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ABSTRACT

In the United States female and male students supposedly have the same educational opportunities. Females continue to score below male students on the mathematics portions of standardized tests and less frequently choose mathematics-oriented careers. In this experimental study (n=95), 47 first-year algebra students participated in a month-long Specialized Supplementary Curriculum Component (SSCC). The SSCC included exposure to three female speakers who used mathematics in their careers and four lectures with follow-up activities about historical female mathematicians. Data for the control group (n=48) and the experimental group (n=47) were analyzed using one-tailed t-tests. Results indicated that students' attitudes toward careers in mathematics and the personal importance of mathematics were significantly improved. Students' attitudes also reflected less stereotyping of mathematics as a male domain. (Author)

The Effects of Female Mathematician Role Models on Eighth- and Ninth-Grade First-Year Algebra Students

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Running head: FEMALE ROLE MODELS

Abstract

In the United States female and male students supposedly have the same educational opportunities. Females continue to score below male students on the mathematics portions of standardized tests and less frequently choose mathematics-oriented careers. In this experimental study (N=95), 47 first-year algebra students participated in a month-long Specialized Supplementary Curriculum Component (SSCC). The SSCC included exposure to three women speakers who used mathematics in their careers and four lectures with follow-up activities about historical women mathematicians. Data for the control group (N=48) and the experimental group (N=47) was analyzed using one-tailed t-tests ($p<0.05$). Results indicate that students attitudes toward careers in mathematics and the personal importance of mathematics were significantly improved. Students attitudes also reflected less stereotyping of mathematics as a male domain.

The Effects of Female Mathematician Role Models on Eighth- and Ninth-Grade First-Year Algebra Students

Historically female students have lagged behind their male counterparts in mathematics achievement. In the United States they have the same educational opportunities, but continue to score below males on the math portions of standardized tests, such as the National Assessment of Educational Progress, and college entrance examinations (Digest of Education Statistics, 1988). According to the United States Department of Education, in 1984 there were 81,600 males enrolled in first-year algebra, but only 76,800 females. In higher-level mathematics courses like geometry or trigonometry, the disparity is even greater, with 60,100 males enrolled versus 50,300 females (Digest of Education Statistics, 1988).

What is even more perplexing, is the fact that at age nine, females score as well as males on the mathematics portion of the National Educational Assessment of Progress test. At age 13, females outscored males by .2%. By age 17, however, males outscored females by 2.7% (Digest of Education Statistics, 1988).

The American College Testing Service (ACT) reports that the average math score for males on the 1987 tests was 18.6 and the females score was only 16.1 (range = 0-30).

Scholastic Aptitude Test (SAT) scores for the same year show males scoring an average of 500 on the math portion, while the females average score was 453 (a range of 400-600 represents scores within the first standard deviation of the mean) (Digest of Education Statistics, 1988).

In 1987, 8,725 men received a bachelor's degree in mathematics from an American college compared to 7,581 women. This difference becomes even greater at the doctoral candidate level, with 618 males receiving doctorates compared to only 124 women (Digest of Education Statistics, 1988).

These statistics show that females do not perform as well as males and do not choose mathematics-related careers as often. Thus, we may be providing students with an education that is non-equitable even though most students get an education in a "coed" setting (Digest of Education Statistics, 1988). Teachers, school counselors, and parents must attend to this inequity before students enter high school.

Additions to the curriculum have been shown to change attitudes in the classroom in subjects other than mathematics (Zoller, 1989). Data developed by the Teacher Education and Mathematics Project (1984) showed that a teaching module that utilized the contributions of women to the field of mathematics developed positive attitudes toward mathematics. Women have contributed to the field of mathematics and they continue to do so in the present; they can provide positive role models. Presenting this information to the students significantly affects their mathematics attitudes.

The purpose of this study was to investigate the effects of a Specialized Supplementary Curriculum Component (SSCC) on a first-year algebra class made up of eighth- and ninth-grade students. The SSCC consisted of students' exposure to three women speakers who use mathematics in their careers, and four lectures with follow-up activities about historical women mathematicians. These presentations were given in whole-class settings.

