Association for Women in Mathematics

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PRESIDENT'S REPORT

This report will be short, reflecting the fact that this is a quiet time of the year, with some of us at our desks while others are away at conferences or on holiday. By the time you read this many of us will be getting ready for the next academic year, and hopefully I would have seen many of you at the Pittsburgh meeting.

I have just returned from attending a conference at the Mathematics Institute at Oberwolfach. There were 7 women out of 50 participants at this meeting, and we came from several countries: England, Germany, Norway, USA and USSR. The men were seated at the dinner tables by drawing lots, but one woman was seated at each table, and was asked to serve the soup. Needless to say, we wrote our piece in the Suggestions Box.

As usual Anne Leggett has asked the AMS candidates for statements, and they appear in this issue. We hope they will be useful to you. Statements from the AWM candidates will appear in the next newsletter.

I have had some responses to my request for volunteers to serve on committees. I was particularly delighted to hear from Beth Broman, a high school senior in Lincoln, Neb., who is interested in serving on the Math. Education Committee. Please keep writing.

Bhama Srinivasan
Math. Dept.
University of Illinois at Chicago Circle
Chicago, IL 60680

AWM ENDORSEMENTS FOR AMS ELECTION

President	Julia Robinson
Vice President	Joan Birman
Member-at-Large	Susan Montgomery
Nominating Committee	Linda Rothschild

These candidates were approved for endorsement by a majority of the AWM Executive Committee. We are pleased to endorse Julia Robinson for President.

REMINDER: NSF PROPOSALS ARE DUE OCTOBER 31.

AMS ELECTIONS

The calendar for the AMS elections gets worse every year. This year, the first batch of candidates was not named until late in May. So the school year was over for many of us before I could mail letters to the candidates (I got the letters ready before candidate selection during finals and addressed them at a meeting I was attending the next week, to give you an idea of the timing). The remaining candidates will have been named by the time you get this, but not at the time I am writing it, so there will be more names on the AMS ballot than there are on the list below.

This long-winded explanation is leading up to the fact that I received only six replies to my letter. Two of these were mailed from England. It would not surprise me to learn that several of my letters are still sitting unopened on people's desks (not everyone has their mail forwarded to England). So I don't know how much of the lack of response to attribute to lack of interest and how much to bad timing.

This year I asked the candidates to write a statement in their support rather than asking them a list of questions. I thought the questions were getting moth-eaten and the answers, stale. Let me know which approach you prefer.

As always, the AWM Executive Committee has evaluated the candidates on the basis of their statements and any other information they had about the candidates. The endorsements appear in the box on the first page. To earn endorsement, a candidate must be approved by six of the ten members of the Executive Committee.

Candidates as of July:

Vice-President: Michael Artin, MIT; Joan Birman, Columbia; James Glimm, Rockefeller; Elias Stein, Princeton

Member-at-Large: A. Bharucha-Reid, Wayne State; Mel Hochster, Univ. of Michigan; Vadim Komkov, West Virginia University; Robert Langlands, Institute for Advanced Study; Susan Montgomery, Univ. of Southern California; Yiannis Moschovakis, UCLA; Wilfried Schmid, Harvard; Hector Sussman, Rutgers

Nominating Committee: Morton Curtis, Rice, Robion Kirby, Berkeley; Lawrence Markus, Minnesota, Inst. of Tech.; Ralph S. Phillips, Stanford; Linda Rothschild, Wisconsin

Statements:

VICE PRESIDENT

Joan S. Birman

I served as a Member-at-Large of the Council of the AMS during the period 1977-1980. From my experience at that time, the business of the Council includes a variety of concrete issues which present themselves in a more-or-less random or unpredictable order, hence rather than attempt to talk about my philosophy I'd like to tell you how I felt about certain specific issues which arose at the time I was on the Council.

An issue which caused a deep rift within the mathematical community in 1979 was the proposed NSF research institute, and more broadly the question of how research support could be increased and how it should be distributed. I felt that the entire matter relating to proposals for the institute was handled badly. Selfish interests spoke in the loudest voices, and the Council failed to take a strong lead. Simultaneously, a subcommittee of the AMS took a very negative and destructive attitude toward a second proposal for new funding in mathematics. I do not feel that the AMS has been sufficiently creative or forceful with regard to research fund-raising and distribution. Mathematicians tend to rely almost entirely on a single funding agency, the NSF. Inordinately large parts of NSF grants are devoured in overhead, and senior mathematicians with huge salaries often receive, in my opinion, more than their just share of the pot (in this regard I favor a low upper bound on summer support). I feel that the AMS should put a major effort into studying the entire area.

The matter of blind refereeing came up twice while I was on the Council. I was initially opposed to it. In my experience as a referee it was a nuisance, and in my experience as an author it was unimportant. However, when I came to appreciate that many of my colleagues felt strongly that it was important to them I changed my mind and supported the continuation of the AMS experiment. Nevertheless, I regard this as a very minor matter.

I was and continue to be in favor of the AMS taking public stands on matters affecting human rights within our community. On the other hand, I opposed the move which began in 1979 to cancel the AMS contract to translate certain Russian journals, as a protest against discriminating policies of these journals. I opposed it because it had the flavor of book-burning.

James Glimm

Two concerns of mine are to continue the intellectual vitality of mathematics and to enhance the employment opportunities of mathematicians. These concerns have influenced my thoughts and actions over a number of years and are relevant to my candidacy for the office of Vice President of the American Mathematical Society. They are issues which affect women and minority mathematicians, but since they are not specifically women's or minority issues, I will also express my views on the latter topics.

The role of women in mathematics will continue to be an important issue in the years ahead. Of primary importance is to encourage women to enter the area of mathematically oriented sciences. Women undergraduates, by not taking basic mathematics courses or a mathematics major are excluding themselves from promising career choices. Of equal importance is the need to help women and minority members who have selected mathematics. Important choices begin with the selection of a field of mathematics and a graduate school, and continue with the choice of courses and thesis topic, employment, research and teaching. Guidance and encouragement in these key areas of career planning are crucial to all mathematicians as they develop, and should be available to women and minority mathematicians. For those whose careers are already formed, the role of the AMS in monitoring and publishing information related to promotion, tenure and salary should continue, as should the general AMS position of concern and support for women's and minority issues.

