AC 2009-1266: THE WAYS IN WHICH K-8 STUDENTS' PARTICIPATION IN A GK-12 PROGRAM AFFECTS ACHIEVEMENT IN AND BELIEFS ABOUT MATHEMATICS

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The Effects of a GK-12 Program on Students' Achievement In and Beliefs About Mathematics

Abstract

To evaluate the effectiveness of a program whose goal is to increase the number and diversity of students enrolled in upper-level mathematics courses, an analysis was conducted comparing the standardized achievement test scores of program participants to similar non-participants. Results indicate that significant gains occur when students participate in the program for two years. In addition, program participants were surveyed to measure students' confidence about their abilities in mathematics, students' beliefs about mathematics as a male domain, and students' perceptions of their teacher's beliefs about their ability to learn mathematics. Analyses indicate that at least one significant mean difference occurred for all three between subject factors (gender, ethnicity, school type) for all three measures of attitudes and beliefs about mathematics.

Introduction

"Investments in math and science under President Eisenhower gave new opportunities to young scientists and engineers all across the country. It made possible somebody like a Sergei Brin to attend graduate school and found an upstart company called Google that would forever change our world," – President Barack Obama, March 10, 2009[1]

Many have noted for years that mathematics and science can shape and change our world. The technological advances propelled by those knowledgeable in mathematics and science during just the past century is remarkable. But, if we as a nation want to remain competitive in these fields we must make sure that students are prepared for advanced study in these areas (Committee on Prospering in the Global Economy of the 21st Century, 2007[2]). The goal of the RAMP-UP (Recognizing Accelerated Math Potential in Underrepresented People) program at North Carolina State University (NCSU) is to increase the number and diversity of students who enroll and succeed in higher-level mathematics courses. To achieve this goal, the RAMP-UP project places NCSU graduate engineering and undergraduate engineering and math education students, and mathematics and computer science students from Shaw University (a historically black university) in local public schools. The placement of these university students (fellows) serves two purposes. One purpose is to enrich the learning experience of K-12 students by serving as role models and mentors. The other purpose is to work with teachers collaboratively to create hands-on mathematics activities and experiments in order to cultivate an excitement for learning mathematics. The K-12 students may have the opportunity to participate with the RAMP-UP program through a variety of settings that include regular classrooms, tutorials before and after school, elective courses, clubs, or special projects such as science fairs or family math nights. To determine the effects of students' participation in these activities on students' achievement in and beliefs about mathematics, data were collected and analyzed.

Methods

The five-year project took place in the context of a large school district in the Southeast United States. There were a total of 9 different schools and over 2000 students who participated in programs sponsored by RAMP-UP during the five-year period. The number of schools participating was increased from year 1 to year 2, remained stable during year 3 and decreased in years 4 and 5. Data were collected each year and findings from years 1 through 4 will be reported in this study.

The effectiveness of this project can be viewed in two ways. One way is to evaluate students' levels of academic achievement, which is based on standardized test scores, and compare that to their counterparts who did not participate in the program. Another way to evaluate the program is to investigate students' beliefs about their ability to do mathematics, their beliefs about teacher's perceptions of their ability to do mathematics, and their beliefs about mathematics as a male domain to determine whether these affective attributes are changed as a result of participation in project activities.

Academic Achievement

To evaluate the effectiveness of the RAMP-UP program on students' academic achievement, students participating in the RAMP-UP program were compared to students who did not. Outcome data for these analyses consisted of mean scale score data on the 2005 and 2006 North Carolina End-of-Grade Mathematics (EOG) exam and the percentage of students scoring at the various levels of achievement (levels I – IV) on these exams. Scores at levels III and IV indicated that the students are working on grade level or higher. EOG exams are only administered to students in grades three through eight. For students enrolled in courses that can earn high school credit (e.g. Algebra I, Geometry, Biology, etc.), end-of-course (EOC) exams are administered.

