SEX DIFFERENCES IN MATHEMATICS

by

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TABLE OF CONTENTS

INTRODUCTION

Earlier in this century, a great mathematician Emmy Noether was not admitted to the faculty at the University of Gottingen due to the fact that she was female, despite the protestations of David Hilbert, another great mathematician and a professor at Gottingen. Noether was allowed to deliver lectures; however, these had to be announced under Hilbert's name.[1]

Mathematics is considered a man's domain as shall become apparent in this paper. I have endeavored to investigate the sex differences which occur in mathematics achievement.

In several instances , I have made mention of "math anxiety". This is a problem which "...disproportionately affects females and racial minorities of both sexes."[2] Rather than treating it as a cause of achievement differences, I have treated it as an effect of cultural conditioning, etc. Also, at times I have treated the natural sciences and engineering as one and the same as mathematics. I feel this is justifiable in examining my topic since the former disciplines rely heavily on the latter.

In the first section, I have set out the differences which have been found at various levels of schooling and at the professional level. I then explored the possible reasons for the sex differences. After that comes the consequences for women of the stereotyping, and finally, suggestions to alleviate the situation.

At the Elementary and Secondary School Level

Until about the age of twelve boys and girls show no differences in their mathematics achievement. At about this time, however, the abilities of girls appear to decline.[3] This is the age "when adolescence makes them [girls] more aware of social roles."[4] However, a survey done by John Ernest and a freshman seminar on women in mathematics (University of California at Santa Barbara; Fall 1974) found no sex differences in the preference patterns of students in grades two through twelve.[5] This was in spite of the fact that there were significant differences in the preferences the students had towards English, science, and social studies.[6] In addition, this pattern was consistent throughout all grades.[7]

In another study using information provided by the Annual High School Mathematics Competition it was found that boys were the high achievers in mathematics in the 1960's but there seemed to be a trend towards the narrowing of the gap.[8] According to the author, "participation [of girls in the competition] has been less than that of the boys - for three years less than half that of the boys..."[9] however, "there has been a steady increase in the proportion of girls participating."[10]

Finally are the statistics for the 1972 entering freshman class at Berkeley. Although 57% of the men had four years of high school mathematics, only 8% of the women did.[11] This is significant at the .001 level.[12] At University of California at Santa Barbara in 1973, a random sample of 50 male and 50 female entering freshman indicated 36% of the men and 16% of the women had completed four years of high school mathematics. This difference, while not as startling as at Berkeley, is statistically significant.[13]

At this point, I would like to tie up a loose end. It might seem inconsistent that after age twelve a girl's ability in mathematics appears to decline while in general her preferences remain the same as a boy's. Insight into this is perhaps offered by Tobias who found that some students at the Wesleyan University Math Anxiety Clinic had a fascination with mathematics and science but tended to deny it because it is "masculine".[14] Indeed, one of my sources cites a woman whose inability in mathematics gave her a kind

of satisfaction.[15] Perhaps, then, lack of success is a device to hide a liking of mathematics, and this would explain the inconsistency.

At the College Level

John Ernest's group tested for sex differences in class grades in a number of elementary mathematics courses at U. C. S. B. They found no statistically significant sex differences in the grades.[16] Also, the Carnegie Commission on Higher Education has found that women college students tend to do better grade-wise in all fields.[17] In addition, the Carnegie Commission has found that the percentage of women receiving bachelor's degrees in mathematical sciences is only slightly smaller thanthat of men. It is in fields where a mathematics background is necessary, eg.natural sciences, engineering, and economics, that women tend to have a considerably smaller representation than men.[18]

Despite these positive findings, however, many women appear to shy away from college mathematics. For example, "The enrollment of women in the honors calculus section [at U. C. S. B.]...is considerably lower than in the regular sections."[19] This fact becomes even more important when one considers that the enrollment of women in that elementary sequence is "disproportionately low" to begin with.[20] Also, whenever students had a chance to drop a course in this sequence, the rate of attrition for the women was greater than for the men.[21]

Tobias tells of teachers who were noticing "... great reluctance on the part of women college students to take courses that require or might require at a later stage either calculus or heavy use of algebra or rigorous statistics."[22] Some students were even contemplating changing their majors in order to avoid a mathematics prerequisite.[23] Sells notes, "'Among students earning the Bachelor's degree in the 21 largest letters and science departments, there is a strong and statistically significant relation between having a one-year college mathematics requirement in the curriculum, and having less than one third of the degrees in the department earned by women.'"[24] In addition, the Carnegie Commission found that, "'Not only have they [women] preferred fields that tend to lead to traditionally female professions, but they also tended to avoid fields requiring extensive application of mathematical reasoning.'"[25]

In summary then, it would appear that while large numbers of college women are frightened by mathematics, those who are not perform comparably to their male counterparts.

