AWM

ASSOCIATION FOR WOMEN IN MATHEMATICS

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PRESIDENT'S REPORT

High on Talent

The third competition for the Alice T. Schafer Undergraduate Prize in Mathematics was a challenge to the judges, I hear, and resulted in one winner, one runner-up, and nine honorable mentions. I read a sample of the files, and all I can say is *wow*! The press release is below (keep reading), so I'll just thank the committee: Jill Mesirov, Ann Stehney, and — chairing in her third and final year of service — Alice herself! The honorees will be recognized at the prize session at SIAM on July 21st, and there will be a dinner that evening in their honor, where they will be guests of Addison-Wesley. Please join them there!

IN THIS ISSUE

Can't Keep Track Without a Scorecard

Beth Ruskai has resigned as Treasurer. But I am delighted to report that JUDY GREEN is the new Treasurer of AWM. Her appointment by the Executive Committee was effective June 1, 1992. Judy brings stability and years of AWM experience to a job which is currently evolving to become at least as crucial to AWM as the President's position is. Having someone of Judy's stature should foster this transition. Many thanks to Judy for agreeing to rescue us, to Marymount for providing support (and approving her tenured appointment there), and to the persuasive powers of the President-Elect. As some long-time members know, Judy and I are related by marriage, but I never succeed at persuading in-laws to do anything, so was delighted to learn that Cora had done the groundwork, with Alice Schafer and Mary Gray as co-conspirators in bringing about this happy ending.

Big Doings at NSF

The principal source of funding for many mathematical activities is NSF, so budget decisions affect many of us, and changes in direction ripple throughout the academic community. We watch, we worry, we criticize. What will be the effect of budgetary shifts from

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The Association was founded in 1971 in Boston, MA. The purpose of the association is to encourage women to study and to have active careers in the mathematical sciences. Equal opportunity and the equal treatment of women in the mathematical sciences are promoted.
The *Newsletter* is published bi-monthly.
The Editor welcomes articles, letters, and announcements.
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traditional support to new initiatives? How high can the cut-off line be drawn for individual grants before even that small segment of our community which gets such support says *enough*? Are our most successful grant applicants willing to accept flat rate summer support/other reductions in order that more basic research be supported? What new projects will get supported? Will 1994 bring more savaging of basic research funds? And so on. The next few years may bring enormous changes, or so those who know tell us, including the possible end of summer salary support for all of us (not just most of us).

I believe that one of AWM's concerns should be to watch out for the research and teaching efforts of women who are not always part of big research teams or curricular projects. NSF makes several things possible for AWM, including the travel grants, distributing *Careers That Count*, and the Workshops for graduate students and postdocs. Let us hope that during this time of change that AWM can provide useful insight into how to support worthy efforts by mathematicians, and that NSF can find the necessary funds. Keep alert!

Judy Sunley Moves Up

Also at NSF, just while we're all anxious, Judy Sunley is moving for a two year assignment to the Directorate for Mathematical and Physical Sciences, as Executive Officer, working with the new Assistant Director for Mathematical and Physical Sciences, William Harris. Congratulations to Judy on this very important assignment, one in which her level head and judgement will help a wide segment of the community in planning and budget decisions. A replacement Division Director is being sought from the mathematical sciences community; this is a choice that matters, coming at such a crucial time. This sort of service is extremely important to mathematics, and can make a positive difference, as Judy has shown.

Can They Make Chan Retire?

Apparently the official answer is yes, and Chandler Davis, AWM member and friend, is being honored on June 13th in Toronto. Lee Lorch has agreed to bring AWM greetings on the occasion, which promises to be an extraordinary mix of mathematics, politics, and science fiction. But official answers have never daunted Chandler before, so it sounds as if his friends just want a reason to share their delight in him.

Departmental Committee?

A new member writes inquiring if anyone has experience in setting up a committee within a department to handle such things as sexual harassment and discrimination. The intent would be to handle certain problems within the departmental framework, without going immediately to a university-wide context, and to provide a knowledgeable group of people to whom one could turn if a problem arose. Can anyone provide information and/or precedents?