The selection of comparison students proceeded in the following manner. First, comparison schools within the county were selected for each participating RAMP-UP school based on the percentages of students receiving free or reduced price lunch. Second, all the race/gender groups were pulled from both RAMP-UP and comparison schools by grade (e.g., 3rd grade black females, black males, white females, etc.). Then for each race/gender group, those students with a certain special education status, LEP status, and EOG math pretest level (for 4th and 5th grade students would be level for the previous grade) were isolated. For example, all the Black females who were not identified as special education, not LEP, and level II on EOG math pretest. Then for each RAMP-UP student within that category, a student was selected from a comparison school that fit all these criteria. When several possibilities were available, the student with the closest EOG math pretest scale score was selected. When more than one student fitting these criteria was available, the selection alternated between schools. If a situation arose where there were not enough comparison students fitting the criteria identified, then an attempt was made to match at the next closest level of a selected variable. For example, there were many more Asian RAMP-UP gifted students at one school than were available at any of the comparison schools; White gifted students were used to match with the Asian gifted students. There were some situations where a decent match was just not possible. In these cases (< 10) these students were excluded from the analyses. For example, there were two autistic students participating in one or more RAMP-UP programs at a particular school and none of the autistic children at the other comparison schools were deemed similar enough to be a good comparison. Academic achievement data were collected each year and findings from Years 1 and 2 will be reported in this study

Students' attitudes and beliefs

To evaluate the effects of the RAMP-UP programs on participating students' attitudes towards and beliefs about mathematics a survey was given to the participating students at the end of each school year (see Table 1).

Table 1
Likert Scale Survey Items and Corresponding Dimension

Item	Dimension
I know I can learn math.	Confidence
Boys are better than girls in math.	Male Domain
Math is hard for me.	Confidence
It's hard to believe a girl could be really good in math.	Male Domain
Girls need more help with math.	Male Domain
I am sure of myself when I do math.	Confidence
I'm not the type to do well in math.	Confidence
Math has been my worst subject.	Confidence
Girls who enjoying studying math are a little strange.	Male Domain
I think I could handle more difficult math.	Confidence
Girls are as good as boys in math.	Male Domain
I feel that my teacher ignores me when I try to talk about math.	Teacher Perception
Girls are smart enough to do well in math.	Male Domain
Most subjects I can handle OK, but I just can't do a good job with math.	Confidence
I can get good grades in math.	Confidence
I know I can do well in math.	Confidence
My teachers wouldn't believe me if I told them that I wanted to work in math or science.	Teacher Perception
I'm no good in math.	Confidence
I would choose a girl rather than a boy to be on my team for a math competition.	Male Domain
My teachers think I'm the kind of person who could do well in math.	Teacher Perception
It takes me longer to understand math than others in my class.	Confidence
My teacher believes anyone can do math if they try.	Teacher Perception
I like the way my teacher teaches math.	Teacher Perception
My book does not help me to understand math.	Teacher Perception

The Likert scale survey includes items based on the Fennema-Sherman Mathematics Attitude Scales (Fennema & Sherman, 1976[3]) to measure students' confidence about their abilities in mathematics, students' beliefs about mathematics as a male domain, and students' perceptions of their teacher's beliefs about their ability to learn mathematics. The Likert scale consisted of five levels of response that ranged from Strongly Agree to Strongly Disagree. To score the survey data, each item was coded based on the student's response. Students who responded "Strongly Agree" were given 5 points and "Strongly Disagree" responses were given 1 point. Negatively worded items were reverse coded. Survey data were collected each year and findings from Years 1 through 4 will be reported in this study.

Results

Academic achievement

Overall results of the academic achievement data indicate that even though K-12 students participating in programs sponsored by RAMP-UP had a higher mean score on the EOG test ($M = 355.78$, $SD = 16.66$) compared to non-participating students ($M = 355.19$, $SD = 17.96$), the difference was not significant ($p > .05$). Results from an analysis employing the Chi-square statistic with significance level .05 indicate that there is a significant difference between the percentages of students attaining the various levels of achievement on the EOC exams for students participating in a RAMP-UP sponsored program for one year, two years, and non-participants ($\chi^2(6, N = 1396) = 12.97$, $p < .05$). Post-hoc tests reveal that students participating in programs sponsored by RAMP-UP for at least two years had a significantly greater percentage of students who met the highest level of performance, level IV, (40.29%) compared to similar students who did not participate in the RAMP-UP sponsored programs (32.06%, $p < .05$) and those who only participated in these programs for one year (32.17%, $p < .05$).

