Sex Roles, Vol. 52, Nos. 5/6, March 2005 (© 2005)
DOI: 10.1007/s11199-005-2678-1

Predictors of Young Adolescents' Math Grades and Course Enrollment Intentions: Gender Similarities and Differences

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Gender differences and similarities in the relations of key constructs in Eccles and colleagues' (Wigfield & Eccles, 2000) model of achievement were examined as predictors of math grades and enrollment intentions for Grade 9 boys ($n = 263$) and girls ($n = 277$). A number of gender similarities were found, particularly in the prediction of math grades. There were, however, two gender-specific paths: for girls, a direct path from competence beliefs to enrollment intentions, and for boys, a direct path from prior math grades to enrollment intentions. In addition, for boys, the path from utility value to enrollment intentions was stronger than it was for girls. These differential predictive patterns were found even though girls and boys reported similar levels of math utility and girls had lower math competence beliefs. For girls, competence beliefs were a significant predictor of both intentions and current math grades, which indicates the central role of competence beliefs.

KEY WORDS: gender differences; competence beliefs; task values; enrollment intentions; math achievement.

Adolescence is a time of identity exploration, formation, and consolidation, when images of various possible selves are shaped and values are established (Harter, 1999). One of the primary tasks of adolescence is developing a sense of identity with respect to the world of occupations, and this appears to be a more conflicted and complex process for girls than for boys (Eccles, 1994; Hackett & Byars, 1996; Kimball, 1989; O'Brien & Fassinger, 1993). Researchers have described mathematics as a critical filter for future academic and occupational options (Hyde, Fennema, Ryan, Frost, & Hopp, 1990). Despite a narrowing over the last 20 years of the gender gap in enrollment in high school math courses (Rock & Pollack, 1995; Wirt et al., 2004) and in bachelor's degrees in math (Wirt et al., 2004), men continue to earn more graduate degrees in math than do women (Betz, 1994; Wirt et al., 2004). Gender differences in math performance that favor men tend to emerge for advanced math courses at both the high school and college levels (Hyde, Fennema, & Lamon, 1990; Kimball, 1989). Furthermore, gender differences in competence beliefs in math continue to be reported both in children in elementary school (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002) and in young adolescents (Marsh & Yeung, 1998). More recently, researchers have examined the effects of high school courses taken (Trusty, 2002; Trusty & Ng, 2000) and knowledge of math stereotypes (Schmader, Johns, & Barquissau, 2004; Spencer, Steele, & Quinn, 1999; Steele, 1997) on women's math performance and choice. These trends, coupled with the importance of math for future educational and occupational choices, underscore the need to continue to examine gender differences in the prediction of math performance and course enrollment. It is particularly important to examine this issue during high school when students are making the choice of whether to stay in the math stream. Within this context, the principal objective of the present study was to investigate the possibility of gender similarities and

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differences in patterns of prediction in models of math grades and enrollment intentions in a sample of Grade 9 students. We focused on competence beliefs and task values for mathematics, two key constructs in Eccles and colleagues' (Wigfield & Eccles, 2000) expectancy-value theory of achievement.

Competence Beliefs and Task Values

Achievement-related competence beliefs and achievement values are factors identified in a number of social cognitive theories (Bandura, 1997, 1999; Lent, Brown, & Hackett, 1994; Steele, 1997; Wigfield & Eccles, 2000) as important influences on behavior, choices, and success in the workplace and other achievement contexts (for reviews, see Stipek, 1992, and Wigfield & Eccles, 2002). In particular, Eccles and colleagues (Wigfield & Eccles, 2000) have developed a model of achievement behavior in which domain-specific competence beliefs (perceptions of one's ability and expectations for one's performance within the relevant domain) and subjective task values (attainment value, intrinsic value, utility value, and cost) are central explanatory constructs. They define attainment value as the importance of doing well on a task, intrinsic value as the inherent enjoyment derived from engaging in a task, utility value as the instrumental value of a task for reaching one's goals, and cost as the value of what one must forgo or endure as a consequence of performing a task.

The model has two principal components: a socialization component and a psychological component. In the socialization component, a number of factors, including past achievement experiences (e.g., grades), parents' and teachers' attitudes and behaviors, and cultural norms, are hypothesized to influence students' domain-specific competence beliefs and task values. The effects of these socialization experiences are mediated by students' interpretations of them—the psychological component. Thus, achievement outcomes, such as grades and educational and occupational choices, are influenced most proximally and directly by internalized competence beliefs and task values.

In applying their model to achievement-related behavior and choices for specific school subjects such as mathematics, Eccles and colleagues have examined the differential predictive influence of these factors. They have proposed that competence beliefs relate more strongly to performance, whereas task values relate more strongly to achievement choices (Wigfield & Eccles, 1992). Numerous investigators have found support for math competence beliefs as predictors of math performance among adolescents (e.g., Eccles et al., 1983; Marsh & Yeung, 1998; Meece, Wigfield, & Eccles, 1990). In a recent meta-analytic review of prospective investigations (Valentine, DuBois, & Cooper, 2004), there was evidence of a small, positive influence of self-beliefs on academic achievement. Consistent with the model of Eccles and colleagues, this estimated effect was stronger for self-beliefs pertaining to academic ability (as opposed to more general self-beliefs or feelings) and most strong when considering measures of self-beliefs and achievement that pertained to the same domain (e.g., math self-concept and math grades). The hypothesized relation between adolescents' math task values and their future intentions and decisions to enroll in optional advanced math courses has received more limited attention (Eccles, 1984; Eccles et al., 1983; Ethington, 1991; Meece et al., 1990), and thus our understanding of this relation is less clear.

It is important to consider the separate components of the task values construct (i.e., attainment, intrinsic, utility, cost) because of the potential for these components to have differential predictive influences on achievement choices. Within specific subject domains, such as math, children's differentiation of the four components of task values develops gradually, moving from nondifferentiation to differentiation by early adolescence (Wigfield et al., 1997; Wigfield & Eccles, 1994). Changes in both the strength (i.e., mean levels) of task values and their relation to achievement choices are expected to vary developmentally. Recent research on the development of task values for math indicates that there is a decline in the value placed on math from Grades 1 to 12 (Fredricks & Eccles, 2002; Jacobs et al., 2002). In terms of the influence of task values, it is expected that young children generally will choose to engage in a task because the intrinsic value they place on that task is high, that is, they enjoy the task (Wigfield & Eccles, 1992). By early adolescence, however, as ideas concerning the usefulness of different activities for future goals begin to develop, utility value is expected to assume a larger role in achievement choices.

By adolescence, students' understanding of the utility value of different subject domains, such as math, can be expected to become increasingly realistic and stable and to assume an increasingly important role in areas such as course enrollment decisions.

As mentioned, although researchers are beginning to examine more closely the developmental pattern of task values (Fredricks & Eccles, 2002; Jacobs et al., 2002), research on specific math values as predictors of math enrollment intentions and decisions has been limited. Furthermore, researchers either have used a global measure of the values construct (e.g., Eccles, 1984; Eccles et al., 1983; Ethington, 1991) or have employed only the importance component of task values (e.g., Meece et al., 1990). Because it is during adolescence that students make their initial choice of whether to continue in math courses, this is an ecologically valid period in which to examine the differentiation of the task values construct and their relative predictive abilities. Based on these considerations, in the present research we specified and tested a structural model that includes hypothesized predictive paths from two individual components of task value (i.e., intrinsic value and utility value) to adolescents' math enrollment intentions.