AWM Keeps Busy

Welcome to AWM's summer employee Norah Mogan and to our intern Carla Salvucci, who report that it's fun to be at the office because it is *never* boring. I can believe that! A special thanks to Ed Connors for matchmaking Carla and AWM. Renewals are still pouring in, and the data gets cleaner every day, thanks to Jodi and her team. But keep a careful watch for the *Newsletter* and check your address. We will be removing names, and errors are inevitable. If newsletters arrive in your department addressed to members who have moved elsewhere, please let the AWM office know.

Goodbye To Mike Dooley

One of AWM's great supporters and friends is moving to another part of Exxon, but not before arranging one last unrestricted gift to AWM. The funds from Exxon were a big part of AWM's resource work and office upgrade, and we thank Mike for all his efforts on our behalf.

Thanks to Another Schafer

Dick Schafer, mindful of the drop in interest rates, has just added a generous contribution to the Schafer Prize Fund in 1992.

And for More Funds

Eleanor Palais, Maria Klawe, and Alice Schafer have agreed to serve as fund-raising committee for AWM. There are so many great ideas for things we could do, and we are limited only by time and money. Now the latter is in expert hands.

NSF Travel Grants

Don't give up on us! The popularity of the program (and the need for travel funds among mathematicians) has resulted in over three times as many noes as yeses on the travel grants, even though we are spreading the money as far as we can by giving partial funds in most cases. In the May round, awards went to Maria Angelone, Karen Brucks, Kathleen Crowe, Roza Galeeva, Maria Girardi, Antonella Grassi, Elisa Prato, and Mary Silber. Congratulations! An unexpected bonus: the selection panel has contacted some applicants to suggest improvements in their applications. Their hope is not just to make the next panel's work even harder, but to increase the success rate in applications for travel funds from other sources as well. If anyone would like to request such advice, there are experienced hands available through the travel grants program; just ask.

For those of us in academia, the summer can be a time of renewal and rededication to things which drew us to mathematics in the first place, with renewed ideas for work and for courses, and perhaps the chance to work with colleagues elsewhere. Have a glorious, selfish summer!

Carol

Carol Wood
June 3, 1992
Middletown, Connecticut

NEW ADDRESSES

What? The editor's email address is changing again? Well, yes. But my departmental network administrator assures me that this new address will be good for a long, *long*, time. It is: leggett@math.luc.edu.

Our book review editor's address has also changed. It is: Cathy Kessel, 2520 Etna, Berkeley, CA 94704.

Here is our new treasurer's address: Judy Green, Department of Mathematics, Marymount University, Arlington, VA 22207; email: jgreen@gwuvm.gwu.edu.

MEMBERSHIP AND NEWSLETTER INFORMATION

Membership dues

Regular: $25
Family: $40
Student, unemployed, retired: $8
Prize Fund add-on: $5
General funds add-on: $10
Contributing: $100
Institutional:
Level 1 (two free ads and up to three student memberships): $80
Level 2 (two free ads and up to ten student memberships): $120

Subscriptions and back orders

Individual and institutional members receive a subscription to the newsletter as a privilege of membership. Libraries, women's studies centers, etc., may purchase a subscription for $30/year. Back orders are $6/issue plus shipping/handling ($5 minimum per order).

Ad information

AWM will accept advertisements for the *Newsletter* for positions available, programs in any of the mathematical sciences, professional activities and opportunities of interest to the AWM membership and other appropriate subjects. The Executive Director, in consultation with the President and the Newsletter Editor when necessary, will determine whether a proposed ad is acceptable under these guidelines. *All institutions and programs advertising in the newsletter must be Affirmative Action/Equal Opportunity designated.*
Institutional members receive two free ads as a privilege of membership. For non-members, the rate is $60 for the first eight lines of type plus $6 for each additional line.