To determine whether students who participated in a RAMP-UP program had significantly greater gains on their EOC exams compared to non-participants, a one-way ANOVA was utilized with gain as the dependent variable and group as the between-subject factor (comparison, $n = 680$; RAMP-UP year 1, $n = 372$; RAMP-UP year 2, $n = 337$). Results indicate that there was a significant difference between the mean gain scores between the three groups ($F(2,1386) = 4.56$, $p < .05$). Bonferroni post-hoc tests reveal that two-year RAMP-UP participants had significantly greater gains on standardized mathematics test scores ($M = .57$, $SD = 1.02$) compared to those who only participated in these programs for one year ($M = .38$, $SD = 1.04$, $p < .05$) and those who did not participate at all ($M = .38$, $SD = 1.00$, $p < .05$).

Looking at specific grade levels, a one-way ANOVA was utilized to compare the EOC test scores between third-grade RAMP-UP participants and third-grade non-participants. The EOC math test score was the dependent variable and group was the between-subject factor (comparison, $n = 271$; RAMP-UP, $n = 290$). Results indicate that there was a significant difference between the mean EOC scores between the two groups ($F(1,559) = 18.13$, $p < .001$) and that third grade students who participated in programs sponsored by RAMP-UP scored significantly higher on the EOG exam ($M = 347.52$, $SD = 9.51$) when compared to their non-participating counterparts ($M = 343.56$, $SD = 12.43$). Furthermore, there is a significant difference between the percentages of students attaining the various levels of achievement on the EOC exams for third grade students participating in a RAMP-UP sponsored program and third grade non-participants ($\chi^2(3, N = 566) = 22.21$, $p < .001$). Post-hoc tests reveal a significantly greater percentage of third grade students participating in programs sponsored by RAMP-UP scored at the highest level, level IV, (35.93%) compared to non participating students (25.27%, p

< .05), and significantly smaller percentage of students participating in programs sponsored by RAMP-UP scored at the lowest level, level I, (2.37%) compared to non-participating students (10.26%, $p < .05$).

A one-way ANOVA was employed to compare the EOC test scores for fourth-grade RAMP-UP participants and their non-participating counterparts. The dependent variable was the EOC test score and the between-subject factor was the group (comparison, $n = 310$; RAMP-UP, $n = 308$). Results indicate that there was a significant difference between the mean EOC scores between the two groups ($F(1,615) = 5.51$, $p < .05$) and that fourth grade program participants also had significantly higher EOG scores ($M = 354.82$, $SD = 9.10$) compared to their non-participating counterparts ($M = 352.67$, $SD = 13.18$). For students enrolled in grades five through eight, there was not a significant difference in the EOG scores for those who participated in programs sponsored by RAMP-UP and those who did not participate in these programs. Additionally, there was not a significant difference between the percentages of students who scored at the levels of achievement for all grade levels greater than 3.

These results indicate that the effect of the RAMP-UP programs on students' academic achievement is greatest for those at the lowest grade levels (grades three and four) and those students who participated in such programs for more than one year had significantly higher scores. However, it should be noted that the number of hours dedicated by RAMP-UP project staff at the lower grade levels was significantly more than at the higher levels. This suggests an analysis that examines the intensity of intervention to determine a critical value that is needed to work with students that results in significant gains in achievement scores.

Students' attitude and beliefs

To analyze the survey data, a 3x3 multivariate analysis of variance (MANOVA) with significance level .05 was conducted. The three dependent variables were confidence, male domain, and teacher perception. The three between-subject factors were gender (male, $n = 1214$, female, $n = 1197$), ethnicity (White, $n = 1116$, Black, $n = 665$, Asian, $n = 248$, Hispanic, $n = 204$, other, $n = 178$), and school type (elementary, $n = 1694$, middle, $n = 681$, high, $n = 36$). A sample of 2411 students was surveyed. The overall multiple analysis of variance is displayed in Table 2.