Gender Similarities and Differences

The central concern of the present research was to investigate gender similarities and differences in the strength and/or presence of relations among competence beliefs, task values, performance in math (grades), and enrollment intentions in a sample of Grade 9 students. Researchers have developed several hypotheses regarding gender differences in the relations among these math-related constructs during adolescence. Proponents of the gender role intensification hypothesis have noted that adolescence may be a time during which both boys and girls experience increased interest in performing gender "appropriate" activities (Hill & Lynch, 1983). Mathematics is a subject domain that is perceived to be stereotypically masculine by children, adolescents, parents, and society in general (e.g., Jacobs & Eccles, 1992; Steele, 1997). Differential socialization by parents, peers, school, and the media has been identified as a factor that contributes to gender differences in math achievement (Eccles, 1994; Farmer, Wardrop, & Rotella, 1999; O'Brien & Fassinger, 1993; Tiedemann, 2000). Gender-differentiated socialization may begin early in childhood with, for example, boys and girls receiving different messages about their efficacy at different tasks (Arbona, 2000) and differential feedback on their math performance and on the value of math for them (Eccles, 1994). Knowledge of the gender stereotyping of math also has been found to be related to women's math self-perceptions and performance (Nosek, Banaji, & Greenwald, 2002; Spencer et al., 1999). Gender stereotypic self-schemas that result from the preceding types of processes may, in turn, contribute to gender differences in competence beliefs and task values for math, as well as differences in the strength of these constructs as influences on math grades and enrollment intentions and decisions.

Gender differences in competence beliefs in math that favor boys have been reported frequently (Fennema & Hart, 1994; Marsh & Yeung, 1998), even though girls typically do as well as, if not better than, boys in math courses (Kimball, 1989). When the role of competence beliefs in predicting math grades has been examined, gender differences in the strength of this relation generally have not been found (Marsh & Yeung, 1998; Meece et al., 1990). Gender differences in competence beliefs in math, however, may have an influence on other achievement outcomes, such as math enrollment intentions and decisions. In fact, it has been suggested that gender differences in competence beliefs may be an important factor that contributes to women's lower probability of taking advanced level math courses and entering math-related occupational fields (Eccles, 1994; Farmer et al., 1999).

Gender differences in the extent to which children value math do not appear to be present during elementary school (Jacobs et al., 2002; Wigfield & Eccles, 1994) nor at the start of junior high (Wigfield, Eccles, MacIver, Reuman, & Midgley, 1991). There is, however, some evidence for gender differences in the value of math for older adolescents and higher achieving populations (Eccles, 1984). High school boys have been found to report greater interest in math (Hyde, Fennema, & Lamon, 1990; Hyde, Fennema, Ryan, et al., 1990) and to rate math higher in utility value, particularly advanced math (Eccles, 1983), than do high school girls. Gender differences in subjective task values have been proposed by a number of researchers (Eccles, 1994; Farmer et al., 1999) as possible critical mediators of the choices boys and girls make about which academic activities to pursue. Consistent with this possibility, in early work (Eccles, 1984) in which actual enrollment was examined, girls were found to be less likely than were boys to enroll in advanced mathematics. This gender difference in enrollment was mediated by gender differences on a global measure of task value. For girls, task value was found to be an important predictor of enrollment in math courses, whereas for boys, enrollment in math was predicted primarily by previous math performance. In this earlier research, a global measure of task value, which consisted of attainment, intrinsic, and utility value, was used. Thus, developmental changes in the separate contributions of each of these values to the prediction of achievement behaviors were not taken into account. In addition, Eccles used a sample of students from across the high school years, thereby introducing the possibility that developmental changes in the predictive influence of task values could confound the results.

The current study extends earlier research as we considered the separate contributions of intrinsic value and utility value and controlled for possible developmental differences in the patterns of influence among variables by focusing on a specific grade level (Grade 9 students). These relations were examined within a model that incorporates performance-related constructs (i.e., past and present grades) as well as competence beliefs, which provides an integrated examination of gender differences.

Hypothesized Model

To address the aims of the present study, we used structural equation modeling (SEM) to test a model that consisted of several key constructs from Eccles and colleagues' model of achievement (see Fig. 1) in the subject area of mathematics. Specifically, to represent the hypothesized differential influence of competence beliefs and task values (Eccles et al., 1983; Wigfield & Eccles, 1992), predictive paths were hypothesized from competence beliefs to performance (math grades), but not achievement choices, and from task values (utility and intrinsic value) to achievement choices (math enrollment intentions), but not performance. Although in Eccles and colleagues' theoretical model (Wigfield & Eccles, 2002) competence beliefs are posited to influence task values over time, we measured these constructs at a single time point and thus did not model a causal link between competence beliefs and task values. Adolescents' prior math grades (Grade 8) were hypothesized to have both a direct and indirect relation to their current grades (Grade 9). A direct path from prior math grades to current math grades reflects the assumption that there is some stability in school achievement from year to year that is not mediated by psychological factors (Silverthorn, DuBois, & Crombie, 2004). In addition, testing for a direct path from prior grades to current grades allowed us to determine if competence beliefs predict math performance when prior grades are controlled.

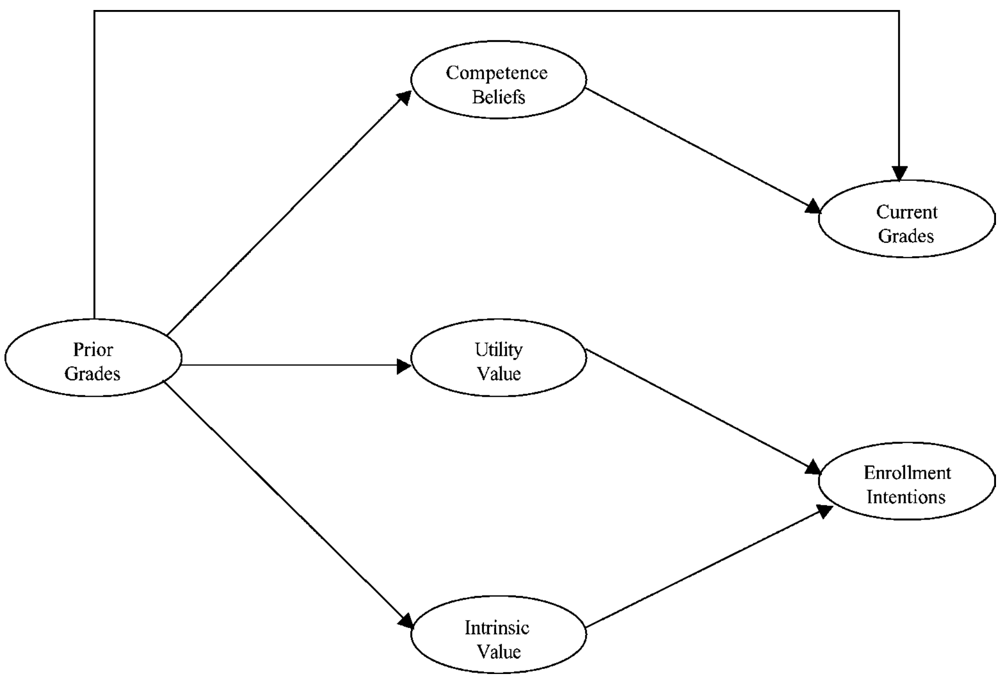

Fig. 1. Hypothesized model of math grades and enrollment intentions.