Deadlines

Editorial: 24th of January, March, May, July, September, November
Ad: 5th of February, April, June, August, October, December

Addresses

Send all **Newsletter** material **except ads and book review material** to Anne Leggett, Dept. of Math. Sci., Loyola University, 6525 N. Sheridan Road, Chicago, IL 60626. FAX: (312) 508-3514; phone: (312) 508-3554; email: leggett@math.luc.edu; LMA24@LUCCPUA.BITNET
Send all material regarding **book reviews** to Cathy Kessel, 2520 Etna, Berkeley, CA 94704. email: kessel@soe.berkeley.edu
Send everything else, **including ads**, to Jodi L. Beldotti, AWM, Box 178, Wellesley College, Wellesley, MA 02181. Phone: (617) 237-7517; email: jbeldotti@lucy.wellesley.edu

AWM ANNOUNCES 1992 ALICE T. SCHAFER PRIZE WINNER

Zvezdelina E. Stankova of Bryn Mawr College has been named the recipient of the third annual Alice T. Schafer Mathematics Prize sponsored by AWM. The prize is given to an undergraduate woman in recognition of excellence in mathematics and carries with it a stipend of $1000. The criteria for selection include the quality of the nominee's performance, interest in mathematics, ability to do independent work, and performance in any mathematical competitions.

The prize committee has also named Julie B. Kerr of Washington State University as Runner-Up and selected nine other nominees for Honorable Mention. The awards will be made at the annual meeting of SIAM, which celebrates its 40th anniversary in Los Angeles in July.

The prize was named to honor Alice T. Schafer, a former AWM President and a founding member of the organization, who has taken a special interest in supporting women at the start of their careers in mathematics. The members of the 1992 prize committee were Alice T. Schafer of Marymount University, Jill P. Mesirov of Thinking Machines Corporation, and Ann K. Stehney of the IDA Center for Communications Research.

The committee noted that the field of 32 candidates seemed especially strong. Their impressive achievements in coursework, independent study, competitions, and undergraduate research programs were accompanied by numerous projects on behalf of the mathematical life of undergraduates at their institutions. Each candidate is a talented young woman who can take pride in her accomplishments and the commendation of her professors.

ZVEZDELINA E. STANKOVA, a 1992 graduate of Bryn Mawr College, has earned wide recognition for her research and performance in mathematics competitions. She participated last summer in the Research Experiences for Undergraduates (REU) at the University of Minnesota at Duluth, and her research there on classifying permutations with forbidden subsequences of length four was praised as impressive work on a difficult problem. Her paper on the subject was well received at the joint mathematics meetings of the American Mathematical Society and the Mathematical Association of American in Baltimore in January. In addition to her research in combinatorics, she has done advanced work in a number of areas. In nominating Stankova, Professor Rhonda J. Hughes of Bryn Mawr wrote, "Her results are strikingly original, and one is always reminded that her work is that of an extraordinary mathematician." A two-time silver medalist on the International Mathematics Olympiad team from her native Bulgaria, known as both an excellent problem-solver and a first-rate expositor, Stankova was the Runner-Up for the Schafer Prize in 1991. She will return to the REU Program in Duluth this summer before beginning graduate work in mathematics at Harvard University in the fall.

JULIE B. KERR, this year's Runner-Up, will graduate in December from Washington State University. She received Special Recognition from the 1990 Schafer Prize committee for her early achievements, including distinction in graduate courses as a first-year student. In each of the last two years, she finished in the top sixty students on the nationwide Putnam Examination for undergraduates. Following a Budapest Semester in Mathematics as a sophomore, Kerr participated in the 1991 NSF-sponsored Mills Summer Mathematics Institute, and she will work this summer in computational number theory at the REU at Rose-Hulman Institute of Technology. An aspiring teacher, Kerr also finds time to tutor in mathematics.

AWM is pleased to award Honorable Mention in the competition to the following outstanding candidates.