MEMBER-AT-LARGE

Mel Hochster

The recent sharp decline in mathematics graduate enrollments signals the possibility of a severe shortage of mathematicians in ten to twelve years. It is important not to overreact, but it takes perhaps ten years to produce a Ph.D., and I feel it is not too soon for the Society to consider how talented high school and even pre-high school students may be encouraged to pursue mathematics as a career. Programs aimed at an early educational level could also be used to encourage women and minority students to enter mathematics: later on, it may well be too late for effective action.

Susan Montgomery

The major responsibility of the AMS is to support research in mathematics, an aim with which I agree. However, in doing this, we should make sure that ours is an open profession, and encourage research activity among traditionally disadvantaged groups.

One particular idea that has occurred to me are fellowships for those (women and minorities especially) who have been out of graduate school for a number of years (≥ 5, and perhaps ≥ 10) and need an opportunity to get back into research. Most fellowships that I know of now are for very recent Ph.D.'s or for well-known senior mathematicians.

Vadim Komkov

In this day and age it is not only against the rules but it is stupid to practice any form of discrimination against women or minorities in academia. Most departments, including my department, follow the affirmative action guidelines and try to recruit women and minority group members for the faculty. Despite this positive attitude and genuine recruitment efforts we do not have a single black and only one woman with a doctorate on our permanent (i.e., tenured or tenure-track) faculty.

At this point I could declare our honorable intentions, describe how I try to guard against any suspicion of discrimination in my decisions concerning hiring, promotion and tenure, and declare self-righteously that as a chairman I did all I could do. The situation which I described is certainly not my fault and not even the fault of a previous chairman. It is the result of social attitudes of our society, including centuries of brainwashing and preselection practices.

The last sentence could be expanded into a lengthy essay. Instead of attempting to write one, I shall only affirm my own beliefs. I believe that the "nuclear family" concept where the father is the breadwinner, the mother is a homemaker and devotes all her time to the home and children was not valid even in the Victorian era. In the United States and Canada the majority of women work all their adult lives and try to pursue a professional career.

The view that boys should be prepared for a professional career, but girls should be discouraged from it, still prevails among many counselors in high schools. The preselection process, where girls are discouraged from studying science or mathematics is still operative. Combining this initial handicap with the policies (still very common in industry and commerce) of promoting men ahead of equally qualified women, results in the present situation of a shortage of women in top positions in science and industry.

I believe that we are reaping the fruits of past attitudes, judging by the statistics concerning the professional status of women and blacks in science and mathematics. I would certainly do all I can to reverse this trend.

P. S. For much deeper reasons causing discrimination against women in most societies, I suggest reading Friedrich Engels "On the origins of family, property, ..." (I forget the exact title of the English translation).

NOMINATING COMMITTEE

Ralph Phillips

The purpose of the nominating committee is simply to nominate officers and members of the council at large for the A.M.S. I believe that the interests of mathematics will be best served by the choice of mathematicians of quality who have some concern and aptitude for administrative work. If elected I intend to make these choices fairly, without regard to sex or race.

AWM ELECTIONS

The ballot for the AWM election will be in the next Newsletter, along with the statements of the candidates. Also on the ballot will be some proposed revisions of the by-laws and a referendum about making our membership list available to sister organizations.

The main effects of the proposed by-laws changes are the following:

1) to specify a fixed term for Council members with termination or reappointment to follow;

2) to eliminate the need to hold elections every year by making the terms of the Treasurer and at-Large members of the Executive Committee to be four years with one additional term possible, rather than two years with two additional terms possible;

3) to specify that the Executive Committee meetings be held in conjunction with the required yearly meeting of the "corporation" (in accordance with Massachusetts law) and that members of the Executive Committee should try to attend meetings as a responsibility of office.

The intent of (1) is not to change the nature of the Council: any interested member may still apply. Presently, no one is removed from the Council list unless she requests it. Thus the listing is not very helpful because many members of the Council are no longer actively involved in their projects. The term is specified to be four years from time of appointment with one additional term possible by making only a brief statement to the Clerk (rather than by writing a statement for the Newsletter as for the original appointment). The four-year term should be short enough that the Council list will fairly accurately reflect AWM activity, but long enough not to require undue amounts of paperwork.

Currently, the election procedure occupies the entire year (you may have noticed that something or other about nominations or statements or deadlines appears in every Newsletter). This perhaps dulls our interest in the elections and certainly requires an excess expenditure of energy on the part of Nominating Committees and others. Hence the proposed change (2). There are some technical changes involving calendar which I will not go into. The changes will not affect this year's election. In the future, elections would be held in odd-numbered years.

The intent of (3) is to attempt to improve attendance at Executive Committee meetings. Also, if a majority of voting members of the Committee cannot make it to the meeting, the revision of the by-law provides for polling absent members concerning actions of the Committee. This should clarify what will happen when we don't have a quorum at an Executive session.

I hope that this informal summary of the by-laws (essentially by Bettye Anne Case) will be useful. In the next issue, I will include the formal wording along with the ballot. If you want a copy of the current by-laws, write the AWM office.

AWM MEETINGS

November in Austin

Martha Smith is organizing an AWM lunch at the AMS meeting in Austin in November. If you are interested in attending the lunch or in planning some other AWM activity, please let her know at Dept. of Math., University of Texas at Austin, Austin, TX 78712.

October in Amherst

Olga Beaver of Williams College is organizing an hour-long AWM program to take place during the regional AMS meeting October 16, 17, 18 in Amherst, Mass. The keynote speaker will be Alice T. Schafer; the title of her talk is "Is AWM Necessary in the Eighties?" The plans are that she will speak for 35-40 minutes with the remainder of the hour set aside for questions and discussion. The time is not yet firm, but it will most probably be in the late afternoon of Saturday, October 17. The time will be announced at the meeting.

New Jersey Chapter of AWM Organized by Pat Kenschaft, Montclair State College

The first meetings of the AWM in New Jersey took place on March 28, 1981, in conjunction with the combined meetings of the New Jersey chapter of the MAA and the Mathematical Association of the Two Year Colleges of New Jersey. They were discussions on "Women in Mathematics: Here and Now," held both during the lunch break and following the afternoon session.