Because of the cross-sectional, correlational design, it should be kept in mind that analyses tested only for associational (i.e., predictive) relations among constructs and thus did not provide a basis for causal inferences (Hoyle, 1995).

METHOD

Participants

The sample for the present study consisted of youth who were participants across the first 2 years (Grades 8 and 9) of a larger longitudinal study of Canadian adolescents. Similar to the U.S., high school begins at Grade 9 in most Canadian provinces, and students enter from schools with varied grade structures. For the students in our sample, ability grouping in math did not occur until Grade 10. Thus, all students, regardless of ability, were enrolled in the same required, general math course in Grade 9.

The initial sample was obtained from Grade 8 classes in six elementary schools from the suburban and outlying areas surrounding a mid-sized central Canadian city; students were followed into 11 high schools. The schools were all public schools and were in middle SES, primarily European-Canadian school districts. Parental consent and adolescent assent were obtained. The average consent rate by class was 60%. Exclusion criteria included enrollment in a special education program (low reading comprehension levels) and recent immigration (language barrier that impedes reading comprehension). Six hundred of the 616 students who completed the survey in Grade 8 met inclusion criteria. Minor attrition occurred in the second year of the study (56 students); primary reasons were moving out of the area or changing to nonparticipating schools, as well as conflicts between the time allotted by the school to complete the measures and other school activities. The resulting sample for the current investigation included 540 students (277 girls, 51.3%, and 263 boys, 48.7%), after removal of four students who were multivariate outliers at the observed variable level.

Demographic information was obtained from 72% of mothers and 57% of fathers of participating students. The majority of the students were from two parent families (89%), in which most fathers worked either as professionals (45%) or in technical positions (30%), as assessed by a Canadian socioeconomic index (Blishen, Carroll, & Moore, 1987), and mothers worked as professionals (18%), in technical (23%) or clerical (27%) positions, or as homemakers (15%). Although ethnicity of participants was not assessed explicitly, data from participating parents indicated that over 75% of parents were born in Canada and that over 90% spoke English in the home.

Procedure

Trained research staff administered questionnaires to small groups of 10–25 students in 35–45-minute sessions. The questionnaires were administered in a classroom setting to allow students to work in a familiar environment. The students completed the questionnaires during the months of April and May, thus ensuring that students were approximately 80% through the Grade 9 school year. Report cards for study participants were obtained at the end of each school year (Grades 8 and 9) from the participating schools. The treatment of participants was in accordance with the ethical standards of both the Canadian and American Psychological Associations.

Measures

Student Questionnaire

All participants completed a questionnaire that assessed several constructs regarding students' academic competence beliefs, task values, and educational plans in different subject areas. For the present study, the items from four scales that measured students' competence beliefs in math, perceptions of the usefulness and intrinsic value of math, and intentions to take optional higher level math courses were analyzed. These items were developed originally by Parsons et al. (1980) and are reported in research conducted by Eccles and colleagues (e.g., Eccles & Wigfield, 1995; Fredricks & Eccles, 2002; Jacobs & Eccles, 1992). The response format for the items consisted of 7-point Likert scales, anchored at the two extremes with short verbal descriptors. Internal consistency reliability estimates are given for each scale for the current samples of girls and boys; individual items, however, were used as indicators of latent variables in structural equation modeling analyses.

Competence beliefs in math were measured by four items: "How good at math are you?" (1 = *Not at All Good*, 7 = *Very Good*), "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*, 7 = *The Best*), "Compared to most of your other school subjects, how good are you at math?" (1 = *Much Worse*, 7 = *Much Better*), and "How well do you think you will do in math this year?" (1 = *Not at all Well*, 7 = *Very Well*). Moderately high internal consistency (median $\alpha = .85$) has been reported based on either a 4- or 3-item scale (Eccles & Wigfield, 1995; Jacobs & Eccles, 1992; Meece et al., 1990; Parsons, Adler, & Kaczala, 1982). For the present sample, similarly high estimates of internal consistency were obtained for both girls and boys (αs of .93 and .92, respectively). To assess further the psychometric strength of the scale, test-retest reliability was measured over a 1-month period for a randomly selected subsample of 62 students and was found to be high ($r = .93$).

Students' perceptions of the usefulness of math were assessed by the four items from Parsons et al.'s (1980) 5-item importance/usefulness scale, which pertain to the usefulness of math. The items are: "In general, how useful is what you learn in math?" (1 = *Not at all Useful*, 7 = *Very Useful*), "How useful do you think the math you are learning will be for what you want to do after you graduate and go to work?" (1 = *Not at all Useful*, 7 = *Very Useful*), "Is the amount of effort it will take you to do well in math this year worthwhile to you?" (1 = *Not at all Worthwhile*, 7 = *Very Worthwhile*), 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*, 7 = *Very Useful*). For the present sample, high internal consistency was obtained for this scale for both girls and boys (.90, .81, respectively). For the subsample of 62 students, 1-month test-retest reliability was $r = .76$.

Students' perceptions of the intrinsic value of math were measured by two items: "How much do you like doing math?" (1 = *A Little*, 7 = *A Lot*), and "In general, I find working on math assignments..." (1 = *Very Boring*, 7 = *Very Interesting*). These are two of four items developed by Parsons et al. (1980), and they are the two items used most recently in the measurement of the intrinsic value of math to students (Eccles & Wigfield, 1995; Fuligni, Eccles, & Barber, 1995), for which moderate to high internal consistency has been reported (.76, .91, respectively). For the present sample, similarly high internal consistency was found for both girls and boys (.89, .88, respectively). For the randomly selected subsample, 1-month test-retest reliability was $r = .84$.

Intentions to enroll in future math courses were measured by a single item: "Will you take more math when you don't have to?" (1 = *I Very Definitely Will Not Take More Math*, 7 = *I Very Definitely Will Take More Math*). High school students' intentions concerning future enrollment in math have been assessed by this item in related research (Eccles, 1984; Eccles & Jacobs, 1986; Meece et al., 1990). For the subsample of 62 students, 1-month test-retest reliability of this 1-item measure was $r = .80$.

Math Performance

Math performance was measured by the students' final math grades in each year. Grades were given as letter grades in Grade 8 and as percentage scores in Grade 9. To achieve consistency in scoring, Grade 8 grades were converted from letter grades (including plus/minus grades) to percentage scores (the range was from a maximum of $A+ = 95$ to $E = 45$, which denotes a failing grade in this school system), following consultation with the participating schools on their standards for each letter grade category.

Analyses

Analyses were conducted in three stages. First, confirmatory factor analyses (CFAs) were employed to test for the validity of the measurement model (i.e., relations of observed variables to latent constructs, or factors, for which they were proposed to serve as indicators as well as the interrelations among the factors) related to the hypothesized structural model. This step was undertaken to ascertain acceptable fit of the measurement of the latent variables that represent the constructs of interest by their manifest (indicator) variables prior to testing the hypothesized relations among the latent variables in the full structural model (Thompson, 2000). Second, structural equation modeling (SEM) procedures were used to test for the validity of the hypothesized structural model. All tests were conducted separately for girls and boys. Post-hoc model testing was undertaken using Lagrange multiplier indices to identify further theoretically relevant paths that, if added, would enhance model fit for either gender (Bentler, 1989). Finally, all model paths were tested for their invariance across gender. CFA and SEM analyses were conducted using EQS structural equation modeling software (Bentler, 1996).

