Influences of Gender on Academic Achievement

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There has been a renewed debate on the controversial issue of gender differences on math and science achievement. This debate currently focuses on why women are not seeking careers in information technology occupations. The most comprehensive reviews of the research in the area of gender differences have shown very few true differences between math and verbal abilities between men and women (Halpern, 2000). In fact, the research has shown only two gender differences in specific sub-areas of spatial and verbal abilities, three-dimensional mental rotation (favoring men), and speech production (favoring women). Other research has also shown a decline in the differences between the genders in the past few decades on standardized test, suggesting that the more exposure that women are getting to math and science classes, the better their scores. Even though this research puts into questions whether gender differences still exist in academic achievement, many researchers are still finding differences in performance as well as general interest in areas related to math and science. Thus, achievement alone cannot be the sole reason for women as they make their career choices.

Work by Eccles, Lord, Roeser, Barber, and Jozefowicz (1997) found that gender differences in enrollment in advanced mathematics courses in high school are mediated by gender differences in expectations for success in math and physics and perceived value of competence in math. Jacobs, Lanaz, Osgood, Eccles, and Wigfield (2002) found that self-concept of ability and task value in math decline for both genders between first and twelfth grades with no real difference between girls and boys trajectories over time. In fact, by the twelfth grade, girls valued math more than boys when controlling for self-concept of ability in math. This research might suggest that women should be just as represented in the technology or mathematical work force as men. This, however, is not the case. Even though women have made great strides in the law, medical, and social science professions, very few can be found in graduate programs or professions in

mathematics, computer science, physics, engineering, or information technology jobs (Eccles, 2001). Many ideas have been put forth on why high achieving women may not be entering this professions including discrimination, gender-typed socialization, self-concept of ability in these areas, and the value and interest that women have in these professions (Eccles, 2001). The focus of this paper will be to examine how the value and interest in math relates to academic achievement over time. We predict that subjective task value, in particular, interest in math, will be associated with math school grades over time, even after controlling for maternal education and achievement-related variables.

Research Questions

Growth curve models for adolescents' school math grades were estimated to address the following questions: (a) What do the average math grade trajectories look like, from 7th to 12th grade, by gender and by school track? (b) What to the average math interest trajectories look like, from 7th to 12th grade, by gender and school track? (c) What education related variables are associated with math grade and interest trajectories—e.g., which are associated with the intercept and slope of math school grades and math interest? And (d) do these predictors differ for young women and young men, for those in high versus low math tracked classes?

Method

Data and Sample

Data from the present study come from the Michigan Study of Adolescent Life Transitions (MSALT), a 17-year, nine-wave longitudinal project originally designed to examine the impact of school transitions and family environments on early adolescents' interest, motivation, and achievement-related self-concepts (Eccles et al., 1989). Originally, the sample included students from 12 schools; three of these schools did not participate after seventh grade. Data from the first six waves (fall and spring of 6th and 7th grades, 10th grade, and 12th grade) as well as school

record data from 6th through 12th grades were utilized. The sample included 1821 adolescents who participated in the first as well as at least one of the last two waves (10th and 12th grades). All members of the sample transitioned from elementary to junior high school between the 6th and 7th grades. Adolescents were predominately white (92.2%), and from working- to middle-class families.

Measures

Measures in the present study include school grades, adolescents' interest in math, score on a standardized math test from seventh grade, teachers' perceptions of adolescents' effort in math, math class track, adolescent gender, and mother's level of education. School grades in math were collected from school record data every semester in 6th, 7th, 9th, 10th, 11th, and 12th grades. A mean of both semesters was used for each grade level. Math school grades were coded on a 16-point scale, where 16=*A+*, 15=*A*, 14=*A-*, 13=*B+*,… 1=*F*. Gender was dummy coded so that 1=*Female*. Adolescents' interest in math was assessed at the all six waves (fall and spring of 6th and 7th grades, 10th grade, and 12th grade) with the following question, "How much do you like doing math?" Adolescents could respond on a 7-point Likert scale, anchored at 1=*a little* and 7=*a lot*. Teachers reported on students' effort in math class in 6th grade, on a Likert scale where 1=*low effort* and 7=*high effort*. A standardized math test, the Michigan Educational Assessment Program [MEAP] was administered to all 7th graders, and scores were collected from record data. Mothers' education was assessed at Wave 1; because the majority of mothers were either high school graduates or completed some college, this variable was coded into 3 meaningful groups: 1=*less than high school*, 2=*high school graduate*, and 3=*some college or more*.