About 25 people attended some part of the meeting that ran from 12:30 to 1:30 p.m. I was the only one who admitted to any sex bias in my own teaching, and there were strong arguments, always refuted, that there is no sexual discrimination in college mathematics classrooms, but that the problems lay in the secondary schools, the elementary schools, family expectations, and the media. The fact that males win the highest awards in mathematics in most countries was introduced as evidence that the difference between male and female achievements is not due to the culture of our country. The arguments were heated but not hostile.

A sizable group returned for refreshments and informal conversation at 3:30 p.m., and eleven (5 men and 6 women) sat down for the formal discussion that began at 4:00 p.m. I observed that about a third of the people at the day-long meetings had been female, but all six speakers had been male and most of the volunteers from the floor had been male. After much discussion the group concluded that over the past several years there had been only one female speaker (apart from a panel devoted to "Women and Mathematics") although there have been two meetings a year with several speakers at each.

Someone lamely suggested that there were no women qualified and willing to speak. Suddenly there were many suggestions. The decision-makers were present at this discussion, and it was quickly decided that the sex balance of speakers will be different in the future in New Jersey. Later I was elected president of the New Jersey Chapter of AWM, and Joy Atkin of the County College of Morris was elected treasurer.

The animated conversation was interrupted by Charles Lewis of Monmouth College. He began, "Let's talk about the future. There's no point in being sorry about the past." He proposed a letter to the state commissioner of education urging him to use his influence and power to get an even sex balance in the advanced high school mathematics courses. We discussed this excellent idea, and the joint effort of several of us follows this article. Copies of this letter have been sent to ten leading NJ newspapers. Feel free to use it or to quote it wherever you like.

Dear Commissioner Burke:

At the Spring joint meeting of several of the organizations below we discussed the critical national problem that too few high school students, especially women, study four or even three years of mathematics. This has reduced the number of college students who are ready to prepare for careers not only in mathematics, science, and engineering, but also for leadership positions in business, social work, nursing, and many other fields.

Although our groups are actively laboring to address the problem, we feel that more help is needed from your powerful office. School boards, superintendents, counselors, and principals in all our high schools must be urged, even pressured, to help remedy this situation. Our nation must stop squandering its most precious resource: youth educated to their fullest capacity. A particular effort is needed to encourage young women to continue academic mathematics throughout high school.

Sincerely,

Michael Aissen	Governor, Mathematical Assn. of America, NJ Section
Kenneth Wolff	President, Assn. of Mathematics Teachers of NJ
Patricia Kenschaft	President, Assn. for Women in Mathematics, NJ Chapter
Susan Marchand	NJ/NY Regional Director, Women and Mathematics, a lecture program run by the MAA to encourage high school women to continue in mathematics and to educate teachers, counselors, and the community

JOURNAL EDITORSHIPS

The AWM Committee on Journal Editorships is studying the use of women referees by various mathematical journals since extensive refereeing experience is a prerequisite for journal editorships and is often rewarding in itself. If you are currently refereeing for a journal, would you please send us your name, the journals and roughly the number of papers refereed per year. We are also interested in the names of women who would like to get more involved in this important professional activity, and are asking that women write to us, giving your area of expertise for research or expository articles and including a list of your publications. We will forward names to appropriate journal editors. Send information to Professor Joan P. Hutchinson, Department of Mathematics, Smith College, Northampton, MA 01063. The other committee members are Linda Rothschild and Michele Vergne (Chair).

WOMEN HONORED

press release,
Aerospace Corporation

Dr. Thelma Estrin

Dr. Thelma Estrin, a member of the Board of Trustees at The Aerospace Corporation, received the 1981 Achievement Award from the Society of Women Engineers at its national convention held at the Disneyland Hotel in Anaheim, California.

She was recognized for "her outstanding contribution to the field of biomedical engineering through the application of computer science."

A professor of engineering in the computer science department at the University of California, Los Angeles, Dr. Estrin was a pioneer in the application of engineering techniques to medicine and biology during the '50's. She was among the leaders in using computer techniques to analyze the electrical activity of the brain and was the first woman to be certified as a clinical engineer.

Dr. Estrin joined UCLA's Brain Research Institute in 1961 and played a key role in developing its data processing laboratory, one of the original integrated computer-based facilities for neuroscientists.

A Fellow of the Institute of Electrical and Electronic Engineers, she is past president of the IEEE's Engineering in Medicine and Biology Society. Dr. Estrin was the first woman nationally elected to the IEEE's Board of Directors and has also served on the Board of Directors of the Association for the Advancement of Medical Instrumentation. She has been a member of the Board of Trustees of The Aerospace Corporation in El Segundo since 1978.

As a longstanding member of the Society of Women Engineers, Dr. Estrin has provided career guidance and moral support for women in the non-traditional fields of engineering and computer science. She is an honorary member of the Los Angeles-based organization Women in Business and belongs to the Association for Women in Science and the Association for Women in Mathematics.

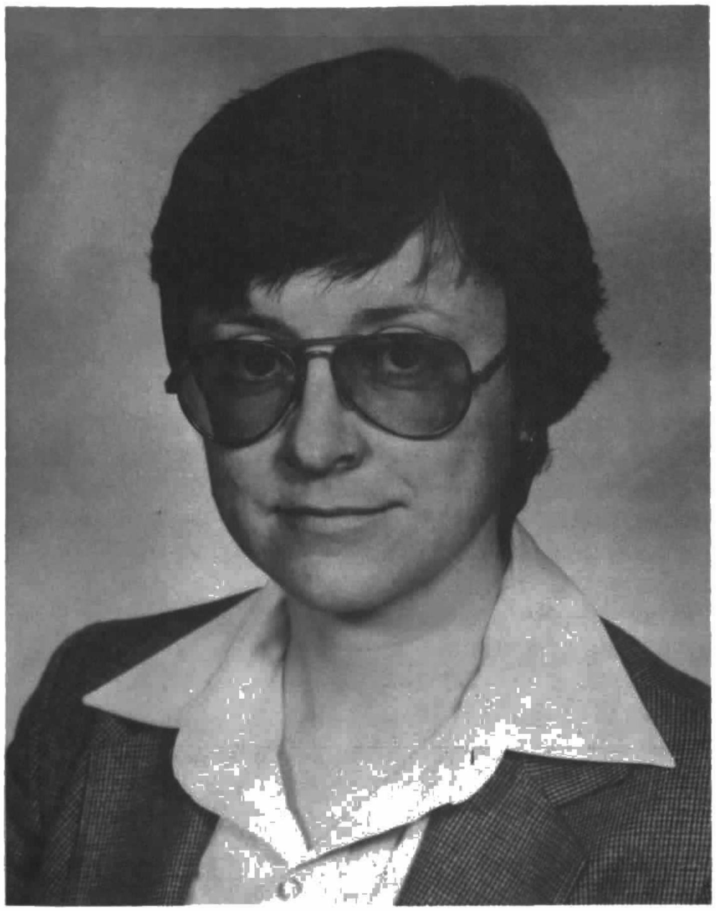
Dr. Estrin graduated from the University of Wisconsin with her bachelor's degree, master's degree and doctorate in electrical engineering. She conducted post-doctoral research with grants provided by a Fulbright Fellowship and a Sabin Fellowship.