Table 2
Multivariate Tests for Gender, Ethnicity, School Type and their Interactions

Source	Hypothesis *df*	Error *df*	F^1	η^2
Gender (G)	3	2383	5.10^{**}	.01
Ethnicity (E)	12	6305	5.62^{***}	.01
School Type (ST)	6	4766	10.30^{***}	.01
G x E	12	6305	.42	.00
G x ST	6	4766	.74	.00
E x ST	21	6843	1.74^{*}	.01
G x E x ST	15	6579	.95	.00

Note: $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.
[1]Due to the violation of the assumption of equality of covariance matrices, Pillai's Trace was used to calculate *F*

Significant main effects include gender, school type and ethnicity. However, these were qualified by a significant interaction effect between ethnicity and school type. Follow-up univariate analysis of variances (ANOVAs) were conducted separately for each dependent variable to examine the location of the significant effects (see Table 3).

Table 3
Between-Subject Effects for Significant Main Effects and Interactions

Source	Dependent Variable	*Df*	*F*	η^2
Gender (G)	Confidence	1	6.00^{*}	.00
	Male Domain	1	6.22^{*}	.00
	Teacher Perception	1	.30	.00
Ethnicity (E)	Confidence	4	9.49^{***}	.02
	Male Domain	4	2.44^{*}	.00
	Teacher Perception	4	3.60^{**}	.01
School Type (ST)	Confidence	2	4.33^{*}	.00
	Male Domain	2	22.34^{***}	.02
	Teacher Perception	2	9.36^{***}	.01
G x E	Confidence	4	.23	.00
	Male Domain	4	.62	.00
	Teacher Perception	4	.61	.00
G x ST	Confidence	2	.51	.00
	Male Domain	2	.52	.00
	Teacher Perception	2	1.34	.00
E x ST	Confidence	7	2.72^{**}	.01
	Male Domain	7	1.19	.00
	Teacher Perception	7	1.71	.01
G x E x ST	Confidence	5	.79	.00
	Male Domain	5	1.71	.00
	Teacher Perception	5	1.18	.00
Error	Confidence	2385		
	Male Domain	2385		
	Teacher Perception	2385		

Note: $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Significant main effects of gender, school type, and ethnicity were found for the confidence variable. Significant main effects of school type and ethnicity were found for the male domain and teacher perception variables. In addition, the interaction was significant for the confidence variable. These significant main effects for each of the dependent variables indicate that there is at least one significant difference between within-subject factors. Bonferroni post-hoc analyses are discussed below.

<u>Confidence</u>

Bonferroni post-hoc tests were conducted to compare the estimated marginal means of the between-subject factors for each of the significant main effects. Table 4 displays the estimated marginal means, associated standard error, and 95% confidence intervals of those means for the between-subject factors for the confidence variable. Eleven survey items were used to measure students' confidence in doing mathematics. Thus, the maximum score for this variable is 55 and the minimum score is 11.

Table 4
Estimated Marginal Means for the Confidence Variable

Source	Between-Subject Factors	*M*	*SE*	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Gender	Female	40.69	.58	39.56	41.83
	Male	42.87	.59	41.73	44.02
Ethnicity	Asian	46.53	.97	44.62	48.43
	Black	38.87	.75	37.40	40.34
	Hispanic	39.87	1.07	37.76	41.97
	White	42.52	.77	41.02	44.02
	Other	42.52	1.07	40.41	44.62
School Type	Elementary School	43.41	.25	42.91	43.90
	Middle School	42.28	.54	41.22	43.35
	High School	38.25	1.47	35.36	41.14

Analyses of these tests reveal that male students were significantly more confident in their abilities to do mathematics than female students ($p < .01$). Asian students were significantly more confident than students from all other ethnicities ($p < .05$). In addition, White students were more confident than Black students ($p < .01$). Within school type, elementary school students were more confident in their abilities in mathematics than high school students ($p < .01$) and middle school students were significantly more confident than high school students ($p < .05$).

To decompose the interactions, each main effect was examined at different levels of a common main effect. Bonferroni adjusted post-hoc tests were used to locate the significant differences in the main interactions for the confidence variable. These interactions are illustrated in line plots displayed in Figures 1a, 1b, and 1c. Line plots are used to visualize group differences where parallel lines generally show no interaction among the factors and intersecting lines commonly indicate interaction among the factors.