Math track reflects our best judgment of the level of the sequence of courses the students took across their four years of high school. We inspected individual course enrollment patterns, which were quite diverse across individuals within schools (Updegraff et al., 1996). Most of the

students followed the sequences recommended in their high school handbooks—that is, sequences linked to either their math ability level or their post high school occupation trajectories. Students were classified into one of four tracks based on their 9th grade math course and information in their high school handbook: honors, college, regular, and basic. Typical course patters for each track are as follows: honors students typically took Geometry in 9th grade, Algebra/Trigonometry in 10th grade, Pre-Calculus in 11th grade, and Calculus in 12th. The college group commonly chose Algebra, Geometry, Algebra 2/Trigonometry, and Pre-Calculus (or no math) in 9th through 12th grades, respectively. The regular group was enrolled in Pre-Algebra in 9th grade, Algebra 1 in 10th, Geometry in 11th, and no math in 12th. Finally, those classified into the basic track were commonly enrolled in General Math in 9th grade, General Math/Pre-Algebra/Algebra in 10th, and no math in 11th or 12th grades. In analyses for this paper, "honors" and "college" were combined into a high track category, and "regular" and "basic" were combined into a low track category. The mean, *SD*, and range for each variable are reported in Table 1.

Analysis Plan

A latent growth curve (LGC) modeling technique was used to estimate adolescent math school grades as well as interest level in math from 7th grade through 12th grade. This technique involves estimating the two components of a curve, the intercept and slope, as latent constructs (Duncan, Duncan, Stryker, Li, & Alpert, 1999). All are analyses were performed using the Amos (Analysis of Moment Structures) program (Arbuckle & Wothke, 1999). Amos allows models to be estimated even when there is some missing data (Kline, 1998), and uses the preferred maximum likelihood (ML) method for estimating parameters (Bollen, 1989) by calculating a log function of the model parameters from the raw data (Arbuckle, 1996; Bollen, 1989; McArdle & Hamagami, 1996). All predictors were mean centered before entered into the growth models, indicating that the

sample means were subtracted to give all variables a mean of zero. Thus, the variance component for growth curve means had a consistent interpretation across models (Jacobs & Osgood, 2002).

In our analyses, 7th grade school math grades served as the intercept for school grade trajectories, and 7th grade math interest served as the intercept for math interest trajectories. First, we estimated the curve for math school grades alone, controlling only for 6th grade math grades. Next we estimated a second LGC model for math interest from 7th through 12th grades, controlling only for 6th grade math interest. We examined these models separately by 9th grade math track (those in the honors and college tracks were compared to those in the regular and basic tracks) and by gender. Next, we estimated models that included latent growth curves for math school grades as well as math interest, for our four groups (divided by gender and math track). These models incorporated education related predictor variables, including mothers' education, 7th grade MEAP score, teachers' ratings of math effort in 6th grade, as well as 6th grade math school grades and math interest.

Results

Math School Grade Trajectories

Figure 1 illustrates mean math school grades from 6th to 12th grades, by track (honors/college vs. regular/basic) and gender. Overall, young women have slightly higher grades than young men (within each tracking group). For both young men and women in the honors/college track group, math grades start out fairly high (around a B+ or B), and then decline throughout high school, ending up at about a B- or C+. For students in the regular/basic math track, lower (about a C+) and then decline, ending up at about a C-. We conducted *t*-tests to determine gender and track differences in both math school grades from 6th through 12th grades. We found that young women's school grades in math were consistently higher at every grade (all t-tests significant at $p < .05$). Young women's grades were about .5 to 1 point higher on a scale of 16,

corresponding to about one-sixth to one-third of a standard deviation. When we examined groups

by math class track, we found that math school grades were higher in 6th and 7th grade for students

the honors/college math class track; there were no significant differences for high school math

grades.