press release
Bell Labs

Dr. Karen E. Mackey, a Wheaton resident and member of the Computing and Networking Technology Department at Bell Laboratories Indian Hill facility, was recently named by the Association for Computing Machinery as an ACM National Lecturer for 1981-1982. She will present talks on computer communications networking and the Bell Labs Network (BLN) at local ACM chapters across the country.

Founded in 1947, ACM promotes the development of information processing as a discipline and the use of computers in an increasing diversity of applications. It also promotes the interchange of information about data processing among specialists and the public.

Dr. Mackey joined Bell Labs in 1979 and is responsible for the development of network management services in the Bell Labs Network. She received a B.S. degree in mathematics, a M.S. degree in computer science and a Ph.D. in computer science from the Pennsylvania State University. She was an assistant professor at the State University of New York at Binghamton and at Northern Illinois University.



Dr. Karen E. Mackey

Sloan Fellowships for Basic Research for 1981-1982 have been awarded on the basis of the recipients' exceptional potential to make creative contributions to scientific knowledge. The fellowships are granted by the Alfred P. Sloan Foundation in the amount of $20,000 for two years. Congratulations to Sloan Fellows Wen-Ch'ing Winnie Li of Penn State and Nancy K. Stanton of Columbia.

The National Science Foundation has awarded 96 Science Faculty Professional Development Awards, including nineteen in the mathematical sciences. These awards are designed to help experienced undergraduate faculty members improve their effectiveness as science teachers. Activities include advanced study or participation in research at academic institutions, industrial facilities, or government laboratories. The following list gives names of award winners, followed by the names of their present affiliations in parentheses, and the names of the institutions which they will visit. Congratulations to: Judith M. Elkins (Sweetbriar College), University of Maryland; Robbyn A. Gourdouze (George C. Wallace Community College), University of Alabama, University; Bernice Kastner (Montgomery College), University of Maryland; and Wilma J. Loudin, (West Virginia University), Morgantown Energy Technology Center.

43 of 450 NSF Graduate Fellowships were awarded to students in mathematics and computer science. Each fellowship is awarded for three years of graduate study and may be used over a five-year period. The listing gives names of fellows with present affiliation in parentheses followed by the name of the fellowship institution. Congratulations to: Joyce E. Anderson (Brown University)*; Carol S. Beckman (Bradley University), University of California, Berkeley; Catherine A. Cole (Butler University), Carnegie-Mellon University; Lucia B. Krompart (Smith College), Massachusetts Institute of Technology; Ellen G. Lowenfeld (Brown University), Carnegie-Mellon University; Wanda F. Reves (Harding University), Stanford University; and Elizabeth A. Sachs (University of California, Berkeley), Princeton University. *Brown

105 fellowships to minority students of outstanding ability for graduate study in the sciences, mathematics and engineering have been awarded by NSF; 11 of these are in mathematics. The fellowships are also for three years of graduate study and may be spread over five years. Names are listed with the name of the institution from which they received their bachelor's degree in parentheses, followed by the institution chosen for their graduate study. Congratulations to: Lucie D. Diverse-Diaz (University of Puerto Rico), Harvard University; Jacquelyn R. Lewis (Spelman College), Stanford University; Joy M. Mills (Howard University), University of Florida; Teresa M. Penberthy (Radcliffe College), Massachusetts Institute of Technology; Lori A. Perine (Bryn Mawr College), University of Pennsylvania; and Lena C. Steele (Carthage College), Stanford University.

NOTES

Sheila Tobias, author of Overcoming Math Anxiety, has written an answer to the Benbow-Stanley study. It will appear in the September issue of Psychology Today.

Twenty-four of the moon's craters are identified by women's names. Two of the women represented are Hypatia and Emmy Noether. [Ms., May 1981, p. 24]

SEX DISCRIMINATION LAW SUIT ANNOUNCED

Three academic women have filed suit against the University of California on behalf of themselves and all women similarly situated, alleging that the University discriminates against women in academic employment. Two of the named plaintiffs have Ph.D.'s in Geography and claim to have been denied employment at two different U.C. campuses. The third named plaintiff who holds a Ph.D. in anthropology was denied tenure after teaching in the Anthropology Department at UCLA since 1972. Because the University of California is the largest university system in the country, because it is a public institution, and because it is the largest recipient of federal research and development funds in the nation, the outcome of this suit has national implications for all women scholars. Of the regular tenure-track faculty, 89.9% are males, while of the tenured faculty, 92.5% are male. A legal defense fund has been established to support the litigation by the Center for Women Scholars (300 Broadway, Suite 23, San Francisco, CA 94133). Tax deductible contributions or requests for additional information may be forwarded to CFWS.

MATHEMATICS, SPATIAL VISUALIZATION, AND RELATED FACTORS: CHANGES IN GIRLS AND BOYS, GRADES 8-11

by Julia Sherman, Ph.D., psychologist
reprinted from Journal of Educational Psychology, 1980, Vol. 72, No. 4, pp. 476-482 by permission of the author

Although girls and boys (N $\approx$200) were similar in cognitive skills and attitudes toward mathematics in Grade 8, boys performed significantly better in mathematics by Grade 11, even with mathematics background controlled. No sex-related difference in spatial visualization developed. Since during this period girls' attitudes toward mathematics became less favorable than boys' attitudes, the results appear attributable to sex-role sociocultural influences.