The female speakers provided living role models for the students. The lectures and follow-up activities about famous women mathematicians provided an historical perspective for the students. Students learned that these living women were people who engage in similar personal activities in their daily lives. The female mathematicians professional activities were varied--as varied as the applications of mathematics.

The presentation of new facts and information related to females in the field of mathematics provided students with the opportunity to change their existing attitudes toward careers in mathematics, sex stereotyping in mathematics, and the personal importance of mathematics.

A directional hypothesis was formulated: There will be a positive change in the mathematics attitudes of first-year algebra students after they have been exposed to a four-week, specialized, supplementary curriculum component about females in mathematics. More specifically: (1) There will be a positive change in attitudes towards careers in mathematics; (2) There will be a positive change in attitudes toward sex-role stereotyping in mathematics; and (3) There will be a positive change in attitudes toward personal values of mathematics.

Method

Subjects

The approval for the investigation to take place in four (randomly selected) of six different first-year algebra class periods at a medium-sized (1,000 students), semi-rural, Midwestern junior high school was given to the first author, a teacher-researcher. The experimental group consisted of 47 students (21 girls, 26 boys) from two classrooms. The control group consisted of 48 students (24 girls, 24 boys) from two classrooms.

Procedure

A mathematical attitude survey consisting of thirty items (see Table 1) was administered to four first-year algebra classes on Monday, February 6, 1989. The researcher-developed survey consisted of thirty statements relating to three constructs: (1) careers in mathematics, (2) sex-stereotyping in mathematics, and (3) personal value of mathematics. Some items were stated negatively while others were positively stated to increase the construct validity of the instrument. Students responded to each item using a Likert five-point scale, (1) strongly disagree, (2) disagree, (3) no opinion, (4) agree, and (5) strongly agree, to reflect their beliefs about each statement.

Insert Table 1 about here

The SSLC for the two experimental classes consisted of three women speakers who used mathematics in their careers and four lectures with follow-up activities about historical women mathematicians. The first speaker spoke to the experimental group on Tuesday, February 7, 1989. Speaker 1 was the regional sales manager for a national chain of retail stores dealing in fur and leather clothing and accessories. Speaker 1 told the students about the math that she uses every day in her job. She demonstrated some of the mathematical problems that occur in retail sales. A question and answer period followed.

The second speakers spoke to the experimental group on Tuesday, February 14, 1989. Speakers 2 were a pair of actuaries from an international actuarial consulting firm. Students learned that an actuary sets up pension plans, life and disability insurance tables, and health care packages for industry and the United States government. This work uses mathematical probability based on human life expectancy, illness and accident rates, physical attributes, and the interaction of other human and environmental phenomenon. The speakers outlined the mathematics background required to be an actuary. They highlighted some of the more exciting aspects of their careers. A question and answer period followed.

The third speaker, a production engineer and a department supervisor with one of the three largest automotive manufacturers in the world culminated the (SSCC) on Thursday, March 2, 1989. Speaker 3 talked to the students about marketing techniques and the mathematics involved in deciding which cars will appeal to which group(s) of prospective customers. A question and answer period followed.

On Wednesday of each of the four weeks in February, a deceased woman was selected for presentation who had made a significant contribution to the field of mathematics. A 15-minute lecture on that person, followed by an activity sheet designed to highlight the field of mathematics associated with them was presented to the experimental group. Students worked individually, in pairs, or in small groups, according to personal preference. Completed activities were discussed. No grades were recorded for either correct answers or participation. Due to the novelty of the activity, all students actively participated with varying degrees in the discussions. The four women chosen were Sonya Kovalesky, Ada Lovelace, Mary Somerville, and Emmy Noether. Information from a book entitled Math Equals (1978) was used to develop the lectures and follow-up activities that were presented to the students during the study.

During the study, the control group was given some special problem-solving activities to approximately match the minutes used for Wednesday presentations. The speaker time minutes were replaced with continued studying of the content material.

On March 6, 1989, the mathematical attitudes of both the experimental and the control groups were re-surveyed using the same instrument. The actual length of the SSCC was twenty-eight days, from February 6, 1989 through March 6, 1989.

Results

A comparison of pre-test and post-test means can be found in Table 2. Table 3 and Table 4 show the breakdown of the pre-test and post-test results for males and females in both the control and the experimental groups.