At the Ph.D. Level

For the period 1972-1975, less than 10% of the doctorates in assorted sciences, mathematics, applied mathematics, economics, religion, business administration, and engineering were earned by women. In contrast, during the same period women received 25% of the Ph.D.s in home economics, art history, Romance languages, Germanic languages, comparitive literature, social work, health sciences, English, speech, psychology, anthropology, library science, linguistics, education, classics, microbiology, and sociology.[26] This is, of course, significant in that a large number of the subjects in the first list require a background in mathematics while a large number of subjects in the second list do not.

"In going from the bachelor's degree into a graduate program we... find that attrition takes a higher toll for women than for men."[27] Also, according to Sells, "'there is a statistically significant drop in the proportion of women earning the bachelor's degree in the physical sciences at Berkeley (26%) and the proportion of women applying to graduate school in the physical sciences(11%).'"[28]

At the Professional Level

The results of the 19th annual survey conducted by the Committee on Employment and Educational Policy of the American Mathematical Society show that women comprise 4.8% of the "ladder faculty" (tenured associate and full professors, and assistant professors who will be considered for tenure) "for all doctorate granting mathematics departments in the United States."[29] Of the tenured faculty only 4.5% were women "... which represents a slight decrease from the previous year's figure of 4.6%."[30] For the 1975-1976 school year U. C. S. B., University of Chicago, Princeton, Yale, Harvard, and M. I. T. had NO women on the ladder faculty.[31]

To sum up this section, I would like to cite the Mathematical

Association of America's 1971 Summer meeting's panel on Women in Mathematics. All panelists agreed that women are scarce in mathematics and furthermore this condition worsens as the level rises.[32]

CAUSES OF SEX DIFFERENCES

Biological

In 1972, R. E. Stafford suggested that quantitative ability is transferred as a recessive characteristic on the X chromosome and as a result, women in general do not have the same power as men to learn mathematics.[33] However, recent data and analyses do not bear this theory out.[34]

According to Tobias, "there is no known connection between the sex gene and 'dyscalculia,' an actual brain dysfunction in performing calculations..."[35] and according to Ernest, "Most studies emphasize cultural and environmental influences rather than intrinsic biological differences..."[36] It would seem, then, that there is an underlying feeling that women are conditioned to avoid mathematics. If there are indeed no sex differences in grades attained or mathematics degrees earned, this would lend credence to that belief.

Spatial Relations Perception Differences

"... the ability to do math beyond computations is correlated with the ability to do spatial relations."[37] Hence, there is the possibility that sex differences in space perception could be related to aptitudes in mathematics.[38] According to Tobias, women of all ages tend to do more poorly on spatial relations tests then males.[39] Ernest says that some results support this, but that men do only slightly better.[40] Fennema and Sherman indicate that the development of the ability to visualize spacial relations may be closely related to sex stereotypes[41] and indeed, Tobias points out the possibility that this is caused by boys playing with "building toys" and being involved with the assembly and disassembly of a great many things.[42] Since spatial skills are not taught in schools, girls do not have the chance to learn them.[43]

It should be noted, however, that the differences in spatial perception are much smaller between the sexes than among individuals of either sex, and these small differences in no way explain the very large sex differences found in the mathematics profession.[44]

Discrimination

Mary Ellen Rudin (a member of the panel at the MAA's Spring 1971 meeting) held that there is "little if any overt discrimination" in the mathematics profession.[45] Her opinion is not born out by the women mathematicians who corresponded with Ernest'sgroup. Slightly over half of them reported experiencing discrimination in one form or another in their professions. "Essentially all of them indicated they had experienced sexist attitudes of some form.[46]

In addition, Ernest says nepotism rules are "...invariably discriminatory against the wife..."[47] These, however, he claims, " ...are rapidly falling away."[48]

Parental Influence

Tobias claims that math anxiety "...is handed down from mother to daughter with father's amused indulgence.('Your mother never could balance a checkbook,' he says fondly.)"[49] In this way, parents' attitudes towards who is good in mathematics will be passed on to their children.