The importance of mathematics to future careers is probably self-evident, but it has been clearly documented by Wise (Note 1). The importance of spatial visualization is less obvious, but spatial visualization has been shown (a) to be related to mathematics performance (Fennema & Sherman, 1977, 1978; Sherman, 1979); (b) to differentiate girls taking more or less high school mathematics (Sherman, in press-b); and (c) to relate to achievement in science (Bennett, Seashore, & Wesman, 1966, 1973), in engineering (Poole & Stanley, 1972), and specifically in chemistry (Baker & Talley, 1972, 1974).

Of all the cognitive skills, mathematics performance and spatial visualization have been thought to show the largest differences in favor of males; these differences, not usually evident in grade school, are thought to emerge during adolescence (Maccoby & Jacklin, 1974). What causes these differences to develop? Hypotheses considered in this article are that the sex-related difference in mathematics performance develops in a function of (a) a sex-related difference in spatial visualization (Sherman, 1967) and (b) sociocultural influences that consider math to be a male domain.

METHOD

Subjects

The subject pool consisted of students previously tested in 1976 during the spring semester of Grade 8 (Fennema & Sherman, 1978). These subjects were representatively selected by class from all four public high school districts in a medium-sized midwestern city. Nearly all subjects were white; socioeconomic status ranged from lower class to upper-middle class. In the 1978-1979 school year, an attempt was made to locate these students and gain their cooperation to participate in the study. Of the 260 girls and 223 boys tested in Grade 8, 135 girls and 75 boys became part of the final sample. The total number of subjects was slightly more or less for some analyses (194-213). There were no differences between the original samples and the final samples for any variable, except that the final sample of males had significantly higher vocabulary scores than the original sample, $t(296) = 2.72$, $p<.01$. There was no significant difference between the sexes for any cognitive variable as assessed in Grade 8 in the original sample, and this remained true of the sample of 210 reported here.

Comparison of the sample of 210 with available data from national normative samples indicated that it was considerably above the average. For example, the means for the Spatial Relations test of the Differential Aptitude Test given to Grade 11 during the fall semester (spring semester data were not available) were 29.6 (SD = 11.8, n = 6900) for females and 32.3 (SD = 13.1, n = 7000) for males (Bennett et al., 1973). Mean and standard deviation for Educational Testing Service (ETS; Note 3) Mathematics Basic Concepts Test for spring semester Grade 11 subjects (n = 715; both sexes were combined because data were unavailable by sex) were 28.94 and 10.10, respectively (Broudy, Note 2). In each case, sample means were nearly one standard deviation above the normative groups.

Measures

In Grade 8 verbal skill was assessed by the vocabulary test of the Cognitive Abilities Test: Verbal Battery (Thorndike & Hagen, 1971). In Grades 8 and 11 spatial visualization was assessed by the Space Relations test of the Differential Aptitude Test (Bennett et al., 1973). In Grade 8 the measures of mathematics performance were the Mathematical Concepts Test (Naslund, Thorpe, & Lefever, 1971) and the Romberg-Wearne Problem Solving Test (Wearne, 1977). In Grade 11 they were the Basic Mathematics Concepts test (ETS, Note 3) and Mental Arithmetic Problems (Form AA), a mathematical problem-solving test derived from the French kit of tests (Stafford, 1965). It was not possible to repeat the same mathematics tests because of time constraints. The math courses in the college preparatory sequence were (a) algebra; (b) geometry; (c) algebra trigonometry or precalculus; (d) advanced algebra, calculus, or a 4th year-level course entitled Advanced Mathematics. Math-related courses included other math courses such as computer science and any science course with a math prerequisite (e.g., physics).

Attitudes toward mathematics were measured by the Fennema-Sherman Mathematics Attitudes Scales II, which consist of 5-point Likert-type scales, each of 12 items. The original scales (Fennema & Sherman, 1976) were simplified for use with a younger population (each scale correlated $p > .90$ with the corresponding original scale in a sample of 38 10th graders). These scales were designed to measure relevant socio-cultural attitudes. The scale titles are listed in Table 1 and are mostly self-explanatory. The scales involve the students' perceptions (e.g., the Mother, Father, and Teacher scales involve the perceived attitudes of these important others toward the student as a learner of mathematics). The scale entitled Effectance Motivation in Math (White, 1959) can be simply described as a kind of joy in problem solving. Scores on the Math as a Male Domain scale ranged from low (math perceived as a male domain) to high (math perceived as sex-neutral). High scores are more favorable to learning mathematics (except perhaps for the Math as a Male Domain scale for males).

Procedure and Analyses

In the spring of 1976 subjects were tested in their own classrooms by trained male and female examiners. In the spring of 1979 those students who could be located and who agreed to participate were tested in small groups at their own schools by trained female examiners. To ensure maximal cooperation and reduce bias in subject participation, they were paid $5 each for their participation. Standard directions for administering and scoring the tests were followed except that time for the Mental Arithmetic Problems Test was extended from 15 to 17 minutes because, unlike the original procedure, answers had to be recorded on separate answer sheets. (Content of a few problems was made more sex-neutral; e.g., "football games" was changed to "swimming matches".) The ETS Mathematics Basic Concepts Test was administered by school personnel to the entire 11th grade (who were in school that day) as part of the school system's assessment procedure.

Grade 11 math performance and the Confidence in Learning Mathematics scale were predicted by multiple regression, with all variables entered simultaneously. In the math regressions, there were 14 predictor variables (4 cognitive, 8 affective, 2 math background). In the regressions predicting Confidence in Learning Mathematics, only the 4 cognitive and 8 affective variables were used. Regressions were done for males, females, and both sexes combined. Differences between the sexes were examined. Changes in attitudes toward mathematics was analyzed by multivariate analysis of variance (MANOVA).

RESULTS

The means and standard deviations of all variables as assessed in Grades 8 and 11 may be found in the Tables. These data provide information on several points: factors predicting skill in mathematical problem solving and knowledge of math concepts, change in attitudes toward mathematics, and factors predicting confidence in oneself as a learner of mathematics.