MARCIA GEIGER ISAKSON graduated this year with a rare double major in applied mathematics and physics at the U.S. Military Academy. Among her honors in the Department of Mathematical Sciences, she won the Top Cadet award in the Research Seminar in Applied Mathematical Projects for work done in a semester at Brookhaven National Laboratory. She was a member of the USMA team that earned Honorable Mention in the 1992 Mathematical Contest in Modeling, sponsored by COMAP. Recipient of a Hertz Fellowship, Isakson will be a graduate student in physics at the University of Texas at Austin in the fall.

CHERYL P. GROOD graduated from the University of Michigan this year, having been a central figure in the Undergraduate Math Club and MAA Student Chapter there. A 1990 participant in the REU at Rose-Hulman Institute, Grood won an Honorable Mention in the 1991 Schafer Prize competition as a junior. She spent last summer at the Mills Summer Mathematics Institute, where she will return by invitation as a student assistant this summer before entering graduate school at the University of Wisconsin at Madison.

KRISTINE HAUSER, a 1992 graduate of Grinnell College, was cited for her maturity in both courses and independent work. She spent two summers doing joint research on the word problem in cycle-free groups with faculty member Royce Wolf, and she presented their results at this year's Conference on Undergraduate Mathematics at the Rose-Hulman Institute of Technology. Hauser will begin graduate study in mathematics at the University of Chicago this fall.

LAURA HEGERLE, who graduated this year from Colorado College, was chosen to participate in an undergraduate research program at Harvey Mudd College after her sophomore year. Since then, she has maintained an interest in graph theory, speaking on her work at a regional MAA meeting and a university seminar in the field. Hegerle plans to go to graduate school after teaching mathematics in the Peace Corps.

EUGENIE HUNSICKER graduated this year from Haverford College, having spent her junior year immersed in a "broad array" of mathematical subjects at Oxford University. She devoted two summers to doing research in algebraic combinatorics with faculty member Curtis Greene, and she presented their results at a recent MAA session of student papers. Hunsicker will enter graduate school in mathematics at the University of Chicago this fall.

MARY C. JOYCE, a 1992 graduate of the University of Massachusetts at Amherst, wrote a senior honors thesis on statistical estimation with censored data. She spent her junior year at the University of Freiburg, and this year she was a member of a UMass team that won Honorable Mention in the Mathematical Contest in Modeling sponsored by COMAP. In the fall, Joyce will enter the University of Illinois at Urbana-Champaign for graduate work in applied mathematics.

MARTHA J. MANCEWICZ, who graduated from Kalamazoo College this year, spent part of her junior year with the Budapest Semester in Mathematics program and part of her senior year in the Mathematics Department of the General Motors Research Laboratory. Her work at GM on developable surfaces was presented to mathematicians, engineers, and visiting high school students at GM and also to a meeting of MAA Student Chapters. Mancewicz will attend the University of North Carolina next year as a graduate student in biostatistics.

JENNIFER WILLIAMS is currently writing a senior honors thesis and expects to graduate this summer from Oklahoma State University. A veteran Putnam Exam entrant, Williams provided the impetus for a Problem Solving Seminar in her department. She was a member of OSU's 1992 Mathematical Contest in Modeling team, whose solution to the "Emergency Power Restoration System Problem" was judged Outstanding (one of only five such awards in the contest as a whole). The team also won the SIAM prize for that problem, and their faculty advisor cites Williams' creative leadership as a significant factor in their success.

VIRGINIA E. WRIGHT completed a joint B.S./M.S. program this year at Emory University. She spent two summers in REU programs, working in number theory and cryptography at Florida State (1990) and in graph theory at the University of Minnesota at Duluth (1991). She has continued her research on n-tuple vertex graphs in the past year and spoken on her results at a number of conferences. Wright has been awarded a Marshall Scholarship to study mathematics at Trinity College, Cambridge.

HONORS AND AWARDS

CONGRATULATIONS to the women listed below for their meritorious achievements.