Insert Table 2 about here

Insert Table 3 about here

Insert Table 4 about here

The comparison of pre-test and post-test results and the p value of significance are shown in Table 1. It can be noted that the experimental group significantly improved their mathematical attitudes on 15 of 30 items. The control group significantly improved their mathematical attitudes on 2 of the 30 items. In cases where the mean appears to have decreased (e.g. Item 2), the attitudes have been interpreted to be more positive because of the nature of the statement to which students were responding. In Item 2, for example, the statement to which the students were responding was, "Boys are smarter than girls in math." On the post-test fewer students agreed with this statement, which can be interpreted that the SSCC may have been responsible for changing attitudes about mathematics being a male domain. Item 15 states, "Men have more career choices than women." Again, the interpretation has been that less agreement with this statement means a positive change in attitude.

Discussion

Role models, sex stereotypes, enrollment patterns, adult expectations, and class activities are some of the social factors which affect mathematics attitudes and achievement (Kahle, 1984). Parents can help to erase mathematics disparity of the sexes by encouraging daughters toward math-related studies and careers. Just as important, parents of male students need to refrain from reinforcing stereotyped attitudes that mathematics is a male domain (Franklin, 1987). Teachers, parents, administrators, and counselors all play an important role in influencing student attitudes toward mathematics (Pedersen, Elmore, & Bleyer, 1985). Undergraduate university women may have avoided mathematics classes because they simply were not interested and not because they were math anxious (Lips, 1984). Perhaps the problem of avoidance needs to be addressed to those responsible for the presentation of the courses and the teaching.

In this investigation, the exposure of a four-week program concerning women and careers using mathematics to a group of eighth and ninth graders did change the mathematical attitudes of the group in a significant manner. For the experimental group the change in attitude was significant on fifteen (15) of the thirty items of the post test. Attitudes of the control group only improved significantly on two of the thirty items. Since the algebra curriculum presented to both groups was exactly the same, except for the experimental material, the assumption may be made that it is highly likely that it is this SSCC material which helped cause the significant difference in students attitudes.

Eight of the items which showed significant improvement dealt with careers. Item number 18, which stated, "Careers in mathematics are exciting," registered the greatest change in mean, perhaps illustrating that the speakers did a good job of convincing the students that occupations in mathematics are exciting and rewarding.

Four of the items which showed significant improvement in attitude (numbers 2, 19, 27, and 29) dealt with stereotypical attitudes concerning the differences between the sexes in regard to mathematics. The choice of women speakers seems to have changed the attitudes of the group, particularly the boys, about mathematics being a male domain. Using the four historical women mathematicians may help to convince the male students that females do have and have had in the past important ideas to contribute to the field of mathematics.

The remaining three items showing significant improvement in attitudes (numbers 19, 23, and 27) were related to the perception of the students as to their beliefs about the study of mathematics and the value of mathematics in their own lives. Fewer students believe that mathematics is the most difficult subject in school.

Research done by the Teacher Education and Mathematics Project (1984), as well as that presented in this paper, shows that teachers can improve attitudes by pointing out historical women mathematicians to their students. Positive role models can make a significant difference in the attitudes of students toward mathematics, the attitudes of students toward the role of women in mathematics, and the attitudes of students toward the role of mathematics in their career options.

Educators at many levels, at home and at school, need to work toward achieving equity for female students in our mathematics classes by reducing anxiety through information and education. We need to encourage all students to continue studying mathematics (National Council of Teachers of Mathematics, 1989; National Research Council, 1989). It is recommended that all students be exposed to positive female role models who can encourage them in their mathematical pursuits.

Further research questions that need to be addressed to mathematics educators include possible other curriculum supplements which could change attitudes. Possibilities include bulletin boards featuring women mathematicians (see Tracy & Davis, 1989), activities that encourage the participation of female students, and mathematics story problems that have content that shows no sex preference. The mathematics attitudes of parents, teachers, and other role models need to be investigated, as those attitudes impact on the students. If these "significant other" role models continue to perceive mathematics as a "male domain" they will continue to treat the females with whom they have contact in a less than equitable manner. If it is possible to change the mathematics attitudes of eigth-and ninth-grade students, would it be better to intervene and try to change these attitudes at an earlier age?