Table 1
Raw Score Means and Standard Deviations for all Variables as Assessed in Grades 8-11

Variable	Female Grade 8	Female Grade 11	Male Grade 8	Male Grade 11	Possible range
Vocabulary					
M	16.88		17.61		0-25
SD	3.52		3.10		
Spatial Visualization					
M	31.45	39.96	33.20	42.23	0-60
SD	9.87	9.82	10.86	9.76	
Math Concepts					
M	29.37	37.32[a]	29.33	41.75[b]	0-40[c]
SD	5.80	8.07	6.23	7.94	0-50[d]
Problem Solving					
M	12.36	12.10	12.36	13.97	0-23[e]
SD	4.15	4.01	4.68	4.93	0-26[f]
Confidence in Learning Math					
M	45.53	39.70	47.33	43.73	12-60
SD	8.56	9.79	8.09	8.92	
Math as a Male Domain					
M	53.82	53.93	48.55	49.40	12-60
SD	4.81	5.28	6.55	6.14	
Attitude toward Success in Math					
M	46.55	48.75	46.63	47.95	12-60
SD	5.78	5.91	6.57	7.28	
Mother					
M	43.88	45.16	43.60	46.81	12-60
SD	5.94	7.80	5.74	6.23	
Father					
M	44.99	45.62	44.47	46.91	12-60
SD	6.62	8.30	7.15	7.72	
Teacher					
M	44.09	42.50	42.73	43.80	12-60
SD	6.65	8.16	7.08	6.81	
Usefulness of Math					
M	47.30	45.54	46.47	48.29	12-60
SD	7.49	9.71	8.92	8.76	
Effectance Motivation in Math					
M	39.45	37.38	37.45	39.23	12-60
SD	8.03	10.52	7.89	8.57	
Years of math					
M		2.53		2.69	0-4
SD		.97		.97	
Math-related Courses					
M		1.49		1.69	0-9
D		1.14		1.22	

Note. For females in Grades 8 and 11, n = 135; for males in Grades 8 and 11, n = 75. [a]n=125. [b]n=69. [c]Range for Science Research Associates Mathematics Concepts Test for Grade 8. [d]Range for Educational Testing Service Mathematics Basic Concepts Test for Grade 11. [e]Range for Romberg-Wearne Problem Solving Test for Grade 8. [f]Range for Mental Arithmetic Problems Test for Grade 11.

Table 2
Correlations Between Math Concepts, Mental Arithmetic Problems Test and Independent Variables

Independent Variable[a]	ETS Math Basic Concepts Female	ETS Math Basic Concepts Male	Mental Arithmetic Problems Female	Mental Arithmetic Problems Male
Vocabulary	.63**	.45**	.56**	.52**
Spatial Visualization	.54**	.50**	.53**	.62**
SRA Math Concepts	.79**	.79**	.67**	.72**
Romberg-Wearne Problem Solving	.70**	.66**	.68**	.79**
Confidence in Learning Math	.43**	.54**	.41**	.39**
Math as a Male Domain	.45**	.02	.38**	-.07
Attitude toward Success in Math	.21*	.06	.17	.21
Mother	.25**	-.12	.27**	.02
Father	.30**	.07	.23**	.01
Teacher	.37**	.18	.36**	.18
Usefulness of Mathematics	.31**	.14	.32**	.16
Effectance Motivation in Math	.30**	.26*	.33**	.15
Years math	.71**	.63**	.59**	.46**
Math-related courses	.05	.24*	.22**	.31**
n	125	69	135	75

[a]All test scores as assessed in Grade 8. *p<.05. **p<.01.

Predicting Math Performance

Since different tests were used in Grades 8 and 11, it was not possible to compare the sexes directly for change in math performance. However, there was no significant difference in Grade 8 between the sexes in either mathematical problem solving or mathematical concepts, whereas males in Grade 11 performed better than females, $t(208)=8.94$, $p<.01$, $t(198)=10.50$, $p<.01$, respectively. The sexes were not different in spatial visualization in Grade 8 (or in Grade 11), in the number of courses taken in the college preparatory math sequence, or in the number of math-related courses taken; yet by Grade 11 they were different in math performance.

Correlations were generally similar between predictor variables and the two measures of math performance. Large, significant correlations (.45 to .79) were found between vocabulary, spatial visualizations, years of math, math concepts, and problem solving as measured in Grade 8, and math performance in Grade 11. Confidence in Learning Mathematics was moderately correlated with mathematics performance (.39-.54). For girls only, there were sizable, significant correlations between the Math as a Male Domain scale and the two measures of math performance (.45 and .38). For girls, 15 of 16

Table 3
Multiple Correlation Coefficients and Standardized Regression Coefficients Predicting ETS Math Basic Concepts and Mental Arithmetic Problems Test

Independent Variable	ETS Math Basic Concepts			Mental Arithmetic Problems		
	Female	Male	Both	Female	Male	Both
Vocabulary	.05	-.03	.07	.09	.02	.11
Spatial Visualization	.17**	.04	.12*	.26**	.16	.20**
SRA Math Concepts	.37**	.41**	.42**	.07	.24*	.19**
Romberg-Wearne Problem Solving	.10	.16	.07	.31**	.48**	.32**
Confidence in Learning Math	.12	.23*	.21**	.02	-.01	.11
Math as a Male Domain	.11	-.05	-.06	.14*	-.07	-.08
Attitude toward Success in Math	.03	.06	.08	-.05	.24**	.09
Mother	.02	-.22*	-.03	.08	-.02	.07
Father	.04	.10	.07	-.04	-.02	-.06
Teacher	.01	-.16	-.11	.04	-.06	-.03
Usefulness of Mathematics	-.06	-.02	-.08	-.05	-.17	-.10
Effectance Motivation in Math	-.13	.08	-.05	-.01	-.02	-.04
Years math	.27**	.29**	.29**	.16*	.12	.12*
Math-related courses	.01	.03	.03	.20**	.14	.17**
Multiple Correlation Coefficient	.87**	.88**	.85**	.80**	.87**	.81**
n	125	69	194	135	75	210

*p<.05. **p<.01.

correlations between attitudes and math performance were larger than .20 and were statistically significant (p<.05), but this was the case for only 3 of 16 correlations for boys. Differences between the sexes in the correlations were significant for the correlations between Math as a Male Domain and both measures of math performance (p<.01).

The multiple correlations predicting knowledge of math concepts and math problem solving were large (>.80) and significant, accounting for 60% of the variation or more. In each case the regressions for males and females were significantly different: for males, F(15,164)=2.23, p<.01; for females, F(15,180)=2.21, p<.01. See Tables 2 and 3.