Lisa J. Fauci (Tulane) and Donna Testerman (Wesleyan) are 1992 Sloan Research Fellows.

This year's recipient of the Martin and Tina Fossum Scholarship is Kristen Cooper of Bloomington, Minnesota. Each year the mathematics department at St. Olaf College awards this scholarship to an outstanding third year woman mathematics major. The scholarship is named after and endowed by the estates of Martin and Tina Fossum. Tina Fossum was an outstanding high school mathematics teacher in Farmington, Minnesota. The Fossums had two sons, both of whom are mathematicians. Tim is a professor at the University of Wisconsin, Parkside, and Robert is a professor at the University of Illinois, Champaign-Urbana, as well as the secretary of the American Mathematical Society.

Professor Marina Ratner, Department of Mathematics, UC Berkeley, was recently elected to the American Academy of Arts and Sciences.

The Student Government Association at Trinity College in Hartford, CT commissioned a portrait of Marjorie Van Einam Butcher, the first woman professor at Trinity, to symbolize coeducation (1969) at Trinity. The portrait has now been painted and hung with appropriate ceremony.

Professor Marcelle Bessman, of Frostburg State University, in Frostburg, MD represented AWM at the inauguration of its new President in April.

Seven of the 40 NSF Mathematical Sciences Postdoctoral Research Fellowships awarded this year went to women. The Fellows are [name, doctoral institution, date of Ph.D., current institution (if different from doctoral institution), fellowship institution(s), sponsoring scientist(s), field]: Danielle Carr, Duke University, 1992 (expected), Boston University and Courant Institute of Mathematical Sciences, Nancy Kopell (Boston) and Charles Peskin (Courant), biomathematics (specifically axonal transport); Marie Dillon Dahleh, Princeton University, 1990, UCLA, UCLA, Christopher Anderson, coherent structures in geophysical flows; Irene Gamba, University of Chicago, 1989, Trenton State University, Courant Institute of Mathematical Sciences, Cathleen Morawetz, transonic problems in ordinary and partial differential equations; Mary Ann Horn, University of Virginia, 1992 (expected), University of Virginia, Walter Littman, exact controllability and stabilization of nonlinear plate equations; Rachel Kuske, Northwestern University, 1992 (expected), Stanford University, Joseph Keller, dynamics of pattern selection and applications of stochastic control; Toniann Pitassi, University of Toronto, 1992 (expected), University of California, San Diego, Russell Impagliazzo, connections between logic and complexity theory; and Alyson Reeves, Cornell University, 1992 (expected), Brandeis University, David Eisenbud, algebraic geometry and computational algebra.

EWM MEETING IN GERMANY

The first European Women in Mathematics (EWM) meeting in Germany took place in Haus Villigst in Schwerte, May 4–5, 1992. As a satellite meeting to the fifth EWM meeting in Luminy (France), December 1991, it was financed by the EC. The meeting was organized by Christine Bessenrodt; it was attended by 28 women mathematicians coming from four European countries.

The program consisted of mathematical talks, talks on famous women mathematicians, and reports and discussions on the topic "women and mathematics." The situation of women mathematicians in different European countries was compared and analyzed, and reports on activities concerning women in mathematics, especially in Germany, were presented. The great demand for this meeting (in spite of its being organized at very short notice) was proof that many women mathematicians have great interest in a network which aids the exchange of information, experiences and ideas. Since the beginning of EWM in 1986, well-organized groups have been formed, for example in France, but in Germany the contacts among women mathematicians were rare and sporadic. The meeting in Haus Villigst was a very good start towards establishing a network also in Germany; the next steps for building it up were planned here.

Women mathematicians in Germany who have not been contacted so far and are interested in joining EWM, please contact: Priv.-Doz. Dr. Christine Bessenrodt, Institut für Experimentelle Mathematik, Universität Essen, Ellernstr. 29, 4300 Essen 12, Germany, tel.: 0201/32064-33, FAX: 0201/32064-25, email: mat440@de0hrz1a.bitnet (in other countries, please contact your regional coordinator).

