DOCUMENT RESUME

ED 482 691 SP 041 861

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TITLE Unisex Math: Narrowing the Gender Gap.

PUB DATE 2003-11-00

NOTE 12p.; Paper presented at the Annual Meeting of the Mid-South Educational Research Association (Biloxi, MS, November 5-7, 2003).

PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)

EDRS PRICE EDRS Price MF01/PC01 Plus Postage.

DESCRIPTORS Elementary Secondary Education; Higher Education; Liberal Arts; Preservice Teacher Education; Self Esteem; *Sex Differences; State Colleges; Student Motivation; *Student Teacher Attitudes

ABSTRACT

This study examined gender differences in attitudes toward mathematics of undergraduate students. The Attitudes Toward Mathematics Instrument (ATMI) was administered to students enrolled in introductory mathematics classes (Pre-Calculus, Calculus, and Business Calculus) at two Southeast universities, one a large state university and the other one a small private liberal arts college. The subjects of the study were 275 college students; 141 attended the state university and 134 attended the liberal arts college. General linear analysis revealed no significant differences between students from the state university and students from the liberal arts college in any of four factors (self-confidence, value of mathematics, enjoyment of mathematics, and motivation). Also, there were no significant differences between males and females on each of the four factors. These results suggest that gender differences in mathematics were not reflected in this sample. (Contains 10 references.) (Author/SM)

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UNISEX MATH: NARROWING THE GENDER GAP

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Paper presented at the Annual Meeting of the
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ABSTRACT

This study examined gender differences in attitudes toward mathematics of undergraduate students. The Attitudes Toward Mathematics Instrument (ATMI) was administered to students enrolled in introductory mathematics classes (Pre-Calculus, Calculus and Business Calculus) at two universities in the Southeast, one a large state university and the other one a small private liberal arts college. The subjects of the study were 275 college students, 141 attended the state university and 134 attended the liberal arts college. General linear analysis revealed no significant differences between students from the state university and students from the liberal arts college in any of the four factors. Also, there were no significant differences between males and females on each of the four factors. These results suggest that gender differences in mathematics were not reflected in this sample.

Unisex Math: Narrowing the Gender Gap

Introduction

Gender differences in mathematics have been attributed to cognitive differences between girls and boys. At least on the SAT, boys have surpassed girls consistently. Recent SAT and ACT reports indicate that in the last decade Math national means have increased for males and females. Math SAT scores are higher for men, remaining at about a 30 point difference between 1996 and 2000, but females have gained 19 points while males have gained 13 points (Hoover, 2001; ACT, 2003). Investigations of differences have focused on such matters as cognitive differences and test-taking performance. Boys tend to perform better on multiple-choice tests in math, while girls are superior in open-ended or essay responses that involve verbal skills (Beller & Gafni, 2000).

While it is clear that girls outperform boys in verbal skills, the reasons for lower math achievement may be related more to attitudes than ability. In a longitudinal study, Davis-Kean, Eccles, & Linver (2003), reported that girls are not under-performing in middle school and high school math; because achievement in math classes is virtually the same for both groups. But girls seem to have less interest in the subject. Attitudes are critical in women's pursuit of math-related occupations.

While the scores of women on math are improving, and the gap between men and women in achievement math scores may be narrowing, there is a widening gap in the percentage of bachelor's degrees awarded to men and women. Hacker (2003) reported that women were awarded 57 percent of all bachelor's degrees last year, up from 35% in 1960 and 50% in 1980. In minority groups the same pattern holds, Asian women earned 53 percent of their group's undergraduate degrees, and Hispanic women earned 58 percent. Although the

percentage of women earning degrees overall is increasing, the percentage of women earning degrees in technical fields has decreased. In 1999, 20 percent of such degrees went to women. The demand for workers in technical professions has opened doors for female applicants, especially in the absence of male candidates, but women are not taking advantage of the opportunities. If the absence of women in the technical fields is increasingly unrelated to opportunity or ability, then the problem may be related to attitudes that dictate career choices. The purpose of this study was to examine differences in attitudes toward math by gender.

Method

Subjects

The subjects were 275 undergraduate students enrolled in introductory mathematics classes (Pre-Calculus, Calculus, and Business Calculus) at two universities in the Southeast, one a large state university and the other one a small liberal arts college. Approximately 87% of the sample was Caucasian and about 11% African-American. One hundred thirty four subjects attended the state university and 141 attended the liberal arts college.