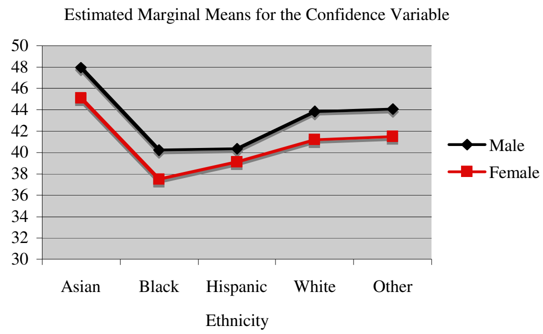

Figure 1a. Plot of the estimated marginal means of the confidence variable for ethnicity and gender.

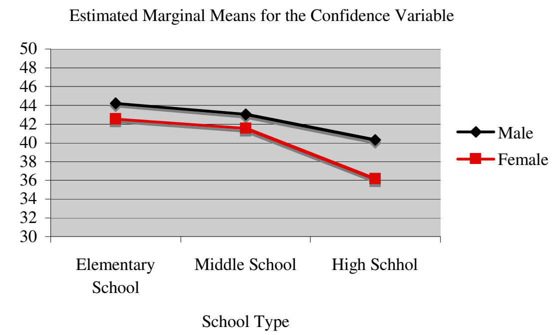

Figure 1b. Plot of the estimated marginal means of the confidence variable school type and gender.

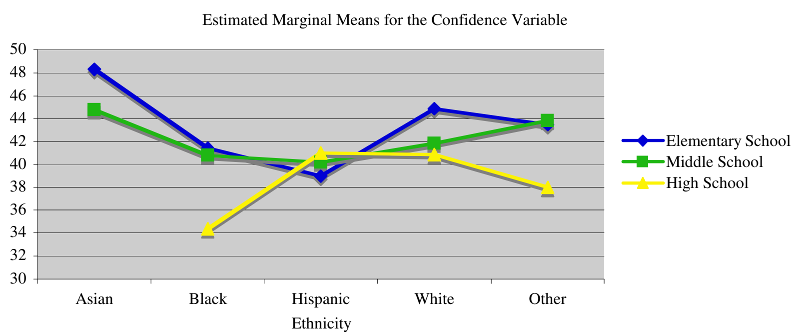

Figure 1c. Plot of the estimated marginal means of the confidence variable for ethnicity and school type.

Elementary school male students were significantly more confident than elementary school female students (Male: $M = 44.24$, $SE = .34$; Female: $M = 42.57$, $SE = .38$; $p < .01$). The difference between the means for male students and female students at the middle school and high school levels were not significant. Table 5 displays the estimate marginal means and associated standard error of the confidence variable for the different ethnicities at the elementary school level.

Table 5
Estimate Marginal Means for the Confidence Variable at the Elementary School Level.

Ethnicity	*M*	*SE*
Asian	48.29	.55
Black	41.42	.39
Hispanic	38.98	.76
White	44.88	.30
Other	43.47	.69

At the elementary school level, Asian students were significantly more confident than all other ethnicities ($p < .001$). In addition, White students were significantly more confident than both Black ($p < .001$) and Hispanic students ($p < .001$) and Black students were significantly more confident than Hispanic students ($p < .001$). At the middle school and high school levels, the differences between the ethnicities were not significant for the confidence variable. Even though there were no significant gender differences for each ethnicity, male students had more confidence than female students for each ethnicity.

The results from these analyses indicate that underrepresented students continue to have less confidence in their mathematics abilities and that this confidence decreases as students move from elementary school to high school. This finding is similar to results found by Mistretta (2004[4]) who found "decreases in levels of enjoyment were noted as grade levels increased for both females and males. Significant grade level differences were found for both females and males between grades four and five, as well as between grades six and seven" (p. 1144). If there is to be an increase in the number of students taking upper level mathematics courses, students need to be involved in activities that not only push their mathematical abilities, but also are enjoyable and build confidence to motivate students to continue to choose to pursue mathematics.