Christine Bessenrodt
EWM Coordinator for Germany

ICME SKITS: HELP WANTED

Fran Rosamond will be representing the MAA Committee on the Participation of Women at the ICME Congress in Quebec. An hour in the program has been allotted for a session called "Skits on Micro-Inequities."

Most skits presented at meetings in the past have portrayed true events that have occurred in the lives of female research mathematicians in the United States. Anecdotes are needed in order to develop skits that show micro-inequities occur internationally and at every level of mathematical activity.

Please send your true stories by early August to: Dr. Frances Rosamond, Chair, Math and Sciences, School of Arts and Sciences, National University, 4125 Camino Del Rio So., San Diego, CA 92108; phone: (619) 563-2670; FAX: (619) 563-7394. If you will be at the meeting and can participate in the skits, contact Fran at the address above or at the meeting (she will be staying in the dorms).

SYMPOSIUM AT OREGON STATE UNIVERSITY

From April 23–26, the College of Science at Oregon State University hosted a symposium for undergraduate women to encourage interest in graduate study in science. The symposium was jointly sponsored by NSF and OSU. Approximately 110 undergraduate women, mostly junior science majors from colleges and universities around the Pacific Northwest, participated; about 15 of the participants were interested in the mathematical sciences.

The program was a full two-day schedule, with roughly half the time devoted to specific scientific disciplines. The general program included speakers and panels relating to general questions about applying to, choosing, and funding graduate school, as well as a discussion of research opportunities for undergraduates and life during and after graduate school.

The mathematics program included a poster session, mathematical talks, computer demonstrations, two panel discussions, and a tea hosted by the mathematics department. One of the panels consisted of female graduate students from OSU, the University of Oregon, and the University of Washington answering questions concerning life as a graduate student in mathematics. Some of the questions were rather personal and pointed, but all were answered in a forthright and friendly manner. The second panel, composed of women with research jobs in the mathematical sciences, answered questions about their experiences in the work force.

Considerable effort went into the planning and execution of the symposium, with at least 60 faculty members and graduate students from across the OSU campus involved, in addition to at least 25 participants from industry and other universities.

The participants were very enthusiastic about the symposium. Evaluations by the participants attest that the symposium increased their interest in science and in considering graduate school as a serious option.

Anyone interested in hosting a similar symposium can contact the Education Directorate of the NSF for funding information.

AWM PROGRAM FOR SIAM

The program for AWM activities at the SIAM meeting, Tuesday, July 21, 1992 at the Century Plaza Hotel, Los Angeles, California follows.

The Alice T. Schafer Mathematics Prize Awards Ceremony will be held from 8:45 A.M. to 9:15 A.M. in the L.A. Ballroom during the SIAM Prize Awards Session. Ann Stehney will be the presenter. The Award Dinner will take place that evening from 6:30 P.M. to 8:30 P.M. at the Waters Edge Restaurant.

A luncheon will be held from 12:00 noon to 2:00 P.M. in the Bel Air Room, Plaza Level. Everyone is invited to attend. The menu will be box-lunch style and will include a sandwich (either pasta salad or ham and cheese), an apple, a bag of chips, a brownie, and lemonade. The speakers will include representatives from funding agencies and government research laboratories, who will give informal talks and answer questions about funding and opportunities in research and government. It is necessary to sign up ahead of time, either by calling the AWM office before July 17, 1992 (617-237-7517) or by signing the sign-up sheet at the AWM information table at the conference before Monday, 2:00 P.M. Seating is limited and will be available on a first-come-first-serve basis.

The AWM Panel on Research in Government, organized by Joyce McLaughlin, will be held in the Westwood room from 3:30 P.M. to 5:30 P.M. Laif Swanson of the Jet Propulsion Laboratory will speak on "Deep Space Communications" at 3:30. Pamela Coxson, Lawrence Berkeley Laboratory, will speak on "Dynamic Positon Emission Tomography and Cardiac Artery Disease" at 4:00. At 4:30, Alex Tolstoy of the Naval Research Laboratory will speak on "Applied Mathematics in Underwater Acoustics." The final speaker at 5:00 will be Suzanne Lenhart, Oak Ridge National Laboratory and University of Tennessee, Knoxville; her topic is "Environmental Modeling at Oak Ridge."