RESULTS

Descriptive statistics for the indicator variables for both girls and boys, along with results of *t* tests for gender differences, are reported in Table I. Girls achieved significantly higher math grades than did boys in Grade 8, and they expressed higher intentions to continue taking math after Grade 9. Boys reported significantly greater competence beliefs on all four items. An evaluation of the significant gender differences using Cohen's *d* indicated that they were of small to moderate magnitude (Cohen, 1988).

Structural Equation Modeling

As noted, primary analyses examined hypothesized measurement (i.e., relations between observed variables and latent constructs or factors and the intercorrelations among factors) and structural (i.e., pathways or relations among latent constructs) models, with a focus on their invariance across gender (for an elaboration and illustrated applications related to both types of models, readers are referred to Byrne, 1994, 1998, 2001).

Models were considered to have adequate fit when a number of criteria were met. These include values of Comparative Fit Index (CFI) that approximate or exceed .95 (Fan, Thompson, & Wang, 1999; Hu & Bentler, 1999), and a Root Mean Square Error of Approximation (RMSEA) of less than .05, although it has been noted that RMSEA values as high as .08 can be considered reasonable (Browne & Cudeck, 1989).

Tests of Measurement Model

Confirmatory factor analysis (CFA) was used to test first for the validity of the measurement model separately for female and male students. A critically important prerequisite to testing for validity of the structural model is knowledge that the assessment instruments, themselves, are valid in their measurement of the related constructs. Determination of this information is based on the extent to which the data adequately fit the hypothesized measurement model. The initially hypothesized measurement model was comprised of six latent variables and their respective observed variables: Grade 8 and 9 grades and math enrollment intentions each with a single indicator, competence beliefs with four indicators, utility value with four indicators, and intrinsic value with two indicators. All latent constructs (i.e., factors) were specified as intercorrelated.

Girls

The initially specified measurement model for girls indicated acceptable fit in terms of the CFI (.96), although the obtained RMSEA (.085) was slightly out of range. Evaluation of Lagrange multiplier indices suggested that allowing the estimation of a covariance between measurement error terms for two utility value indicator items would improve model fit for girls. Examination of these items indicated that both were based on the perceived *future* utility of math, a combination of utility value and future

Table I. Descriptive Statistics for Observed Variables

	Girls (n = 277)				Boys (n = 263)					
Variable	*M*	*SD*	Skewness	Kurtosis	*M*	*SD*	Skewness	Kurtosis	*t*	Cohen's *d*
Prior grades	78.76	12.00	−0.75	0.34	74.69	13.43	−0.50	−0.52	3.72**	0.32
Competence item 1	4.96	1.46	−0.84	0.47	5.44	1.37	−0.91	0.45	−3.95**	−0.34
Competence item 2	4.79	1.37	−0.61	−0.22	5.07	1.33	−0.67	−0.16	−2.37*	−0.20
Competence item 3	4.53	1.57	−0.46	−0.28	5.06	1.51	−0.64	−0.05	−3.97**	−0.34
Competence item 4	5.05	1.48	−0.76	0.34	5.32	1.43	−0.85	0.61	−2.15*	−0.19
Utility item 1	5.46	1.53	−0.90	0.28	5.25	1.55	−0.93	0.36	1.60	0.14
Utility item 2	5.27	1.61	−0.69	−0.41	5.22	1.59	−0.86	0.13	0.31	0.03
Utility item 3	5.34	1.48	−0.78	0.09	5.22	1.50	−0.78	0.08	0.92	0.08
Utility item 4	5.49	1.45	−0.86	0.24	5.35	1.43	−0.81	0.29	0.20	0.02
Intrinsic item 1	4.42	1.86	−0.38	−0.77	4.50	1.71	−0.56	−0.58	−0.56	−0.05
Intrinsic item 2	3.98	1.65	−0.16	−0.70	3.97	1.70	−0.31	−0.87	0.03	0.003
Current grades	71.97	4.02	−0.48	−0.22	70.39	15.29	−0.49	−0.22	1.25	0.11
Enrollment intentions	5.68	1.56	−1.40	1.41	5.37	1.74	−1.40	0.20	2.15*	0.19

Note. The range of scores for the observed variables (with the exception of grades) is 1–7. *t* -test is evaluated at $df = 538$. Significant positive *t* values indicate higher scores for girls; significant negative *t* values indicate higher scores for boys.
$^{*}p < .05$. $^{**}p < .01$.

Table II. Latent Factors Correlations for Measurement Models

Factors	1	2	3	4	5	6
1. Prior grades (Grade 8)	—	.60	.23	.36	.61	.22
2. Competence beliefs	.57	—	.50	.73	.75	.49
3. Utility value	.21	.52	—	.65	.31	.49
4. Intrinsic value	.36	.71	.80	—	.48	.51
5. Current grades (Grade 9)	.67	.79	.31	.48	—	.36
6. Enrollment intentions	.37	.41	.51	.49	.34	—

Note. All correlations are significant at $p < .01$. Correlations above the diagonal are for girls ($n = 277$) and below the diagonal are for boys ($n = 263$).

orientation (Wigfield & Eccles, 1992), and thus a decision was made to estimate this parameter in the model. The addition of this parameter resulted in a statistically significant improvement in model fit, $\Delta\chi^2[1] = 24.36$, $p < .001$. This model fit the data according to criteria (CFI = .97; RMSEA = .076), and thus was retained as the final measurement model, $\chi^2[52] = 134.48$, $p < .001$. All factor loadings were statistically significant (ps < .001). Table II summarizes the latent factor correlations for the measurement model, all of which were statistically significant (range .22–.75, ps < .01).

Boys

For boys, the initially specified measurement model fit the data well (CFI = .98; RMSEA = .064). Lagrange multiplier indices were examined to identify any additional potentially significant parameters. As in the model for girls, the correlated measurement error between the future-oriented utility value indicator variables was identified. Consequently, this parameter was estimated and it resulted in a statistically significant improvement in model fit, $\Delta\chi^2[1] = 11.74$, $p < .001$. This model fit the data well (CFI = .98; RMSEA = .058), and was retained as the final model, $\chi^2[52] = 97.26$, $p < .001$. As with the model for girls, all factor loadings were statistically significant, as were factor correlations (range .21–.80, ps < .01; see Table II).

The final measurement model for each gender contained identical parameterization. The measurement model was tested further to investigate whether parameter estimates (i.e., factor loadings and correlations among factors representing the latent constructs) varied as a function of gender. To test for this possibility, all factor loadings and factor covariances were constrained equally across gender. Evaluation of Lagrange multiplier indices indicated gender differences in two factor covariances at the measurement level: the correlation between prior and current grades and between prior grades and future enrollment intentions, which were larger in magnitude for boys (see Table II). With these two exceptions, the remaining hypothesized constraints were found to be tenable (i.e., the model applied equally well to both boys and girls in terms of factor loadings and all factor correlations except the two noted previously).