What may also be important is who helps the child in mathematics. If as Ernest's group found, there are no sex differences in which parent children seek out for help, but from the 6th grade on the father becomes the family "authority" on mathematics, this is bound to affect childrens attitudes.[50] If, as Tobias claims, children turn to the same-sex parent for help in all subjects from the 7th grade on, a mother's mathematics inhibitions may be passed directly to her daughter.[51]

In addition, Hilton and Berglünd found (1971) that parents buy more mathematical games for their boys and Astin found (1974) that they offer "more explicit reward and reinforcement to their sons to learn mathematics than to their daughters."[52]

L. R. Aiken found that parent exert a strong influence on their child's feelings towards mathematics.[53] If the above evidence is any indication, this influence is exerted towards a stereotypical alignment.

Teacher and Counselor Influence

Ernest's group did a study of elementary and high school teachers: 24 women and three men. Given a choice of mathematics, science, English, and social studies, 44% listed mathematics as their favorite subject to teach and another 1/3 ranked mathematics second. Nonetheless, 41% believed boys did better in science while only one felt girls did (Ernest does not make it clear if this is one per cent or one teacher). Sixty-three per cent believed girls did better in English while no one believed boys did. Finally, 41% believed boys are better in mathematics than girls are, and no one expected girls to be better in mathematics than boys.[54] Thus, if there is a "'Pygmalion effect'" "according to which the student performs, to some (measurable) extent, in response to the expectations of the teacher"[55] boys are apt to do betterthan girls in mathematics, which Ernest claims they do.[56]

According to Angela Stent, "...some female high school counselors, themselves insecure about math, dissuade girls from taking math courses."[57] And Lucy Sells believes, "Nobody told girls that they couldn't get jobs in the real world unless they knew math.'"[58]

Thus girls may be influenced both by teachers' attitudes and poor counseling into being fearful or just uninterested in mathematics.

Lack of Role Models

Mathematician Martha K. Smith says, "'If a young girl never encounters a woman in mathematics, it is quite reasonable that she should conclude that mathematics isn't something women do... Perhaps more likely, she may not even think of the possibility of a woman mathematician.'"[59] According to Ernest,"Considering the importance of encouragement, the dearth of women faculty in mathematics, physics, chemistry, and engineering can only have an inhibiting affect on female enrollments in these subjects."[60]

Stereotypes in Mathematics Books

The Sexism in Textbooks Committee of Scott, Foresman and Company

defines sexism in textbooks by:

> Textbooks are sexist if they omit the actions and and achievements of women, if they demean women by using patronizing language, or if they show women or men only in stereotyped roles with less than the full range of human interests, traits, and capabilities.[61]

Winifred T. Jay did a study of sex stereotypes in 12 mathematics books for grades two, four, and six. This study involved approximately 4100 pages of text.

Four basic questions were asked in this study:

1. Are there more masculine, feminine, or neutral situations in word problems and illustrations found in selected elementary school mathematics textbooks?
2. Are there more famous men than famous women in the selected mathematics textbooks?
3. Are there more male occupations than female occupations featured in the selected mathematics textbooks?
4. Do the selected mathematics textbooks feature men and women in unusual, nonstereotyped roles?[62]

To answer the first question, 81 children, one class each from grades two, four, and six, and thirty parents, ten from each grade, from a public school in Hawaii, were asked to classify word problems, illustrations, etc. as masculine, feminine, or either.[63]

Out of 160 "settings" 113 were rated neutral, 23 masculine, nine feminine, and there was no concensus on 15. Despite the very large number of neytrals, the authors claim that this shows a bias towards masculine settings since the masculine to feminine ratio is greater than two to one.[64]

To answer questions two and three, two adult female coders analyzed approximately 4100 pages of text. Out of 49 famous people mentioned, 46 of them were male. The three women were found in two of the four 6th grade texts studied. Thus there were no famous women found in ten of the twelve books, and none were

found in any of the textbooks for other than the 6th grade.[65]

Out of 104 occupations cited in the twelve books, 86 were associated with men, 18 associated with women. Men's occupations were varied and included acrobat, astronaut, doctor, inventor, lawyer, mathematician, president, scientist, weatherman, zoo-keeper, and "men who perform various services in the community."[66] Not one of these jobs appeared on the list of female occupations. Those women's occupations which did not appear on the list of male occupations included buyer, cafeteria manager, journalist, librarian, nurse, queen, and ticket seller. Of these, only four, teacher, journalist, librarian, and nurse require professional training.[67]