AWM thanks the officers and staff of the Society for Industrial and Applied Mathematics, as well as the National Science Foundation and Addison-Wesley, for their support of these activities.

CALL FOR VOLUNTEERS

We could use more volunteers to staff the AWM Information Table at the SIAM meeting, especially on Tuesday. If you will be at the meeting and have an hour or two (or even just a half an hour) to spare, please help out. Even if you have never done it before or don't think you will be able to answer all the questions you'll be asked, don't hesitate. Jodi will be happy to fill you in on what needs to be done. Also, there is a procedure guide at the table which answers the routine questions and tells you what to do with an unusual one.

So come to the table, meet some people, network a little, and help spread the news about AWM. Contact Jodi Beldotti at (617) 237-7517, or see her at the meeting.

NSF-AWM TRAVEL GRANTS FOR WOMEN

The objective of the NSF-AWM Travel Grants is to enable women to attend research conferences in their field, thereby providing a valuable opportunity to advance women's research activities, as well as to increase the awareness that women are actively involved in research. If more women attend meetings, we increase the size of the pool from which speakers at subsequent meetings are drawn and thus address the problem of the absence of women speakers at many research conferences.

The Travel Grants. The grants will support travel and subsistence to a meeting or conference in the applicant's field of specialization. A maximum of $1000 for domestic travel and of $2000 for foreign travel will be applied. International travel must be on U.S. flag carriers.

Eligibility. Applicants must be women holding a doctorate in a field of research supported by the Division of Mathematical Sciences of the NSF (or have equivalent experience). A woman may not be awarded more than one grant in any two-year period and should not have available other sources of funding (except possibly partial institutional support).

Target Dates. The three award periods have deadlines of February 1, May 1 and October 1.

Applicants should send *five copies* of their application, which consists of a description of their current research and of how the proposed travel would benefit their research program, a curriculum vita and a budget to: Association for Women in Mathematics, Box 178, Wellesley College, Wellesley, MA 02181.

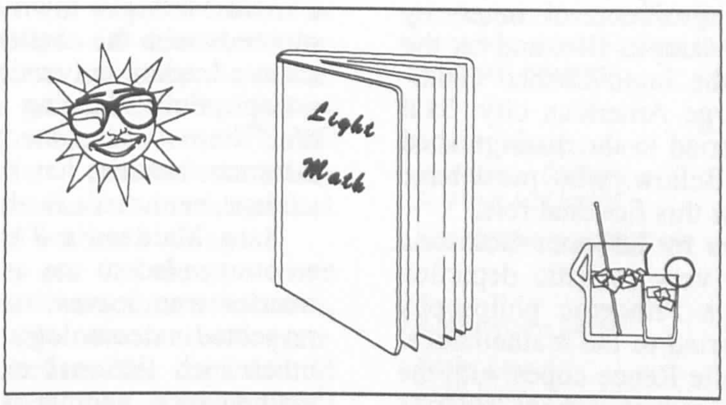
BOOK REVIEW

Summertime and the Living Is ...

Contrary to popular belief, summertime is not a time of complete leisure for most mathematicians. Academic vacation does not mean lying on a beach, sipping a cool drink, and reading a favorite novel, but then again, about that reading ...

For many of us, summer is a time for a different kind of work with a different sort of intensity, but I, for one, find it a time also to indulge in some good recreational reading — and I don't mean just the *Monthly* — I mean good novels with psychological drama, real-life insights, and personal inspiration. But more is available — we are out there, even in novels. The good news is that women mathematicians appear in a wide variety of fiction. This article provides an annotated reading list of such books that I have encountered and enjoyed.