Of the 134 students enrolled at the state university, 71 were male, 58 female, and 5 did not report their gender. Of the 141 students enrolled at the state university, 80 were male, 57 female and 4 did not report their gender. The ages of the sample ranged from 17 to 34. Ten participants did not report their ages. All subjects were volunteers and all students in the classes agreed to participate.

Materials

The Attitudes Toward Mathematics Inventory (ATMI) is a 40-item scale. The items were constructed using a Likert-format scale of five alternatives for the responses with anchors of 1: strongly disagree, 2: disagree, 3: neutral, 4: agree, and 5: strongly agree. Eleven

items of this instrument were reversed items. These items were given the appropriate value for the data analysis. The score was the sum of the ratings.

A Student's Demographic Questionnaire was also used. This questionnaire consisted of four questions. The purpose of these questions was for identifying location, gender, age, and ethnic background.

Exploratory factor analysis of the ATMI using a sample of high school students resulted in four factors identified as self-confidence, value, enjoyment, and motivation. Self-confidence consisted of 15 items. The value scale consisted of 10 items. The enjoyment scale consisted of 10 items. The motivation scale consisted of five items. Table 1 shows anchor items by factors. Alpha coefficients for the scores on these scales were found to be .95, .89, .89, and .88 respectively (Tapia 1996).

Procedure

The ATMI was administered to participants during their mathematics classes. Directions were provided in written form and students recorded their responses on computer scannable answer sheets.

Results

Tapia (1996) found a four-factor solution from an exploratory factor analysis with maximum likelihood method of extraction and a varimax, orthogonal, rotation. The names for the factors reported were self-confidence, value of mathematics, enjoyment of mathematics, and motivation. Based on that factor analysis, the 40 items were classified into four categories each of which was represented by a factor. A composite score for each category was calculated by adding up all the numbers of the scaled responses to the items belonging to that category. Cronbach alpha coefficients were calculated for the scores on the

scales and were found to be .96 for self-confidence, .91 for value, .90 for enjoyment, and .88 for motivation.

Table 1 Anchor Items by Factors

Items by Factor
Self-confidence
Mathematics does not scare me at all.
Studying mathematics makes me feel nervous.
My mind goes blank and I am unable to think clearly when working mathematics.
Value
Mathematics is a very worthwhile and necessary subject.
Mathematics courses will be very helpful no matter what I decide to study.
Mathematics is important in everyday life.
Enjoyment
I really like mathematics.
I have usually enjoyed studying mathematics in school.
I am happier in a math class than in any other class.
Motivation
I am willing to take more than the required amount of mathematics.
I plan to take as much mathematics as I can during my education.
The challenge of mathematics appeals to me.

The data were analyzed using two separate one-way analysis of variance (ANOVA) with four factors as dependent variables: (1) Self-confidence, (2) Value, (3) Enjoyment, and (4) Motivation and gender and location as independent variables respectively. ANOVA was performed by using SPSS.

Data were analyzed by gender at the .05 level. Levene's statistics for self-confidence ($p < .23$), value ($p < .14$), enjoyment ($p < .31$), and motivation ($p < .14$) indicated the assumption of homogeneity of variance had been met. Data analysis indicated no significant

differences of the scores of the dependent variables when grouped by gender. Partial eta squared values indicated very small effect size. Table 2 shows the results of the analysis of variance and partial eta squared values. Table 3 shows means and standard deviations by gender of the scores on the four dependent variables by gender.