In search of an answer for question four, the coders "found no genuine nonstereotyped roles..."[68] There were four borderline cases: male elementary school teachers (teaching mathematics, science, or physical education), fathers doing grocery shopping (for meats), girls painting a room, and a girl swimming across a pool.[69] Not surprisingly then, the authors conclude that sex stereotyping exists in mathematics textbooks.[70]

A review of textbooks in the 1975-1977 period shows that some changes have been made, most notably a greater range of occupations given to women in problems and illustrations.[71] Finally, Helen Fuesy Kuhnke, reviewed two mathematics textbook series which she says show "... a positive response from the publishers to the critics of sex role stereotyping, which indicates that the biases in textbooks can be eliminated when a concerted effort is made."[72]

My sources do not mention how this stereotyping affects the situation of women and mathematics, and indeed, when Ernest cites Jay and Schminke[73], he does not comment on this either. Two things seem obvious to me.

1. By not counteracting general cultural stereotypes, authors are doing nothing to alleviate the scarcity of women in mathematics.
2. By stereotyping mathematics as a male subject and not providing role models for girls to follow, authors authors are not encouraging, and may even be discouraging, girls' becoming proficient in mathematics.

Mathematics as a "Masculine" Discipline

"'Many people on hearing the words 'female mathematician' conjure up an image of a six-foot, gray-haired, tweed suited oxford clad woman... This image, of course, doesn't attract the young woman who is continually being bombarded with messages, direct and indirect, to be beautiful, 'feminine' and to catch a man.'"[74]

Girls are conditioned at a very young age to believe that mathematics is an unsuitable subject for females to study.[75] Indeed, "...the cultural conditioning from early childhood through post-Ph.D. seems to be the chief factor operating against the potential woman mathematician.[76] According to Elizabeth Fennema and Julie Sherman, "'...there is...an accumulation of evidence which points to the conclusion that sexual stereotyping of mathematics as a male domain operates through a myriad of subtle influences from peer to parent and within the girl herself to eventuate in the fulfillment of the stereotyped expectation of a 'female head that's not much for figures.'"[77]

Lynn Fox did her doctoral thesis at Johns Hopkins on the subject of precocious mathematics students. She discovered that mathematically-gifted girls are more subject to negative stereotypes than are boys.[78]

In addition, the stereotype of mathematics as an activity for males is quite universal. A study of junior high school girls in Germany "found that underachieving in mathematics in this age group correlated with a strong desire to have a feminine identity."[79] Similar attitudes and, correspondingly, underachievement were documented by a United Nations study in nine countries and by research on sex differences in science and mathematics in England and in the United States.[80]

The most unfortunate aspect of this stereotyping is that it may not be <u>true</u>. In 1971 Ravenna Helson did a study of creative women mathematicians. Her results did not "'show the creative woman to be more masculine, if one means by this that they might have been expected to score higher on measures of masculinity-femininity, or dominance, assertiveness, or analytical ability.'"[81]

In fact, an earlier study (1960) by Philip Lambert of undergraduates at UCLA found female mathematics majors to be "significantly more feminine" than female non-mathematics majors. A second example confirmed this result.[82]

CONSEQUENCES OF STEREOTYPING MATHEMATICS AS MASCULINE

"'I realized that mathematical illiteracy was keeping women from realizing their full academic and vocational potential.'"[83] Tobias noticed that women were choosing majors in the humanities and other non-quantitative disciplines not necessarily because they were "people oriented" but because they were frightened by, and hence wished to avoid, mathematics and courses which were dependent on a knowledge of mathematics.[84] In addition, "women ... are not taking enough of the optional mathematics courses offered in high school..."[85] and hence are unprepared to enter college in majors in science, engineering, etc.[86] An especially poignant realization is that the large number of Berkeley women who entered in the fall of 1972 with less than four years of high school mathematics were not elligible to enter the calculus sequence. This in turn meant that they could major in only five of the twenty majors offered.[87] These were the humanities, music, social work, elementary education, and guidance and counseling.[88]