Tests of Hypothesized Structural Model

In the hypothesized model (see Fig. 1), seven structural regression paths were hypothesized as follows: (a) prior grades to competence beliefs, to utility value, to intrinsic value, and to current grades, (b) competence beliefs to current grades, (c) utility value to enrollment intentions, and (d) intrinsic value to enrollment intentions. In addition, covariances were specified between the disturbance terms of the competence beliefs, utility value, and intrinsic value latent variables. A disturbance term represents the portion of a latent variable's variance that is not accounted for by its specified relations with other latent variables in the structural model. A summary of the structural model tests for both girls and boys is presented in Table III.

Girls

For girls, the initially specified model exhibited good fit (CFI = .97; RMSEA = .076). Evaluation of Lagrange multiplier indices identified a direct path from competence beliefs to enrollment intentions. Given prior theory and research that suggest a potential relation between competence beliefs and enrollment intentions for girls (Eccles, 1994; Ethington, 1991), this modification was deemed to be substantively reasonable within the context of the model. The addition of this path resulted in a significant improvement in model fit, $\Delta\chi^2[1] = 8.58$, $p < .01$. Following this modification, the multivariate significance of model parameters was examined using the Wald test, and one nonsignificant path was removed (intrinsic value to enrollment intentions), $\Delta\chi^2[1] = 3.52$, $p > .05$. This model fit the data well (CFI = .97; RMSEA = .074), and was retained as the final model. The final model for girls is presented in Fig. 2. The path that was added to the model (competence beliefs to enrollment intentions) is represented by a

Table III. Summary of Structural Model Tests for Girls and Boys

Model	χ^2 (*df*)	$\Delta\chi^2(\Delta df)$	CFI	RMSEA
Girls ($n = 277$)				
Initial model	148.51(57)***	—	0.97	0.076
Free CB → intentions	139.93(56)***	8.58(1)**	0.97	0.074
Remove IV → intentions	143.45(57)***	3.52(1)	0.97	0.074
Boys ($n = 263$)				
Initial model	124.44(57)***	—	0.97	0.067
Free PG → intentions	104.04(56)***	20.40(1)***	0.98	0.057
Remove IV → intentions	104.50(57)***	0.46(1)	0.98	0.057

Note. CFI: Comparative Fit Index; RMSEA: Root Mean Square Error of Approximation; PG: Prior Grades; CG: Current Grades; CB: Competence Beliefs; IV: Intrinsic Value.
**$p < .01$. ***$p < .001$.

dashed line. The model accounted for 60 and 33% of the variance in current (Grade 9) grades and enrollment intentions, respectively.

The magnitude and statistical significance of pathways that represent indirect (i.e., mediated) effects of prior grades on current grades (via competence beliefs) and on enrollment intentions (via competence beliefs and utility value) in the final model also were evaluated. Following guidelines for use of SEM in mediational hypothesis testing (Kenny, Kashy, & Bolger, 1998), indirect effects were evaluated in models that included (i.e., controlled for) paths that represent direct influences of prior grades on current grades and enrollment intentions. The indirect effect of prior grades on current grades via competence beliefs was tested in the final model and was found to be significant (standardized estimate of .36, $p < .001$); the path that represents the direct effect of prior grades on current grades, which was specified in the hypothesized model, also was found to be significant (standardized path = .26, $p < .001$). These findings indicate that for girls the association between prior grades and current grades was mediated by competence beliefs, although mediation was only partial given the significant direct association that remained between prior and current grades. The indirect effect of prior grades on enrollment intentions via competence beliefs and utility value was tested in a new model in which a direct path from prior grades to enrollment intentions also was specified. This indirect effect was significant (standardized estimate of .27, $p < .001$), whereas the direct path was not (standardized path = −.04, *ns*). These findings indicate that for girls the association between prior grades and enrollment intentions was mediated by competence beliefs and utility value and that this mediation accounted for nearly all of the association between prior grades and enrollment intentions given the nonsignificant, near-zero magnitude of the direct path that was found between these variables (Kenny et al., 1998).

Boys

The initial model for boys exhibited good fit in terms of all criteria (CFI = .97; RMSEA = .067). Evaluation of Lagrange multiplier indices, however, identified an additional path from prior grades to enrollment intentions. This parameter was added to the model as it was judged to be consistent with previous research (Eccles, 1984) and theory (Eccles, 1994). The addition of this parameter resulted in a significant improvement in model fit, $\Delta\chi^2[1] = 20.40$, $p < .001$. Similar to the model for girls, the path from intrinsic value to enrollment intentions was no longer statistically significant and was removed from the model, $\Delta\chi^2[1] = 0.46$, *ns*. This model fit the data well (CFI = .98; RMSEA = .057), and was retained as the final model. The final model for boys is presented in Fig. 3. The path that was added to the model (prior grades to enrollment intentions) is represented by a dashed line. The model accounted for 69 and 34% of the variance in current (Grade 9) grades and enrollment intentions, respectively. In the final model for boys, the direct effects of prior grades on current grades and intentions were both included and found to be significant (standardized effects = .33 and .27, *p*s < .001); thus, it was possible to test for the indirect effects of prior grades on both current grades and enrollment intentions using this final model. The indirect effects of prior grades were significant for both current grades (standardized estimate of .34, $p < .001$) and enrollment intentions (standardized estimate of .10, $p < .01$). These findings indicate, for