Male Domain

Similar to the confidence variable, Bonferroni post-hoc tests were performed to compare the data for the male domain variable. Table 6 displays the estimated marginal means, associated standard errors, and 95% confidence interval for the between-subject factors for the male domain variable. Seven survey items were used to measure students' beliefs concerning mathematics as a male domain. Thus, the maximum score for this variable is 35 and the minimum score is 7.

Table 6
Estimated Marginal Means for the Male Domain Variable

Source	Between-Subject Factors	*M*	*SE*	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Gender	Female	23.57	.25	23.09	24.06
	Male	22.58	.25	22.09	23.07
Ethnicity	Asian	24.07	.41	23.26	24.88
	Black	22.98	.32	22.36	23.61
	Hispanic	22.28	.46	21.38	23.17
	White	23.48	.33	22.85	24.12
	Other	22.71	.46	21.81	23.60
School Type	Elementary School	23.60	.11	23.39	23.81
	Middle School	24.39	.23	23.94	24.85
	High School	20.02	.89	18.79	21.25

For the male domain variable, male students held significantly stronger beliefs that mathematics is a male domain than female students ($p < .01$). The only significant difference between the ethnicities for the male domain variable was that Asian students held significantly stronger beliefs than Hispanic students ($p < .05$). Middle school students held significantly stronger beliefs that mathematics is a male domain compared to both elementary school students

($p < .01$) and high school students ($p < .001$). In addition, elementary school students' beliefs were significantly stronger than high school students ($p < .001$).

To decompose the interactions, each main effect was examined at different levels of a common main effect. Bonferroni adjusted post-hoc tests were used to locate the significant differences in the interactions. Line plots illustrate these interactions in Figures 2a, 2b, and 2c.

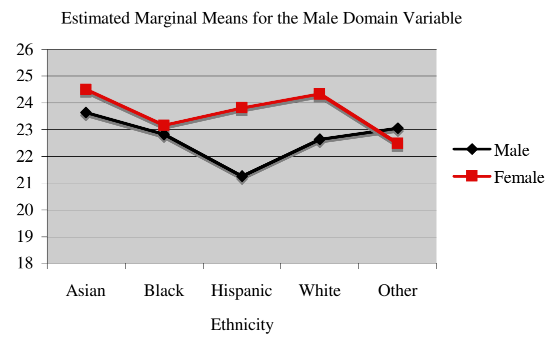

Figure 2a. Plot of the estimated marginal means of the male domain variable for ethnicity and gender.

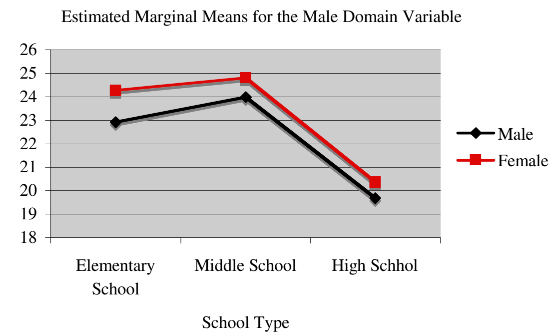

Figure 2b. Plot of the estimated marginal means of the male domain variable school type and gender.

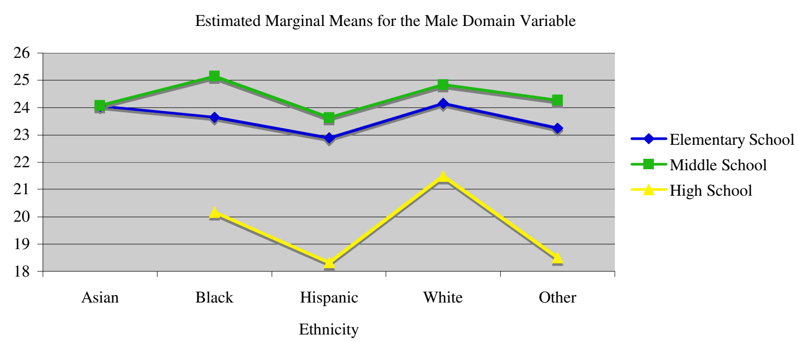

Figure 2c. Plot of the estimated marginal means of the male domain variable for ethnicity and school type.