"Sells claims that math is a 'critical filter' in the job market and that women who fail to take college math will be excluded from many professions."[89] Many students are ignorant of the important role mathematical training plays in their employability and they do not realize that preparation in mathematics makes many positions, which are not available to people without that training, available to them.[90] Also, Tobias says, "...when an employer or colleague recognizes it [mathematics anxiety] in an employee, she can be barred from any endeavor or new assignment by the threat that the new job will involve some work with 'data or tables or functions.'"[91]

In summary, then, according to the Carnegie Commission of Higher Education, "...one of the main barriers that prohibits the advancement of women in today's society is poor mathematical training."[92]

HOW TO SOLVE THE PROBLEM

Encouraging Women to Participate More in Mathematics

Mills College is an all women's school in Oakland, California. Lenore Blum, of the mathematics department there, found that the enrollment in their mathematics courses nearly doubled after she made an effort to encourage women to enter science. This effort included the development of special programs, counseling, and publicity.[93] Similarly, in 1971 there were nine men and no women in the honors calculus section at U. C. S. B. (which Ernest taught). The following year, again scheduled to teach the course, "...he visited all the regular sections, described the nature of the honors section, and specifically encouraged women to enroll."[94] His efforts were rewarded by six men and three women taking the course in 1972.[95] Professor Joan Birman of Barnard-Columbia had a similar experience.[96] And women students at the Massachusetts Institute of Technology compiled a booklet to inform women of the school's options for them. The result was a quadrupling of the number of inquiries received from women.[97]

It would seem, then, that something as simple as encouragement could make a great difference to some women. Unfortunately, if Stanford is any indication, this encouragement is not forthcoming. A survey taken of women majoring in the sciences, mathematics, and engineering there found that they "reported having received less encouragement, to study mathematics than did any group of Stanford males, even those ... majoring in history or the humanities."[98]

Remedial and Pre-Calculus Courses

The Carnegie Commission recommends, "'Because of the evidence that many women enter college with inadequate mathematical training, special provision should be made to ensure that women desiring to major in fields calling for extensive use of mathematic are encouraged to make up this deficiencyin order to enter the fields of their choice.'"[99] Ernest's group goes a step further in recommending that all schools offer, for credit, the

appropriate pre-calculus courses.[100]

Breaking Down the Stereotypes

Martha K. Smith recommends, "'...get all the trained women mathematicians possible into positions where they will have an impact on both male and female students and colleagues. Women need to see examples of practicing mathematicians; men need to become accustomed to accepting a women a an honest-to-goodness colleague rather than a curiosity.'"[101]

I. B. M. has funded a Mathematics Association of America proposal for a lectureship program designed to interest female secondary school students in mathematics by providing role models. (Under this grant female mathematicians will visit secondary schools in various parts of the country.) In addition, this program will impress guidance personnel with the importance of mathematics study for girls and the career opportunities available for women in mathematics and science.[102] Wellesley College is bringing in professional women to discuss the various ways in which mathematics is used in careers as diverse as music, psychology, and archaeology[103] as well as having student tutors serve as role models.[104] Also, there do exist career movies with women in professional roles.[105]

Jay and Schminke give many good suggestions for counteracting stereotyping mathematics textbooks. Among them are:

1. supplemental problems given by the teacher.
   e.g. "Carol has a board $4\frac{3}{4}$ feet long. She cuts off a piece $2\frac{1}{2}$ feet long. How much is left?"[106]
2. more important women in exercises.
   e.g. "Amelia Earhart, the first women to cross the Atlantic by airplane, was born in 1897. In 1937, while flying over the South Pacific her plane disappeared. If she died in the plane crash how old was she at the time?"[107]
3. women featured in traditional male-oriented occupations.
   e.g. "Michelle's mother works at the computer center 8 hours a day. How many hours does she work in a five-day week?"[108]

4. group discussions[109]
5. women in male-oriented professions coming to talk with students. Also, student reports on women "firsts"[110]
6. homework assignments of interviewing women in the local community who have become successful in careers requiring a background in mathematics[111]
7. class trips to places of business that require knowledge in mathematics.[112]

I believe a great concern of people implementing these suggestions should be to not overwhelm young boys with so many women and no men. Perhaps some of these ideas could be modified to show students men in non-traditional occupations. Also, having students interview a member of the same sex or one each of both sexes would help reduce the possibility of scaring young boys away from mathematics.