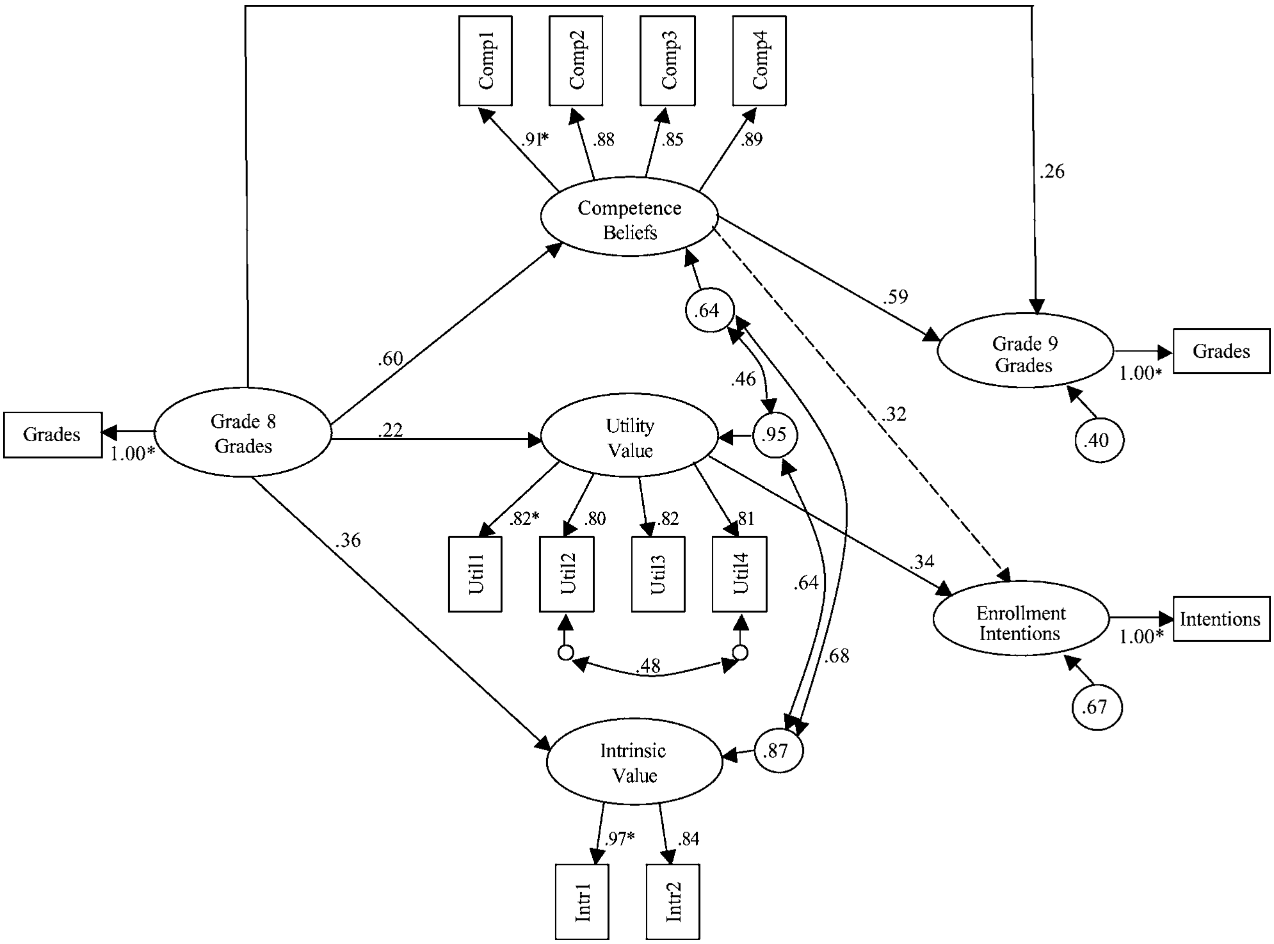

Fig. 2. Final model of math grades and enrollment intentions for girls with maximum likelihood estimates (standardized solution estimates). Asterisks indicate parameters constrained to unstandardized value of 1 for purposes of statistical identification and scaling. All parameters were significant at $p < .001$.

boys, partial mediation of the effect of prior grades on current grades via competence beliefs, as well as partial mediation of the effect of prior grades on enrollment intentions via utility value.

Tests of Structural Invariance Across Gender

For tests of structural invariance, the final models obtained for girls and boys served as the baseline models. From the baseline models (see Figs. 2 and 3), it is apparent *a priori* that there is not complete structural invariance, as there is a path in each model that is not estimated in the model for the other gender: for girls, the direct path from competence beliefs to enrollment intentions, and for boys, the direct path from prior math grades to enrollment intentions.

Table IV summarizes the tests of model invariance. Test results for Model 1, in which the factor loadings linking observed indicator variables to relevant latent variables were constrained to be equal across gender (previously established in preliminary analyses for the measurement model), whereas common structural paths were unconstrained, demonstrated good fit to the data in terms of the CFI (.98). This model served as the benchmark against which all subsequent tests for invariance were compared. As can be seen in Table IV, results related to Model 2, in which all common structural paths were held invariant, yielded a significant decrement in goodness-of-fit, $\Delta\chi^2[6] = 12.99$, $p < .05$, which indicates some degree of inequality in the common structural paths for girls and boys. Examination of Lagrange multiplier chi-square fit statistics for

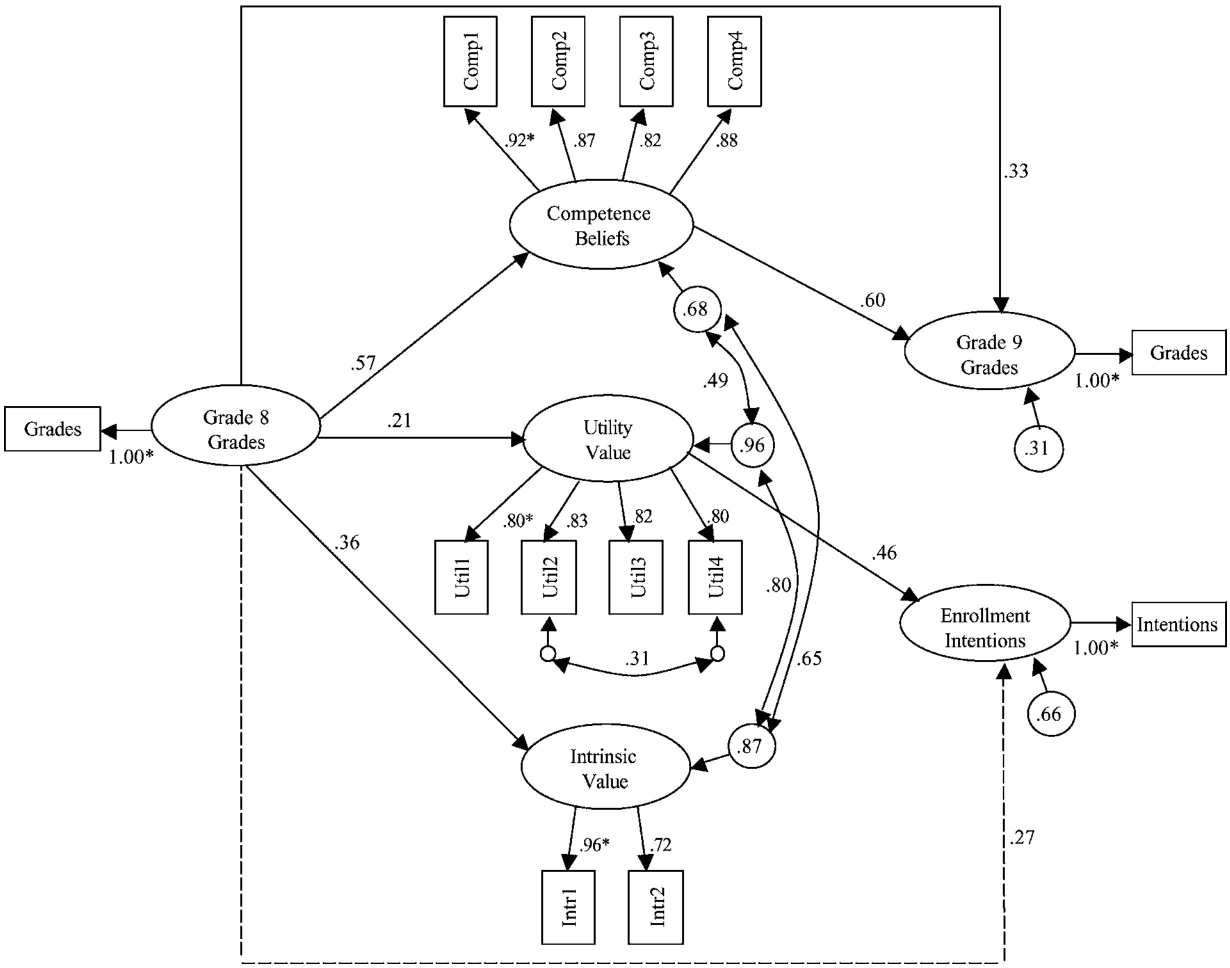

Fig. 3. Final model of math grades and enrollment for boys with maximum likelihood estimates (standardized solution estimates). Asterisks indicate parameters constrained to unstandardized value of 1 for purposes of statistical identification and scaling. All parameters were significant at $p < .001$ except for the estimate for the path from Grade 8 grades to utility value ($p < .01$) and the correlated measurement error between two indicator variables of utility value ($p < .01$).

this fully constrained model indicated three constraints, which represent three regression paths, that did not hold across gender. Theory and research (Eccles, 1994; Simmons & Blyth, 1987) suggest the potential for a greater instrumental focus in achievement-related choices for boys. Based on these considerations, the path from utility value to enrollment intentions was deemed the most substantively reasonable parameter to allow to vary (i.e., differ) across gender. Results for Model 3, in which all structural paths were held invariant with the exception of the path from utility value to intentions, did not result in a significant decrement in chi-square from the baseline model. Thus, gender invariance was evident in (a) the form of a gender-specific path for each model for girls and boys and (b) a regression path from utility value to enrollment intentions that was larger in magnitude for boys than for girls (standardized paths = .46 and .34, respectively).