For the male domain variable, both White and Hispanic females (White: $M = 24.33$, $SE = .49$; Hispanic: $M = 23.81$, $SE = .36$) views of mathematics as a male domain were significantly higher than White and Hispanic males (White: $M = 22.64$, $ED = .43$, $p < .05$; Hispanic, $M = 21.26$, $SE = .72$, $p < .01$), respectively. There was not a significant gender difference for Asian and Black students. Also, elementary school female students ($M = 24.27$, $SE = .16$) views of mathematics as a male domain were significantly higher than elementary school male students ($M = 22.93$, $SE = .14$, $p < .001$). Even though female middle school and high school students held a stronger view that mathematics is a male domain compared to their male counterparts, the differences in the means was not significant. Asian and White elementary school students (Asian: $M = 24.06$, $SE = .24$; White: $M = 24.15$, $SE = .13$) held a significantly stronger belief that mathematics is a male domain compared to Hispanic elementary school students ($M = 22.89$, $SE = .32$, $p < .05$). Black middle school students ($M = 25.15$, $SE = .25$) had significantly higher views that mathematics was a male domain compared to Hispanic middle school students ($M =$

23.63, *SE* = .41, $p < .005$). There were no significant differences between ethnicities at the high school level.

Similar to findings of others, this study found that students' views of mathematics as a male domain decreases as grade level increases (Kloosterman, Tassell, Ponniah, & Essex, 2001[5]; McGraw & Lubienski, 2007[6]). However, there is still this view at the lower grades, especially at the middle school level. Because there is a need to increase the participation of females who pursue STEM majors in college and STEM careers beyond college, knowing that views of mathematics as being a field for males is diminishing is encouraging.

Teacher Perception

To determine the location of the significance for the teacher perception variable, Bonferroni post-hoc tests were conducted. Table 7 presents the estimated marginal means, associated standard errors, and 95% confidence interval for the between-subject factors for the teacher perception variable. Six survey items were used to measure the teacher perception variable. Thus, the maximum score for this variable is 30 and the minimum score is 6.

Table 7
Estimate Marginal Means for the Teacher Perception Variable

Source	Between-Subject Factors	*M*	*SE*	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Gender	Female	26.66	.35	25.98	27.35
	Male	26.84	.35	26.15	27.54
Ethnicity	Asian	28.91	.59	27.76	30.06
	Black	27.25	.45	26.36	28.14
	Hispanic	26.19	.65	24.92	27.47
	White	26.37	.46	25.46	27.28
	Other	25.45	.65	24.18	26.73
School Type	Elementary School	27.97	.15	27.67	28.27
	Middle School	27.10	.33	26.46	27.74
	High School	24.15	.89	22.40	25.90

For the teacher perception variable, there was not a significant difference between male students and female students in their perceptions of the teacher's beliefs of their ability to do mathematics. Asian students' perception of their teachers' beliefs was significantly higher than Hispanic students ($p < .05$) and White students ($p < .01$). Elementary school students' perception of their teachers' beliefs was significantly higher than both middle school students ($p < .05$) and high school students ($p < .01$). In addition, middle school students' perceptions were significantly higher than high school students ($p < .01$). These results seem to indicate that the students' perceptions of their teachers' perceptions of their ability to do mathematics decreases as the level of schooling increases.

To decompose the interactions, each main effect was examined at different levels of a common main effect. Bonferroni adjusted post-hoc tests were used to locate the significant differences in the interactions. Line plots illustrate these interactions in Figures 3a, 3b, and 3c.

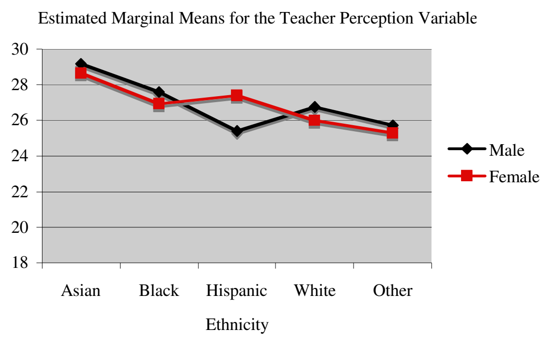

Figure 3a. Plot of the estimated marginal means of the teacher perception variable for ethnicity and gender.