Table 2 ANOVA Table by Gender

		Sum of Squares	Df	Mean square	F	Sig.	Partial eta squared
Self-Conf	Between Groups	8.56	1	8.56	.047	.829	.000
	Within Groups	48553.93	264	183.92			
	Total	48562.49	265				
Value	Between Groups	43.04	1	43.30	.852	.357	.003
	Within Groups	13413.80	264	50.81			
	Total	13457.10	265				
Enjoyment	Between Groups	25.65	1	25.65	.391	.532	.001
	Within Groups	17311.39	264	65.57			
	Total	17337.04	265				
Motivation	Between Groups	14.22	1	14.22	.682	.410	.003
	Within Groups	5501.62	264	20.84			
	Total	5515.84	265				

Table 3 Means and Standard Deviations by Gender

	Gender	Mean	Std. Deviation	N
Self-Conf	Male	52.63	12.91	151
	Female	52.29	14.38	115
	Total	52.49	13.54	266
Value	Male	37.91	7.62	151
	Female	38.72	6.42	115
	Total	38.26	7.13	266
Enjoyment	Male	32.67	7.82	151
	Female	33.30	8.44	115
	Total	32.94	8.09	266
Motivation	Male	14.91	4.32	151
	Female	15.37	4.87	115
	Total	15.11	4.56	266

Data were analyzed by location at the .05 level. Levene's statistics for self-confidence ($p < ..64$), value ($p < .07$), enjoyment ($p < .93$), and motivation ($p < .92$) indicated the assumption of homogeneity of variance had been met. Data analysis indicated no significant differences of the scores of the dependent variables when grouped by location. Partial eta squared values indicated very small effect size. Table 4 shows the results of the analysis of variance and partial eta squared values. Table 5 shows means and standard deviations of the scores on the four dependent variables by location.

Table 4 ANOVA Table by Location

		Sum of Squares	df	Mean square	F	Sig.	Partial eta squared
Self-Conf	Between Groups	61.27	1	61.27	.334	.564	.001
	Within Groups	50008.57	273	183.18			
	Total	50069.84	274				
Value	Between Groups	183.10	1	183.09	3.75	.054	.014
	Within Groups	13327.06	273	48.82			
	Total	13510.16	274				
Enjoyment	Between Groups	63.94	1	63.94	.992	.320	.004
	Within Groups	17600.30	273	64.47			
	Total	17664.24	274				
Motivation	Between Groups	64.89	1	64.89	`3.195	.075	.012
	Within Groups	5543.93	273	20.31			
	Total	5608.82	274				

Conclusions

The one-way analysis of variance indicated that there were no significant differences when the data were grouped by gender. Also no significant differences were found when a one-way analysis of variance was conducted and the data were grouped by location. Contrary to expectations and prior research, there were no differences in this sample by gender in terms

of self-confidence, value, enjoyment, or motivation in mathematics, nor were there differences that could be attributed to the nature of the college attended

Table 5 Means and Standard Deviations by Location

Location		Mean	Std. Deviation	n
Self-Conf	State Univ	52.78	13.42	141
	Lib Arts College	51.84	13.65	134
	Total	52.32	13.51	275
Value	State Univ	39.04	6.46	141
	Lib Arts College	37.40	7.50	134
	Total	38.24	7.02	275
Enjoyment	State Univ	33.39	7.97	141
	Lib Arts College	32.43	8.08	134
	Total	32.92	8.03	275
Motivation	State Univ	15.54	4.57	141
	Lib Arts College	14.58	4.43	134
	Total	15.07	4.52	275

If these results are typical of the nation as a whole, it is increasingly important to develop programs to encourage girls in elementary and middle school to develop an interest in careers related to math and science. It is also important to consider special programming in high school, because girls may have a high level of interest in middle school that diminishes after puberty and drops significantly during and after high school graduation.

Lantz (1985) reported that stereotypes about subject areas traditionally regarded as "masculine" discouraged girls from pursuing nontraditional careers. This remains as an important factor (Silverman & Pritchard, 1996). Drzewiecki and Westberg (1997) conducted a study to try to interest girls in advanced math classes. Cooperative grouping was used to improve positive, general attitudes toward math. The study indicated that cooperative group learning did not improve female students' attitudes. This research also indicated that being placed in coed groups did not help girls who were lacking confidence.

The TIMSS (2000) data give the best overall picture of gender differences across several cultures. In math achievement the gender differences are only apparent in a few countries in the elementary grades, but diverge in secondary school. Males in secondary school had significantly higher average achievement than females in most countries. Males outperformed females in measurement but females were better in algebra. It now seems clear that the gender differences in math achievement cannot be easily dismissed as cognitive differences between the sexes. Women are apparently just as capable as men of high achievement in mathematics, but whether they remain interested in the subject or decide to choose a math related or technical field for a career depends on a complex of social factors inherent in the culture.

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