Summary

Findings indicated both similarities and differences across boys and girls in tests of the hypothesized model. In terms of gender similarities, for current math grades, for both boys and girls, competence beliefs were a strong direct predictor and prior grades were both an indirect and direct predictor. For enrollment intentions, for each gender, there was a significant indirect effect of prior grades. In terms of gender differences, for enrollment intentions, for girls, there was a significant direct path from

Table IV. Summary of Tests for Structural Model Invariance Across Gender

Competing models	χ^2 (df)	$\Delta\chi^2(\Delta df)$	CFI
Baseline models	250.30(122)***	—	0.98
Model 1 with all common structural paths held invariant	263.29(128)***	12.99(6)*	0.97
Model 1 with all common structural paths held invariant excepting utility value → enrollment intentions	259.12(127)***	8.82(5)	0.98

Note. CFI: Comparative Fit Index.
$^*p < .05$. $^{***}p < .001$.

competence beliefs not observed for boys; furthermore, the path from utility value to enrollment intentions was smaller in magnitude for girls than for boys. For boys, prior grades were linked to enrollment intentions, not only indirectly, as noted, but also directly.

DISCUSSION

Results of this research provide further support for the importance of key constructs in Eccles and colleagues' (Wigfield & Eccles, 2000) expectancy-value model of achievement as predictors of adolescents' math performance and enrollment intentions for advanced math courses. With relevance to the primary aims of the study, the results indicate both gender similarities and differences in the predictive patterns hypothesized in the model. Both the similarities and differences found add to our understanding of the role of competence beliefs and task values as influences on girls' and boys' math performance and enrollment intentions at a critical juncture in their education.

Gender Similarities

The prediction of math grades was quite similar across gender. The paths from prior grades to competence beliefs and competence beliefs to current grades were comparable in magnitude for boys and girls. This is consistent with prior research (Marsh & Yeung, 1998; Meece et al., 1990) in which competence beliefs predicted math performance for both boys and girls. At the same time, in both this and prior research, boys have been found to have higher competence beliefs than do girls without having higher grades (Kimball, 1989; Wigfield & Eccles, 2002). In the current study, although girls outperformed boys in math at the Grade 8 level, by Grade 9 no gender difference was found. This finding is consistent with research results that indicate that girls begin to underperform, relative to boys, as math courses become more advanced (Hyde, Fennema, & Lamon, 1990; Hyde, Fennema, Ryan, et al., 1990; Kimball, 1989). A complex mix of developmental and sociocultural factors could be contributing to this trend and thus merit careful investigation in future work.

Gender similarities were apparent, within the context of our model, for paths that involve intrinsic and utility values. Eccles and Wigfield (1995) have emphasized the need for researchers to study the comparative predictive strength of different components of task value as students progress through their high school years. In the current study, this issue was addressed by examining two separate components of task values: intrinsic value and utility value. The path from intrinsic value to intentions was not significant for either girls or boys, whereas utility value predicted enrollment intentions for both genders. Research on the relation of the separate components of intrinsic and utility value to intentions or enrollment in math is lacking. As noted, in previous research in which task values were found to predict math enrollment intentions (Eccles et al., 1983; Ethington, 1991) or actual enrollment (Eccles, 1984), global measures of task values (including intrinsic, utility, and importance values) generally have been employed. In view of our current findings, it may be that this relation was due more to the utility and/or importance component of this global construct and less to the intrinsic component, thus emphasizing the importance of specificity of measurement especially among adolescents.

Gender Differences

There were gender differences in the prediction of course enrollment intentions. For girls, competence beliefs in math had a central role for predicting not only current math grades, as hypothesized, but also future math enrollment intentions. Furthermore, girls' competence beliefs in math had as great a role in predicting their future enrollment intentions as did their utility value of math. In prior research, Ethington (1991) also found that self-concept of math ability had a direct relation to intentions for enrollment in advanced math courses for girls, but not for boys. This aspect of our results for girls also is consistent with the relatively central role of competence beliefs in predicting achievement strivings, which has been emphasized by cognitive motivational theorists (Covington, 1984; Nicholls, 1984).

The predictive importance of competence beliefs for girls is in contrast to the results of two previous studies in which competence beliefs and task values were both included among the predictors examined. Eccles (1984) found that a global measure of task values and prior performance history were the most important factors in predicting enrollment in Grade 12 math courses for girls. Similarly, Meece and colleagues (1990) found that, for junior high school students, importance value was the only direct predictor of intentions in their model, and this path was stronger for girls than for boys. Their measurement of competence beliefs, however, occurred in the year prior to the measurement of importance values and intentions, which resulted in a possible confound between strength of prediction for variables and their time of measurement. These earlier results (Eccles, 1984; Meece et al., 1990) also occurred within a climate of gender differences in enrollment in advanced high school math courses. In contrast, in the current study, the finding that girls reported higher enrollment intentions than did boys was found in the context of a trend toward less pronounced gender disparities in patterns of high school math enrollment (Wirt et al., 2004). In this climate, it is possible that the value of math for girls will no longer be the primary influence on enrollment intentions and that competence beliefs will assume an increasingly important role. This interpretation is given with the cautionary note that our results may be sample specific and that additional research on this and other populations is necessary.

From a developmental perspective, the relatively powerful role of math competence beliefs for girls in predicting enrollment intentions, compared to that of utility or intrinsic value or prior math grades, also could be attributed in part to the intensification of gender role socialization during adolescence (Hill & Lynch, 1983). Enrollment decisions for future advanced math courses involve selecting an activity that is (1) stereotypically masculine and (2) relatively novel and unfamiliar. These are two conditions under which the following pattern of gender differences in causal attributions generally is found: girls are more likely to attribute their successes to effort than to ability and their failures to lack of ability, whereas the opposite is more likely for boys (see Kimball, 1989). Thus, for girls, advanced math courses are likely perceived as an activity that requires a fair amount of sustained effort to succeed and, therefore, as having a high perceived cost (Wigfield & Eccles, 1992). In contrast, if a girl's competence beliefs in math are high, she would more likely be at ease with math (both at present and in the future), include math as part of her self-schema, and perceive math as less difficult and less of a cost, and thus be less conflicted about enrolling in advanced math courses. This description of factors that may affect girls' decision-making processes is also consistent with the relatively lower predictive strength that utility value had in the structural model for girls' future math intentions relative to boys. Even though girls may have as high a perception of the utility value of math as do boys, as occurred in the present study, if girls have a high perceived cost for enrollment in advanced math courses, then the value of math would not be expected to have as strong an influence on their decision making. Furthermore, in research on group status, it has been found that members of lower status groups (e.g., women) will value domains in which a higher status group excels because they assume that these domains (e.g., math) have utility (Schmader, Major, Eccleston, & McCoy, 2001), without these beliefs necessarily being predictive of intentions.