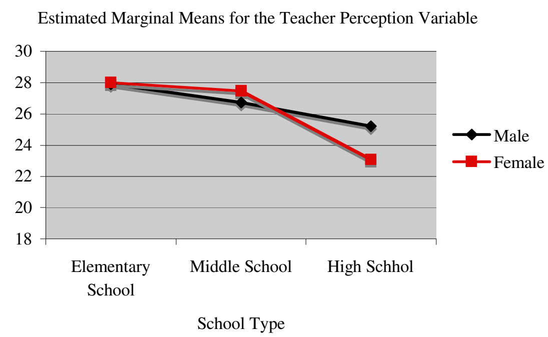

Figure 3b. Plot of the estimated marginal means of the teacher perception variable school type and gender.

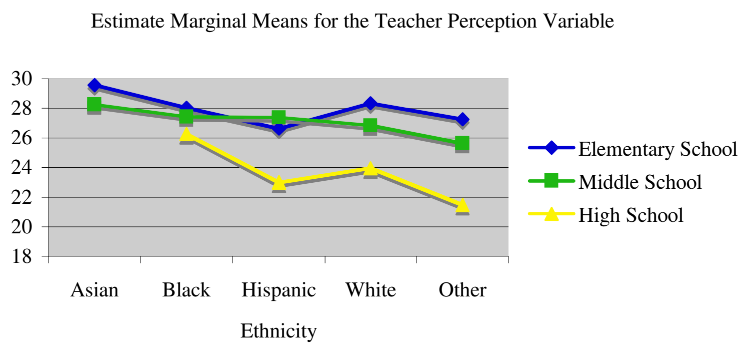

Figure 3c. Plot of the estimated marginal means of the teacher perception variable for ethnicity and school type.

For the teacher perception variable, there were no significant gender differences for the ethnicity and school type factors. It is interesting to note that Hispanic female students held a higher view of their teachers' perception of their ability to do mathematics compared to their male counterparts which is not the case for the other ethnicities. Table 8 displays the estimated marginal means of the teacher perception variable for the different ethnicities at the elementary school level.

Table 8
Estimate Marginal Means for the Teacher Perception Variable at the Elementary School Level.

Ethnicity	*M*	*SE*
Asian	29.57	.33
Black	28.04	.24
Hispanic	26.62	.46
White	28.35	.18
Other	27.26	.42

Asian elementary school students view that their teacher's perception of their ability to do mathematics was significantly higher than all other ethnicities at the elementary school level ($p < .05$). In addition, White elementary school students held a significantly higher view than Hispanic elementary school students ($p < .01$). There were no significant differences between the ethnicities at the middle school and high school levels.

The result that the students' perceptions of their teachers' perceptions of their ability to do mathematics decreases as the students progress from elementary to high school is similar to that found for the confidence variable which is not surprising. Students who are not confident in their abilities to do mathematics may think that their teachers do not think they can do mathematics. Teachers need to take the view that all students can do mathematics.

Discussion

It is well documented that the number of students choosing STEM-related areas in higher education has been declining, with a consequent negative impact on the pool of U.S. workers adequate to meet the needs of a 21st century workforce (Friedman, 2005[7]; Casner-Lotto & Barrington, 2006[8]). However, success in required high school curricula such as mathematics can determine if STEM-related majors are even options later on. Steps must be taken to increase students' participation and success in higher-level mathematics courses in high school so they are prepared for and interested in taking appropriate high school mathematics courses. These steps must begin before students enter high school to assure students remain interested and confident in the subject and have success to build upon later. Providing role model mentors, opportunities to participate in after-school mathematics-related club activities, family math nights, and tutoring, may be ways of supporting student achievement and confidence in mathematics. However, the analysis provided in this study did not examine the effects of individual activities to determine whether some are more influential than others. Another question that may be of interest for future research is how much time must be devoted to one or more of these activities to see positive student outcomes. Future research in this and other related areas is needed to know how to best encourage students to be successful in mathematics in high school so they have the opportunity to pursue STEM-related majors in college. It is important to encourage more students to pursue STEM-related majors since we know the profound impacts developments in science and mathematics can have on our economic future and on the world around us.

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