To impress upon colleagues the fact that women can be mathematicians also, Mary Gray recommends the "increased visability of women."[113] She also suggests that the Mathematical Association of America have women mathematician in its films and more women lecturers for its meetings. In addition, she implores that men must be made aware of the bias against women.[114]

Special Programs

At Wellesley College in Wellesley, Massachusetts there is a special one-semester mathematics course designed for women students who may have discontinued their study of mathematics but may wish to improve their skills. The course is taught with the understanding that many of these women are afraid of mathematics, and is intended to help reduce their anxiety.[115]

Wesleyan University in Middletown, Connecticut has a "Math Anxiety Clinic." This "...program offers a unique combination of supportive classes, workshops, a psychology lab, and individual counseling."[116]

Mills College also has a mathematics anxiety program. The program is "...set up to get students into a substantive mathematics curriculum quickly, and also to provide ... students ... opportunities to become actively involved in (peer) teaching and

in (industrial) research projects."[117] Their pre-calculus course is "streamlined" to prepare students for calculus sequence in just one semester.[118]

Nan Robertson, a New York Times reporter, tells of having attended Mind Over Math, a group therapy workshop started last June by Stanley Kogelman and Joe Warren.[119] For $75 one attends five 80-minute sessions.[120] The technique of Mind Over Math "...is to draw people out gently and encourage them to share their problems and fears with other members of the group."[121]

There are, then, many ways to avoid, eliminate, or lessen the fear of mathematics. Some are extremely inexpensive and easy to implement; others are quite expensive. However, the fact that math avoidance can be overcome (For Mills College, at least, in the two years after their program began, enrollment in pre-calculus increased 133%, the percentage of students starting calculus increased 68%, and students enrolled in "regular math and computer science courses"[122] increased 58% with a steady student population.)[123] would seem to indicate that it is not a biological phenomenon.

CONCLU ION

Last year I was tutoring a Lafayette female in calculus. I had made an arithmetic error in the course of doing a problem, so I suggested to her that she do it in the same manner I did to see if we could pick up the mistake. She panicked. At the time, I could not understand why, but now I have some insight into the situation.

I believe the evidence implies that, even if there is a biological reason for sex differences in mathematics, clearing up the cultural conditioning would do much to eliminate the differential. As we have seen, the lack of mathematical knowledge may be a seriuos handicap for a women. It is thus extremely necessary to correct the problem, in order that women may gain an equal position in society.

NOTES

[1]John Ernest, "Mathematics and Sex," The American Mathematical Monthly, Vol. 83 (Oct., 1976), p. 595.

[2]Sheila Tobias, "Math Anxiety: Why is a smart girl like you counting on your fingers?," Ms., Vol. 5 (Sept. 1976), p. 56.

[3]Angela Stent, Can Math Anxiety Be Conquered?, p. 40.

[4]"Math Mistique: Fear of Figuring," Time, Vol. 109 (Mar. 14, 1977), p. 36.

[5]Ernest, Am. Math. Monthly, p. 596.

[6]Ibid.

[7]Ibid., p. 597.

[8]Nura D. Turner, "Can the Girls be Creeping up on the Boys?," International Journal of Mathematics Education in Science and Technology, Vol. 2 (Oct.-Dec., 1971), p. 337.

[9]Ibid., p339.

[10]Ibid.

[11]Lucy Sells, High School Mathematics as the Critical Filter in the Job Market, p. 6.

[12]Ibid., p. 7.

[13]Ernest, Am. Math. Monthly, p. 602.

[14]Tobias, Ms., p. 59.

[15]Bonnie Donady, Stanley Kogelman, and Sheila Tobias, Math Anxiety and Female Mental Health: Some Unexpected Links, (Presented at the Meeting of the National Advisory Committee on Mental Health Services and Women At Harvard University, Cambridge, Massachusetts, August 4, 1976), p. 7.

[16]Ernest, Am. Math. Monthly, p.599.

[17]Ibid., p. 603.

[18]Ibid., p. 604.

[19]Ibid., p. 603.

[20]Ibid.

[21]Ibid.

[22]Tobias, Ms., p. 56

[23]Ibid.

[24]Lucy Sells, quoted by Ernest, Am. Math. Monthly, p. 601.

[25]Carnegie Commission on Higher Education, quoted by Ernest, Am. Math. Monthly, p. 602.

[26]Ernest, Am. Math. Monthly, pp. 601-602.

[27]Ibid. p. 604.

[28]Lucy Sells, quoted by Ernest, Am. Math. Monthly, p. 604.