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Table 1

ATTITUDE SURVEY

Circle one: Grade 8 9
Sex M F
Algebra Grade on last report card A B C D E

Circle the number that most describes your feeling about each statement. Use the following scale to evaluate each statement:

5 - Strongly agree
4 - Agree
3 - No opinion
2 - Disagree
1 - Strongly disagree

SA	A	NO	D	SD		
5	4	3	2	1	1.	After school sctivities are important for school success.
5	4	3	2	1	2.	Boys are smarter than girls in math.
5	4	3	2	1	3.	It is important for women to have a career.
5	4	3	2	1	4.	There are many career opportunities for women.
5	4	3	2	1	5.	It is not important to do well in math classes.
5	4	3	2	1	6.	Most occupations require some math knowledge.
5	4	3	2	1	7.	A solid math background keeps many career options open.
5	4	3	2	1	8.	Only people who want to be engineers need to be good in math.
5	4	3	2	1	9.	Boys need good grades in school.
5	4	3	2	1	10.	Employers are interested in school grades in math.
5	4	3	2	1	11.	Math is the most difficult subject in school.
5	4	3	2	1	12.	If you like math, you will do better.
5	4	3	2	1	13.	Many career choices require a knowledge of mathematics.
5	4	3	2	1	14.	Women can be successful in business.
5	4	3	2	1	15.	Men have more career choices than women.

SA	A	NO	D	SD		
5	4	3	2	1	16.	Boys are better at logical thinking than girls.
5	4	3	2	1	17.	Girls are afraid to sign up for high level math classes.
5	4	3	2	1	18.	Careers in mathematics are exciting.
5	4	3	2	1	19.	Girls need good grades in math.
5	4	3	2	1	20.	Careers in mathematics are dull and boring.
5	4	3	2	1	21.	More men than women choose careers that use mathematics.
5	4	3	2	1	22.	Colleges like incoming freshmen to have solid math backgrounds.
5	4	3	2	1	23.	Girls do not need to be successful in mathematics.
5	4	3	2	1	24.	Mathematics is necessary for everyday life.
5	4	3	2	1	25.	After I complete my math requirement, more math classes would just be a waste of time.
5	4	3	2	1	26.	Many career choices require a knowledge of algebra.
5	4	3	2	1	27.	I hate math because it is boring and useless.
5	4	3	2	1	28.	Once you are finished with school, you can forget about needing mathematics.
5	4	3	2	1	29.	Girls get better grades than boys because they are smarter.
5	4	3	2	1	30.	Algebra is a waste of time because very few people use it in their careers.

Table 2

Results of One-Tailed T-tests on Mathematical Attitudes Items

	Experimental Group			Control Group		
	Pre-Test	Post-Test		Pre-Test	Post-Test	
Item	Mean	Mean	p	Mean	Mean	p
1	3.83	3.85	0.4404	3.42	3.70	0.1063
2	2.54	2.13	0.0136*	2.28	2.09	0.1407
3	4.11	4.26	0.1904	3.88	3.95	0.3536
4	3.91	4.02	0.2187	4.16	4.07	0.2993
5	4.35	4.11	0.1233	4.07	3.70	0.1095
6	4.11	4.24	0.1210	3.98	4.12	0.1391
7	4.13	4.43	0.0138*	4.09	4.07	0.4348
8	3.91	4.26	0.0146*	4.02	4.19	0.1871
9	4.22	4.26	0.3740	4.05	4.16	0.2443
10	3.92	4.00	0.3010	3.72	3.86	0.1922
11	3.17	3.98	0.1813	2.44	2.72	0.1825
12	3.17	2.98	0.1813	3.95	3.84	0.3183
13	4.24	4.24	0.5000	3.88	4.19	0.0027*
14	4.43	4.46	0.4311	4.51	4.56	0.3453
15	3.35	3.13	0.1367	2.77	2.95	0.2144
16	2.72	2.28	0.0087*	2.33	2.14	0.1478
17	2.76	2.76	0.5000	2.13	2.24	0.2245
18	2.76	3.27	0.0011*	2.71	2.81	0.3027
19	3.98	4.31	0.0070*	3.79	3.95	0.1836
20	3.20	3.71	0.0044*	3.21	3.42	0.1223
21	3.47	3.07	0.0108*	3.02	2.93	0.2593
22	3.91	4.13	0.0231*	3.73	3.83	0.3027
23	2.15	1.78	0.0119*	2.10	1.86	0.1103
24	4.02	4.07	0.3599	3.81	3.90	0.3302
25	3.85	4.00	0.1331	3.74	3.81	0.3811
26	3.67	3.91	0.0296*	3.40	3.64	0.1028
27	3.67	4.15	0.0044*	3.73	3.98	0.0950
28	4.04	4.30	0.0432*	4.07	4.40	0.0288*
29	2.35	2.02	0.0245*	2.36	2.40	0.4071
30	3.76	4.09	0.0161*	3.56	3.83	0.0722