Knowledge of math concepts in grade 11 was best predicted by knowledge of math concepts in Grade 8 (.42) and number of years of college preparatory mathematics (.29). Confidence in Learning Mathematics was a significant predictor for both sexes combined (.21) and for males, but not for females. Spatial visualization was statistically significant and was the 4th most important predictor for both sexes combined (.12), the 3rd most important predictor for females (.17), but it was not a significant predictor for males (11th of 14). No comparison of sex differences in individual regression coefficients was statistically significant.

In predicting problem solving in Grade 11, problem solving as measured in Grade 8 had the highest standardized regression coefficient (.32) for both sexes; the second highest was spatial visualization (.20). Spatial visualization was a stronger predictor for females (.26) than for males ($p<.05$). Math Concepts (.19), number of years of the college preparatory math sequence (.12), and years of math-related courses (.17) also significantly predicted Grade 11 problem-solving scores. Math as a Male Domain was a significant predictor for girls (.14) but not for boys. (The difference between the sexes was significant, $p<.05$). The less a girl stereotyped math as a male domain in Grade 8, the higher her problem-solving score in Grade 11. A significant predictor for males was the Grade 8 Attitude toward Success in Mathematics scale (.24); it was a more positive predictor for males than for females ($p<.01$). Aside from those previously mentioned, there were no other differences between the sexes in standardized regression coefficients.

Change in Attitudes Toward Mathematics

Split-half reliabilities for the Fennema-Sherman Mathematics Attitudes Scales II were statistically significant and ranged from .69 to .89 (six of the eight were larger than .80). Reliabilities were judged adequate, though .69 for the Math as a Male Domain scale was somewhat low. Stability coefficients (Grades 8-11) were low to moderate (.37) -.56), showing considerable shifting in attitudes toward mathematics. The most stable attitudes for both sexes combined were found on the Confidence in Learning Math and Effectance Motivation in Math scales; the least stable attitudes were found on the Attitude toward Success in Math and perceived Usefulness of Math scales.

The results of a MANOVA analyzing changes in mean scores from Grades 8-11 showed no overall effects for sex or grade: for sex, $F(1,208)=.01$, $p>.05$; for grade, $F(1,208)=.10$, $p>.05$; but all interactions were statistically significant, including a triple interaction of Sex x Grade x Scales, $F(7.208)=2.80$, $p<.01$. This interaction showed that from Grades 8-11, attitudes toward mathematics changed differently for males and females depending on the attitude. For this reason, analysis of simple effects was required to understand the results. The sex-related effects were different at each grade. In the 8th grade the only significant difference between the sexes in attitudes toward mathematics was that males regarded math as more of a male domain, $F(1,208)=44.44$, $p<.01$. However, by the 11th grade, males were significantly more confident of themselves as learners of mathematics, $F(1,208)=8.73$, $p<.01$, regarded math as more useful, $F(1,208)=4.15$, $p<.05$, and continued to regard math as more of a male domain, $F(1,208)=31.46$, $p<.01$.

Overall, statistically significant changes in Grades 8-11 were found for these effects: girls' attitudes declined for four scales and improved for two scales; boys' attitudes declined for one scale and improved for two scales. From Grades 8-11 both girls and boys became less confident of themselves as learners of mathematics: for girls, $F(1,134)=61.17$, $p<.01$; for boys, $F(1,74)=14.25$, $p<.01$. Girls became less fearful of success in mathematics, $F(1,134)=16.31$, $p<.01$, and perceived their mothers as being more positive toward them as learners of mathematics, $F(1,134)=4.08$, $p<.05$. Males also perceived their mothers as being more positive toward them as learners of mathematics, $F(1,74)=23.93$, $p<.01$, and their positive attitude increased more than the girls' shown in a significant interaction effect, $F(1,208)=3.93$, $p<.05$. Boys' perceptions of their fathers' attitudes toward them as learners of mathematics also improved, $F(1,74)=7.42$, $p<.01$, but this was not the case for girls. For the Teacher, Usefulness of Math, and Effectance Motivation scales, girls' attitudes declined, $F(1,134)=6.34$, $p<.01$, $F(1,134)=5.42$, $p<.05$, $F(1,134)=7.82$, $p<.01$, respectively, whereas boys' attitudes improved slightly; all three interactions of sex with attitude change were statistically significant, $F(1,208)=6.61$, $p<.01$, $F(1,208)=6.93$, $p<.01$, $F(1,208)=9.52$, $p<.01$, respectively. (Simple effects not mentioned are nonsignificant.)

Predicting Grade 11 Confidence in Learning Math

There were no statistically significant differences between the sexes in the size of the first-order correlations between independent variables as assessed in Grade 8 and Confidence in Learning Math as assessed in Grade 11. Confidence in Learning Mathematics in Grade 8 correlated highest with Confidence in Learning Mathematics in Grade 11 (.56), followed by Effectance Motivation in Math (.46), the two measures of math performance (.40, .39), and spatial visualization (.38). Math as a Male Domain was a significant correlate (.27) for females but not for males. The more that girls saw math as a sex-neutral subject rather than as a male subject, the higher their confidence in learning math in Grade 11.

The multiple correlations predicting Confidence in Learning Math for females, males, and both sexes combined, (.70,.67,.66, respectively), were statistically significant, accounting for 40-50% of the variance. Overall, the regressions were significantly different for the two sexes, $F(13,184)=2.01$, $p<.05$. For females, vocabulary had the highest weight (-.31), followed by significant positive weights for Confidence in Learning Math (.29), Effectance Motivation (.24), spatial visualization (.22), and Math as a Male Domain (.16). For males the only significant predictor was Confidence in Learning Math (.41). Vocabulary was a more negative predictor and Math as a Male Domain was a more positive predictor for girls than for boys (for both, $p<.01$). There were no other statistically significant differences between the individual standardized regression coefficients.

DISCUSSION

Although girls and boys were not different in math background or math performance in Grade 8, significant differences were found in Grade 11. Different tests were used to assess math performance in Grades 8 and 11 but they were sufficiently similar so that the finding of a sex-related difference in Grade 11 when none existed in Grade 8 is probably a genuine phenomenon; it is also consistent with a large portion of the literature. Similar sex-related differences in math achievement in Grade 11 had been found at some high schools sampled but not at others (Fennema & Sherman, 1977). Since the presence or absence of a sex-related difference covaried with the presence or absence of more favorable attitudes toward mathematics among males, it was concluded that the source of the difference could be attributed to sex-related differences in these attitudinal factors. Present data are consistent with that conclusion.