[29]Ernest, Am. Math. Monthly, p. 607.

[30]Ibid.

[31]Ibid.

32 Mary Gray, "Women in Mathematics," The Am. Math. Monthly, Vol. 79 (May, 1972), p. 476.

[33]R. E. Stafford, cited by Elizabeth Fennema and Julia A. Sherman, in "Sexual Stereotyping and Mathematics Learning," The Arithmetic Teacher, Vol. 24 (May, 1977), p. 370.

[34]Fennema and Sherman, The Arithmetic Teacher, p. 370.

[35]Tobias, Ms., p. 59.

[36]Ernest, Am. Math. Monthly, p. 600.

[37]Tobias, Ms., p. 58.

[38]Ernest, Am. Math. Monthly, p. 600.

[39]Tobias, Ms., p. 58.

[40]Ernest, Am. Math. Monthly, p. 600.

[41]Elizabeth Fennema and Julia A. Sherman, cited by Ernest, Am. Math. Monthly, p. 600.

[42]Tobias, Ms., p. 58.

[43]Ibid.

[44]Ernest, Am. Math. Monthly, p. 600.

[45]Mary Ellen Rudin, cited by Gray, Am. Math. Monthly, p. 476.

[46]Ernest, Am. Math. Monthly, p. 605.

[47]Ibid., p. 607.

[48]Ibid.

[49]Tobias, Ms. p. 57.

[50]Ernest, Am. Math. Monthly, p. 597.

[51]Tobias, Ms., p. 58.

[52]Hilton and Beglünd, and Astin, cited by Fennema and Sherman, The Arithmetic Teacher, P. 371.

[53]L. R. Aiken, cited by Ernest, Am. Math. Monthly, p. 597.

[54]Ernest, Am. Math. Monthly, p. 599.

[55]Ibid., p. 600.

[56]Ibid.

[57]Stent, p. 40.

[58]Lucy Sells, quoted by Time, p. 36.

[59]Martha K. Smith, quoted by Ernest, Am. Math. Monthly, p. 605.

[60]Ernest, Am. Math. Monthly, p. 605.

[61]Sexism in Textbooks Committee of Scott, Foresman and Company, quoted by Henry S. Kepner, Jr. and Lilane R. Koehn, "Sex roles in mathematics: A study of the status of sex stereotypes in elementary mathematics texts," The Arith. Teacher, Vol. 24 (May, 1977), p. 382.

[62]Winifred T. Jay and Clarence W. Schminke, "Sex bias in elementary school mathematics texts," The Arithmetic Teacher," Vol. 22 (March, 1975), p. 242.

[63]Ibid.

[64]Ibid.

[65]Ibid., p. 243.

[66]Ibid.

[67]Ibid.

[68]Ibid.

[69]Ibid., pp. 243-244.

[70]Ibid.

[71]Kepner and Koehn, The Arith. Teacher, p. 384.

[72]Helen Fuesey Kuhnke, "Update on sex-role stereotyping in elementary mathematics texts," The Arith. Teacher, Vol. 24 (May, 1977), p. 375.

[73]Ernest, Am. Math. Monthly, p. 610

[74]Martha K. Smith, quoted by Ernest, Am. Math. Monthly, p. 605.

[75]Stent, p. 40.

[76]Gray, Am. Math. Monthly, p. 479.

[77]Fennema and Sherman, quoted by Ernest, Am. Math. Monthly, p. 599.

[78]Lynn Fox, cited by Time, p. 36.

[79]Erika Schildkamp-Kundiger, cited by Sheila Tobias and Bonnie Donady, Counselling the Math Anxious (For the Journal of the NAWDC, Oct. 1976), p. 2.

[80]Tobias and Donady, p. 2.

[81]Ravenna Helson, quoted by Ernest, Am. Math. Monthly, p. 605

[82]Philip Lambert, quoted by Ernest, Am. Math. Monthly, p. 605.

[83]Sheila Tobias, quoted by Stent, p. 40.

[84]Jean Smith, Teaching in the Math Clinic (May, 1976), p. 2.

[85]Ernest, Am. Math. Monthly, p. 601.

[86]Ibid.

[87]Time, p. 36.

[88]Tobias, Ms., p. 57.

[89]Stent, p. 40.

[90]Wellesley College-Wesleyan University Mathematics Project, Summary of Plans for Academic Year 1976-1977, p. 1.

[91]Tobias, Ms., p. 57.

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