Note. * p < .05 were statistically significant items.

Table 3

Means and Standard Deviations of the Mathematical Attitudes Pretest: Experimental Group, Females and Males

	Females		Males	
Item	Mean	Standard Deviation	Mean	Standard Deviation
1	3.71	0.85	3.92	0.76
2	1.90	1.04	3.08	1.15
3	4.52	0.75	3.76	0.83
4	4.00	0.89	3.83	0.70
5	4.43	0.60	4.28	1.02
6	4.24	0.44	4.00	0.76
7	4.19	0.51	4.08	0.70
8	3.76	1.00	4.04	0.89
9	3.90	0.83	4.48	0.51
10	3.95	0.67	3.92	0.70
11	3.19	1.21	3.16	1.43
12	4.00	0.84	3.76	0.97
13	4.24	0.44	4.24	0.60
14	4.81	0.40	4.12	0.73
15	3.00	1.30	3.64	1.04
16	1.86	0.96	3.44	1.16
17	2.29	0.90	3.16	0.90
18	2.81	0.68	2.71	1.12
19	4.10	0.72	3.88	0.73
20	3.38	0.74	3.04	1.23
21	3.50	0.76	3.44	1.08
22	3.86	0.79	3.16	[illegible]
23	1.76	0.70	2.48	0.82
24	4.14	0.65	3.72	0.91
25	3.86	0.65	3.84	0.85
26	[illegible]	0.80	3.68	[illegible]
27	3.57	1.03	3.76	[illegible]
28	4.14	0.57	3.76	0.93
29	[illegible]	1.22	2.12	[illegible]
30	3.95	[illegible]	3.60	[illegible]

Table 4

Means and Standard Deviations of the Mathematical Attitudes Posttest: Experimental Group, Females and Males

	Females		Males	
Item	Mean	Standard Deviation	Mean	Standard Deviation
1	3.71	0.96	3.96	0.89
2	1.33	0.58	2.80	0.91
3	4.48	1.03	4.08	0.57
4	4.05	0.67	4.00	0.78
5	4.48	0.98	3.80	1.47
6	4.24	0.54	4.24	0.78
7	4.52	0.51	4.36	0.95
8	4.48	0.51	4.08	0.57
9	4.19	0.68	4.32	0.69
10	4.10	0.62	3.92	0.76
11	2.86	1.15	3.08	1.32
12	3.95	0.74	4.16	0.62
13	4.29	0.46	4.20	0.58
14	4.76	0.44	4.20	0.76
15	2.62	1.20	3.56	1.12
16	1.67	0.80	2.80	0.82
17	2.52	1.08	2.96	0.68
18	3.43	0.87	3.13	0.75
19	4.30	0.57	4.32	0.80
20	3.67	0.86	3.75	0.94
21	2.95	0.89	3.16	0.55
22	4.00	0.71	4.24	0.50
23	1.76	[illegible]	1.80	0.71
24	4.10	[illegible]	4.04	0.68
25	3.95	[illegible]	4.04	0.84
26	4.05	0.50	3.80	1.00
27	4.10	0.70	4.20	0.71
28	4.14	[illegible]	4.44	0.58
29	2.00	1.00	2.04	0.93
30	4.14	0.65	4.04	0.84