Although boys increased slightly more than girls in spatial skill, this difference was not statistically significant. The factors that did change differentially for the two sexes were their attitudes toward mathematics. Girls showed more and deeper declines, as well as fewer and less extensive improvements in attitudes toward mathematics. Girls' attitudes declined as measured on the Confidence in Learning Math, Teacher, Usefulness of Mathematics, and Effectance Motivation in Math scales.

Further evidence for the importance of sex-role factors may be found in the results of the Math as a Male Domain scale. The extent to which math was considered sex neutral rather than a male domain related more to female than to male math performance. For females, Math as a Male Domain was the only eighth-grade affective variable with a significant weight in predicting math performance (problem solving) in Grade 11. Math as a Male Domain was also a significantly more positive predictor of Confidence in Learning Math in Grade 11 for females than for males. The most likely interpretation of these findings is that the sterotyping of math as a male domain negatively affects girls' mathematics learning.

Math as a Male Domain may be a key to organizing other perceptions. Looking at the cross-lagged correlations was instructive in this regard. Assuming there is a causal relationship between attitudes and later math performance, the correlation between attitudes in Grade 8 and math performance in Grade 11 should be higher than the correlations between math performance in Grade 8 and attitudes in Grade 11. For girls, this was the case for the correlations between Math as a Male Domain and problem solving (.38 and .13, respectively), and math concepts (.45 and .23 respectively).

This was not the case for any other variable for either sex. The perception of math as a male domain thus emerged as an important causal variable.

Girls' more positive attitude toward success in mathematics from Grade 8 to Grade 11 is consistent both with data from a cross-sectional sample (Fennema & Sherman, 1978) and from another independent longitudinal sample (Sherman, in press-a); it appears to be a function of increased maturity (Sherman, in press-c, in press-d). Fear of success in mathematics is but one factor in a system of sex-role influences, and it is less important for mathematics than some of the other attitudes. Its role in predicting Grade 11 problem solving for boys underscores the fact that its influence is not limited to girls.

Replicating results of other data sets (Sherman, 1979; Sherman, in press-e), spatial visualization was a significant predictor of mathematics performance and tended to be a significantly higher predictor for girls than for boys. The correlations were not so dimorphic as the standardized regression coefficients. In competition with other variables, spatial visualization contributed more uniquely to the prediction of math performance for females than for males. This is probably because of the slight male advantage in spatial visualization. [Note: It might be thought that the lack of a sex-related difference especially at Grade 11 is at variance with the literature (e.g., Differential Aptitude Test norms). However, the size of the difference (2-3 items) was similar and, in fact, would be statistically significant with the same large numbers ($\approx$14,000) as in the normative sample.] Spatial visualization skill is thus less likely to be problematic for males than females. Hence, spatial visualization skill would differentiate more among females than males in predicting math performance.

Confidence in learning math is important because of its relationship to mathematical performance, but perhaps even more because of its role in deciding whether or not to take further mathematics courses. The results predicting Confidence in Learning Math in Grade 11 are particularly interesting in that females showed a significant negative weight for vocabulary and a significant positive weight for spatial visualization, whereas neither measure of math performance in Grade 8 was a significant predictor. The high negative weight for vocabulary would seem anomalous, but not in view of the hypothesis that more females than males develop their verbal facility and rely on this skill when a spatial approach might be more effective (Sherman, 1967, 1968). Tobias (1978) provided an introspective account of how verbal facility interfered with mathematics learning. The Effectance Motivation and Math as a Male Domain scales were also significant predictors for females but not for males. For males the only significant eighth-grade predictor was Confidence in Learning Math.

Conclusions

The present data add to an accumulated picture stressing the importance of sex-role factors in the development of sex-related differences in mathematics performance. Findings, however, are fundamentally correlational, and verification is needed through experimental methods.

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RE-ENTRY PROGRAM

The Mathematics and Computer Science Department of the University of Denver has been awarded a $99,983 National Science Foundation grant to fund a project designed to meet the needs of women re-entering scientific and technical fields. The program is structured to upgrade and update present skills and to teach new marketable skills to women with undergraduate degrees in biological, physical, medical or the social sciences who are currently unemployed or underemployed. The project is one of 14 Science Career Facilitation Projects and 20 Science Career Workshops funded this year through the Women in Science program, a part of NSF's Science and Engineering Education Directorate.

The University of Denver program offers two academic quarters of training in computer science, leading to a formal certification of computing efficiency. Completion of a third quarter, at the participant's option, will confirm advanced certification and, if desired, admittance to the Master in Computer Science program, with up to eight quarter hours of credit accepted toward the degree. The program begins with the University's Fall Quarter, 1981. For more information or to learn how to apply, interested women may write Dr. Jodi Wetzel, Director, Women's Resource Center, University of Denver, Denver CO 80208 or call her at (303)753-2856.

AAAS INVENTORY

An inventory of Programs in Science, Mathematics and Engineering for Women in the United States: 1966-1978 has recently been issued by the American Association for the Advancement of Science. Compiled by Michele L. Aldrich and Paula Quick Hall of the AAAS Office of Opportunities in Science under a project supported by the National Science Foundation, this volume of approximately 300 pages describes over three hundred projects designed to increase the numbers and status of women in science, mathematics, and engineering training and careers. The project descriptions are arranged by educational level. It is noted in the introduction that mathematics, since it is needed for all the fields of science and engineering, has been the focus of much attention in the projects inventoried. The volume includes a 50-page bibliography of publications on women in science, mathematics, and engineering and also includes lists of associations and committees concerned with problems in that area. Single copies of the inventory volume (AAAS Publication 80-11) are available free on request from the Office of Opportunities in Science, American Association for the Advancement of Science, 1776 Mass. Ave., N.W., Wash., D.C. 20036.

OF POSSIBLE INTEREST

Expenses incurred by a college lecturer to acquire a doctorate were deductible as business expenses, the Tax Court has held. ¶8416. [Tax Week, May 29, 1981]

Women's Studies International Quarterly, sample copy available on request. Pergamon Press, Fairview Park, Elmsford, NY 10523.

Women's Studies, Routledge & Kegan Paul, 9 Park St., Boston, MA 02108.

Praeger Special Studies, 521 Fifth Ave., NY, NY 10175.

Women's Issues, Lexington Books, 125 Spring St., Lexington, MA 02173.

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