Math Interest Trajectories

Figure 2 illustrates means of math interest from 6th to 12th grades, by track (honors/college

vs. regular/basic) and gender. For all four math track by gender groups, math interest starts out

between a 4.5 and 5.5 on a 7 point scale. For all gender and track groups, math interest declines, so

by 12th grade is much lower (between 3 and 4). We conducted *t*-test to examine differences by

gender and track. Young men's math interest was consistently higher than young women's; this

difference, however, was not statistically significant at any grade level. Math interest was

significantly higher for 6th and 7th graders in the honors/college math track, with no significant

differences for high school math grades.

Predicting School Grade and Interest Trajectories for Young Women

Our next set of analyses predicts trajectories of school grades and math interest—

specifically, we examine the predictors of intercept and slope of math grades and interest, separately

for four groups (young women and young men in both high and low math track groups). Our

trajectories in these analyses begin at 7th grade, so the transition to junior high school is not

included in our trajectories (all students in the sample made this transition between 6th and 7th

grades). For the trajectory models, growth curves of math grades and math interest were predicted

simultaneously, taking into account the possible effects of education-related variables (6th grade

math grades, 6th grade math interest, 7th grade standardized MEAP score, 6th grade teacher rating

of students' effort in math, and maternal education level).

For the group of young women in the college/honors track, 7th grade school grades (a higher

math grades intercept) were predicted by higher 6th grade school grades, higher MEAP score, higher teachers' ratings of 6th grade math effort, lower 6th grade math interest, and higher 7th grade math interest (math interest intercept). A decreasing slope of math grades was predicted by lower maternal level of education, a negative math interest slope, higher 7th grade school grades (math grades intercept), and lower 7th grade MEAP. A higher intercept of math interest (at 7th grade) was predicted by lower MEAP score and higher 6th grade math interest. The slope of math interest was predicted by higher math interest in 7th grade, and lower math grades in 7th grade.

The LGC model for the group of young women in a regular/basic math track was similar. A higher math grades intercept was predicted by higher 6th grade math scores, lower 6th grade math interest, higher 7th grade math interest (math interest intercept), and higher 7th grade MEAP score. The slope for math grades was predicted by higher 6th grade and lower 7th grade math school grades. A higher math interest intercept was predicted by higher 6th grade math interest; a positive math interest slope was predicted by higher 6th grade math interest and lower 7th grade math interest.

Predicting School Grade and Interest Trajectories for Young Men

The LGC model for young men in the honors/college track revealed several similar predictors. A higher school grades intercept was associated with higher 6th grade math grades, lower 6th grade math interest, higher 7th grade math interest, higher 7th grade MEAP score, and higher teachers' evaluation of math effort. A negative math grades slope was associated with a declining math interest slope. A higher math interest intercept was associated with a higher 6th grade math interest level. Finally, an increasing math interest slope was associated with higher 6th grade math interest, but lower 7th grade math interest and lower 6th grade school math grades.

For young men in the regular/basic tracking group, a higher math grades intercept was associated with higher 6th grade math grades, higher 7th grade math interest, and higher 7th grade

MEAP score. A declining math grades slope was associated with lower interest in math in 6th grade, and higher interest in math in 7th grade. A higher math interest intercept was associated with higher 6th grade math interest, and an increasing slope in math interest was associated with lower 6th grade math grades, higher 7th grade math grades, and lower 7th grade math interest.

Discussion

Similar to the findings of Jacobs et al. (2002), our results suggest that for both boys and girls, math grades fall over the course of junior high and high school. As can be seen in Figures 1 and 2, young women achieve at comparable or higher levels in math as males, but their interest especially for the high achieving females, is the same or lower than males. Our results, also, suggest that for young men in higher-level math tracks, math interest is much more strongly related to math school grades than for young women in the same math courses. Indeed, interest in math courses or math-related activities remain flat across the junior high and high school years for women who are in the higher level math courses.

This research would suggest that in order to encourage more women into math, science, and information technology fields, interventions need to be designed that focus not on the academic achievement of women but in how to make math- and science-related occupations more interesting for young, high achieving women. This type of intervention should start early in the academic careers for these adolescents and young women; our results suggest the lack of interest in math begin earlier than the junior high school years and never improve.

