.59, p < .01$). Self-concept of ability and interest also were correlated ($r=.64, p < .01$). 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 1 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), math aptitude, and tenth grade Math GPA. Interest in math was predicted by math aptitude and GPA. Utility of math was predicted by gender (males highers, math aptitude, and GPA. The fourth regression tested the combined effect of self-concept of ability, interest, and utility of math, and gender, math aptitude, and tenth grade Math GPA on the number of math courses taken. Gender, math aptitude, tenth grade Math GPA, and utility of math were significantly directly related to the number of math classes. In addition, gender, aptitude, and GPA had an indirect effect on course taking, through their effect on math utility. Together, these variables accounted for 12% of the variance in the number of math courses.

Next, regressions were conducted separately for self-concept of ability, utility, and interest in math. The first regression including self-concept of ability in math, gender, math aptitude, and tenth grade Math GPA revealed that the three exogenous variables were significantly associated with the number of math classes, but that self-concept of math ability did not have a significant impact on course taking once gender, aptitude, and GPA were controlled (see Figure 2). Eleven percent of the variance was accounted for in this model.

Analyses including gender, math aptitude, tenth grade Math GPA, and interest in math revealed that all four variables had significant direct effects on the number of math classes, and that math aptitude and gender also had indirect effects though interest in math. Again, eleven percent of the variance in the number of courses taken was accounted for in this model (see Figure 3).
Finally, analyses including utility of math, gender, math aptitude, and tenth grade Math GPA revealed similar results. Each variable had a significant direct effects, all three exogenous predictors had an additional indirect effect through utility, and 12% of the variance in the number of courses taken was accounted for by the model (see Figure 4).
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 math course enrollment patterns. 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 paper was two-fold: to summarize the nature of high school course taking trajectories and to examine the relation of gender to math tracking groups and course taking. Four tracking groups were described, based on course catalogues and the course sequences followed by the sample: honors, college, regular, and basic. Gender differences were found in the membership of those tracking groups, and in the course enrollment patterns of the track members.

Honors math students, who were disproportionately male, typically took Geometry in ninth grade, and then proceeded up to Calculus in twelfth grade, averaging 6.7 semesters of math courses. Girls in this tracking group took significantly fewer semesters of math courses (6.4 semesters) than the boys in this track (7 semesters). Thus, not only were girls underrepresented in this track, but those girls who were in the honors track also stopped their math education earlier than their male peers. These results are consistent with other research showing that gender differences in math-related attitudes are most apparent among the most able students (Crandall, 1969; Eccles, 1984; Eccles & Harold, 19xx; Frome & Eccles, 1995; Phillips, 1984).

College track students took the math course sequence a year behind the honors group, taking Algebra 1 in ninth grade, and finishing with Pre-Algebra if they took math during all four years of high school. On average, the students in this group took 6.5 semesters of math, and no gender differences in group representation or in course taking were found. In addition, although the boys in the college track took fewer semesters than boys in the honors track, college and
honors track girls did not differ with respect to the number of semesters of math taken (did not report this test in results—does it seem interesting?).

The Regular tracking group students took Pre-Algebra, Algebra 1, and Geometry, and did not typically take math in twelfth grade (6.1 semesters). Girls were over-represented in the Regular group, relative to their proportion in the sample. Basic tracking group students took only 5.2 semesters of high school math, beginning with General Math in ninth grade, and the gender difference approached significance, with the girls in this group taking fewer semesters of math than the boys.

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 math aptitude and 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 fairly 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.

The pattern for gender is particularly interesting. Although gender was not related in this population to self-concept of math ability at the zero-order level, males reported 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). 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 some of these studies, the boys report higher ability self-concepts; in others, like this study, the boys and girls report similar ability self-concepts. But
what is similar across these studies is that the girls do not report higher ability math self-concepts even though they are receiving higher grades. There has been some speculation as to whether this discrepancies 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, in other analyses on this population, we have reached a different conclusion: at the seventh grade the females in the top quartile of this population in terms of math performance were found to be more accurate than the boys in their math ability self-concepts; the boys in the top quartile overestimated their math ability (Frome & Eccles, 1995).

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.

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) and somewhat at odds with the burgeoning literature stressing the importance of efficacy-related constructs as both predictors of 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 right now seems to be that they are reciprocally related. But whatever the direction, by tenth grade, there is a strong association between these two variables. By this age, ability self-concepts are a fairly 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
tasks like advanced high school math courses. Consistent with this hypothesis, both Eccles et al.
(1984) and Eccles (1984) found that self-concept of ability was a powerful predictor of
subsequent grades but 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, subjective task value was a significant predictor of
course enrollment even after current achievement levels were controlled. It is likely that values
continue to predict course enrollment precisely because they are more independent of actual
ability level.

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.
Reference


Table 1

Gender Composition of Tracking Groups
(n=1771)

<table>
<thead>
<tr>
<th>Tracking Group</th>
<th>Girls</th>
<th>Boys</th>
<th>Total Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honors</td>
<td>138 (47%)</td>
<td>154 (53%)</td>
<td>292</td>
</tr>
<tr>
<td>College</td>
<td>351 (52%)</td>
<td>322 (48%)</td>
<td>673</td>
</tr>
<tr>
<td>Regular</td>
<td>228 (58%)</td>
<td>167 (42%)</td>
<td>395</td>
</tr>
<tr>
<td>Basic</td>
<td>211 (53%)</td>
<td>190 (47%)</td>
<td>401</td>
</tr>
<tr>
<td>Total</td>
<td>928 (53%)</td>
<td>833 (47%)</td>
<td>1761</td>
</tr>
</tbody>
</table>

$X^2(3)=7.54, p < .06$
Table 2
Number of Math Classes by Gender and Tracking Group
(n=1771)

<table>
<thead>
<tr>
<th>Tracking Group</th>
<th>Girls M (SD)</th>
<th>Boys M (SD)</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honors</td>
<td>6.4 (1.7)</td>
<td>7.0 (1.5)</td>
<td>6.7</td>
</tr>
<tr>
<td>College</td>
<td>6.5 (1.5)</td>
<td>6.5 (1.5)</td>
<td>6.5</td>
</tr>
<tr>
<td>Regular</td>
<td>6.1 (1.8)</td>
<td>6.1 (1.8)</td>
<td>6.1</td>
</tr>
<tr>
<td>Basic</td>
<td>5.0 (1.8)</td>
<td>5.4 (1.9)</td>
<td>5.2</td>
</tr>
<tr>
<td>Total</td>
<td>6.0</td>
<td>6.3</td>
<td></td>
</tr>
</tbody>
</table>

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