In terms of alternative, methodological explanations, it is possible that the path from competence beliefs to intentions for girls was significant because intentions rather than actual enrollment were measured. For example, it is possible that a relation between competence beliefs and enrollment intentions is attributable to their shared status as psychological rather than behavioral constructs, each measured by self-report. This would not account, however, for the lack of a similar relation between competence beliefs and enrollment intentions for boys. Thus, the current results provide some interesting initial evidence that competence beliefs have an important role in predicting the enrollment intentions of female high school students in the area of mathematics. We present this interpretation with appropriate caution, as other researchers (Trusty, 2002; Trusty & Ng, 2000) have found that self-perceptions of ability in math are not as predictive of enrollment in math or science college majors for women as they are for men. Further research is needed to clarify the link between competence beliefs and enrollment in optional math courses for girls.

It is noteworthy that a different conclusion concerning the role of competence beliefs in math for girls would have been reached if the students had been considered as one group. For example, if boys' and girls' samples had been combined, the direct path between competence beliefs and enrollment intentions most likely would not have been significant. This result would have supported the conceptualization that competence beliefs predict performance measures rather than intentions and would have been consistent with the results of prior research in which boys' and girls' data were combined (Eccles et al., 1983). Thus, it is important to continue to examine boys and girls separately in models of math achievement. Other researchers (Farmer et al., 1999; Trusty, 2002) similarly have suggested that, in research on career choice, we need to examine men and women separately as the processes involved in career choice appear to differ substantially, particularly for the choices of math and science fields.

For boys, results indicate a different pattern of relations; math values, specifically utility value, have a predominant role in predicting enrollment intentions. In addition, in contrast to girls, boys' prior math grades have a direct relation to future enrollment intentions. The predictive role of prior grades is similar to the results of Eccles (1984) who found that grades were the strongest predictor of enrollment in Grade 12 math for men. One possible explanation for this finding, consistent with a differential socialization hypothesis, is that boys who are successful in math are encouraged through socialization agents, such as teachers and parents, to continue with more advanced course work, independent of whether they have internalized a sense of competence in this area. The current results also are consistent with research on adolescents' hierarchy of values in which boys are reported to be more focused than are girls in their achievement goals, to place a higher value on a dominant goal, and to have less conflict between occupational goals and future parent roles (Eccles, 1994; Simmons & Blyth, 1987). The two predominant factors that predict boys' math enrollment intentions (i.e., their prior math grades and their perceptions of the future usefulness of mathematics) suggest this relatively instrumental focus.

Applied Implications

From an applied perspective, our results suggest that approaches that address gender inequalities in the area of mathematics by focusing solely on objective levels of classroom math performance will be limited in their effects. The finding that, at Grade 9, girls' math grades were just as high as boys' math grades supports this conclusion. Findings instead are most consistent with a need for greater attention to the mediating role of cognitive constructs that have been demonstrated previously to be important explanatory constructs for math achievement (Eccles, Wigfield, & Schiefele, 1998; Spencer et al., 1999).

The extent to which students value math is an important area for teachers to address in encouraging students to continue to take math in high school. As would be expected, based on developmental changes that occur from childhood to adolescence, the perceived intrinsic value of math does not appear to be a major factor in predicting either girls' or boys' choices concerning enrollment in optional high school math. In the present study, however, only two items were used to measure intrinsic value and thus the predictive role of intrinsic value may not have been captured adequately. For both boys and girls, the importance of perceptions of the usefulness of math is highlighted by the findings of the present study. Based on these results, an effective means of encouraging students to stay in math courses would be to emphasize the usefulness of math for a variety of future educational and career plans. Boys tend to learn about science (and math) through their experiences both inside and outside of school, whereas girls obtain most of their experience in the classroom (Jovanovic & King, 1998; Potter & Rosser, 1992). Therefore, it is particularly important that math teachers stress the usefulness of math in ways that address future goals that are relevant to their female students.

Current results indicate that enhancement of girls' self-perceptions of their math competence is one particularly promising direction to pursue. The traditional approach of focusing on good math grades appears to be effective in encouraging boys to take optional higher level math. For girls, however, the present results suggest that the more important factor is competence beliefs because these beliefs not only have a direct relation to enrollment intentions but also mediate the relation of prior grades to intentions. These relations are evident at a point in their schooling when girls are making their first major choice of which elective courses to select and whether to stay in math courses. Strengthened competence beliefs pertaining to math therefore could help to encourage girls, not only to enroll in advanced math courses, but also to consider a math-related career. It is possible that cognitive constructs such as competence beliefs are more important for girls because they may receive less encouragement and support to pursue advanced math due to traditional gender role socialization experiences. In addition, the need for girls to counter the gender stereotyping of math and the associated influences of stereotype threat (Schmader et al., 2004; Spencer et al., 1999) may also contribute to the importance of competence beliefs for girls. As has been suggested by recent work (Jacobs et al., 2002), experiences during the school years appear to lessen the gender differences in beliefs about math, consistent with an important role of teachers and educational processes.

Limitations and Future Research

The present study also has several limitations that should be noted and addressed in future research. First, despite the use of structural equation modeling, the correlational and primarily cross-sectional nature of the data make it inappropriate to draw causal inferences. Longitudinal studies of relations among competence beliefs, task values, math grades, enrollment intentions, and actual course enrollment are needed, in which temporal precedence can clearly be established. Second, there was an absence of multiple indicator variables for some constructs in the model that were investigated (e.g., intrinsic value and enrollment intentions). Enrollment intentions were assessed by a 1-item measure. This measure has been used in prior research and it exhibited good test-retest reliability in the present study. Nevertheless, the ability of a 1-item measure to capture accurately this major decision-making in adolescents' academic life is open to question. Third, this study focused on a limited number of factors that potentially influence academic achievement. Key constructs from Eccles and colleagues' expectancy-value model of achievement were included. Although reasonably well-fitting, final models for both girls and boys nevertheless indicated room for improvements in fit for each gender. The inclusion of a broader range of explanatory factors in future research could be useful in this regard (e.g., cost of effort to do well, stereotype threat, career goals). Finally, a number of model modifications were made in a post hoc manner on the same samples of boys and girls on which the original model was tested. Jöreskog and Sörbom (1993) have suggested that modifications of a model can be made when adding a parameter is defensible substantively and the estimated value can be interpreted clearly, which was the case in the present study. It is important, however, that replication studies be conducted to determine the extent to which the results of this study can be generalized.

Findings of the present study contribute to the extant literature by documenting both similarities and differences between boys and girls in patterns of prediction of their current math performance and future math enrollment intentions. Different, and possibly misleading, conclusions would have been reached if the model had been estimated for boys and girls as one group, rather than for each group separately. Thus, a prudent approach for future research would be to examine boys and girls separately and in comparison to one another as they progress through high school. In this manner, more definitive and valid conclusions may be drawn concerning models of math achievement and associated strategies for intervention.

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