Table 1

Descriptive statistics for all variables

	N	Min	Max	Mean	SD	%
6th grade math grades	1633	1	16	11.7	2.5	
7th grade math grades	1696	3	16	10.7	3.0	
9th grade math grades	1651	1	16	9.7	3.0	
10th grade math grades	1641	1	16	9.5	3.2	
11th grade math grades	1310	1	16	9.4	3.2	
12th grade math grades	860	2	16	9.4	3.3	
6th grade math interest	1597	1	7	4.9	1.9	
7th grade math interest	1708	1	7	4.9	1.8	
10th grade math interest	1411	1	7	3.8	1.9	
12th grade math interest	1280	1	7	3.7	2.0	
Adolescent gender (1=F)	1821	0	1			53%
Teacher rated effort in math, 6th grade	1603	1	7	5.2	1.4	
MEAP score, 7th grade	1519	3	28	23.3	4.5	
Mother's Education	1618	1	3	1.7	.8	
Honors math track, 9th grade	279					17%
College math track, 9th grade	652					40%
Regular math track, 9th grade	359					22%
Basic math track, 9th grade	361					21%

Table 2

Results of Latent Growth Curve Models: Prediction of Young Women's Math School Grades and Math Interest

	Unstand. Coefficient	*SE*	Standardized Coefficient	Critical ratio
Honors/College Track				
Math Grades Intercept				
6th grade math grades	.346	.056	.352	6.194
6th grade math interest	-.232	.077	-.184	-3.002
7th grade math interest	.468	.114	.284	4.109
7th grade MEAP	.211	.030	.328	6.942
Teachers' eval. Math effort	.291	.091	.166	3.192
Math Grades Slope				
Mothers' education	.112	.042	.138	2.684
7th grade math grades	-.256	.037	-.851	-6.996
Slope of math interest	1.330	.241	.527	5.521
7th grade MEAP	.031	.014	.160	2.227
Math Interest Intercept				
7th grade MEAP	-.047	.022	-.120	-2.167
6th grade math interest	.504	.035	.659	14.367
Math Interest Slope				
7th grade math grades	.037	.016	.307	2.227
7th grade math interest	-.069	.026	-.352	-2.677
Regular/Basic Track				
Math Grades Intercept				
6th grade math grades	.421	.060	.515	6.995
6th grade math interest	-.173	.084	-.155	-2.059
7th grade math interest	.484	.125	.326	3.875
7th grade MEAP	.119	.028	.274	4.192
Math Grades Slope				
6th grade math grades	.055	.027	.284	2.078
7th grade math grades	-.218	.052	.560	-4.181
Math Interest Intercept				
6th grade math interest	.405	.045	.539	9.086
Math Interest Slope				
6th grade math interest	.039	.015	.258	2.667
7th grade math interest	-.131	.025	-.651	-5.295

Table 3

Results of Latent Growth Curve Models: Prediction of Young Men's Math School Grades and Math Interest

	Unstand. Coefficient	*SE*	Standardized Coefficient	Critical ratio
Honors/College Track				
Math Grades Intercept				
6th grade math grades	.369	.058	.384	6.337
6th grade math interest	-.281	.075	-.235	-3.727
7th grade math interest	.507	.100	.352	5.086
7th grade MEAP	.216	.028	.396	7.628
Teachers' eval. Math effort	.256	.089	.162	2.877
Math Grades Slope				
Slope of math interest	1.323	.357	.771	3.703
Math Interest Intercept				
6th grade math interest	.456	.042	.549	10.809
Math Interest Slope				
6th grade math interest	.046	.016	.307	2.864
7th grade math interest	-.129	.024	-.711	-5.318
6th grade math grades	-.033	.015	-.274	-2.219
Regular/Basic Track				
Math Grades Intercept				
6th grade math grades	.398	.064	.655	6.196
7th grade math interest	.408	.132	.322	3.095
7th grade MEAP	.086	.029	.256	2.958
Math Grades Slope				
6th grade math interest	.097	.036	.513	2.719
7th grade math interest	-.175	.044	-.762	-3.943
Math Interest Intercept				
6th grade math interest	.547	.050	.662	10.956
Math Interest Slope				
6th grade math grades	-.055	.024	-.667	-2.268
7th grade math grades	.149	.051	.326	2.901
7th grade math interest	-.177	.032	-.656	-5.462

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