Last summer I prepared for a January course in our four-week, full-credit, ungraded interim session on "The Portrayal of Women Mathematicians in Biography, Autobiography, and Fiction." * We know a lot about the many excellent biographies of women mathematicians; they have been written about in the AWM *Newsletter* and elsewhere. Less well known, it seems to me, is the variety of novels depicting women mathematicians in significant roles. I include in the list below a few historical accounts (since they provide similar reading) and, to widen the scope, also novels featuring women in quantitative sciences (e.g., computer science, theoretical physics, astronomy) and philosophy. All such women grow up with an interest in math and science; later the focus of their work may differ from that of a mathematician, but there seem to be more similarities than differences in these portrayals and possibly in reality as well.



Here are first a number of older, more classical works; when a book is out of print, I supply reference information.

Vera Barantzova by Sophia Kovalevsky is perhaps the ultimate combination of biography, autobiography, and fiction. This is a supposedly fictional account, narrated by an unnamed female mathematician who, at the age of 22, has just returned to St. Petersburg after three years at a small German university. On her return, she forsakes her mathematics and throws herself into the seemingly fascinating, "yet so empty in reality," social and literary life of St. Petersburg. The focus of the novel, however, is on the life of Vera Barantzova, a young woman who decides to spend her life working politically for "the cause." The novel is filled with details of degenerate, aristocratic Russian life, romantic liaisons, and the intensity of liberal "nihilist" dissidents, written in a lively manner with clear autobiographical overtones. [Ref.: London, Ward & Downey, 1895, available at Connecticut College Library; also known as *Vera Vorontzoff*, Boston & N.Y., Lamson Wolffe, 1895, at Kent State University Libraries; also called *The Nihilist*.]

Night and Day by Virginia Woolf is also a classic with a closet mathematician, the aristocratic Katherine Hilbery who spends her days fulfilling the social expectations of her parents. Her mother holds literary salons in the tradition of her poet laureate father (Katherine's grandfather) and attempts ineffectually to write his biography, though ably assisted in both ventures by her daughter. At night, when relieved of family duties, Katherine escapes to her room, locks the door, and brings out a mathematics book to read. The main focus of the novel is on Katherine's development beyond these confines and discovery of herself and a truly meaningful relationship.

Nancy Mitford's *Voltaire in Love* reads like historical fiction — it contains swashbuckling adventure, romance, and deception in its description of Emilie du Chatelet and Voltaire's long professional collaboration and personal relationship from 1733 until her death in 1749. It focuses on their life together at the du Chatelet Chateau de Cirey, their intense studies, lively social life, and amateur theatricals, interspersed with travel to Paris and Prussia [Ref.: London, Hamish Hamilton, 1957; N.Y., Harper, 1957]. Another account, written in a similar style, is *The Divine Mistress* [Samuel Edwards, N.Y., McKay, 1970].

Hypatia by Charles Kingsley was, I thought as a teenager, my introduction to the history of mathematics. Although little is really known about Hypatia's life and mathematical work, Kingsley has constructed an historically accurate tale of Alexandria during the (fifth century) end of the Roman Empire; this is both a romance and a philosophical study of ecclesiastical history, emphasizing the life, work, and tragedy of Hypatia.

In recent years there has been increased interest in female mathematicians and scientists; often they are depicted as unconventional and high-achieving characters.

The Dean's December by Saul Bellow recounts the return of an American émigré astrophysicist to her impoverished family in Romania (in the early 1980s) accompanied by her husband, the narrator and dean at a prominent Chicago university. The book focuses both on the problems of inner-city violence as it impinges on campus life, and on the striking contrast between the impoverished conditions in Romania and a large American city. Saul Bellow was previously married to the distinguished mathematician Alexandra Bellow, who must have been an important model for this fictional role.

The Mind-Body Problem by Rebecca Goldstein is a funny, touching, and very realistic depiction of Renee Feuer's life as a Princeton philosophy graduate student while married to the mathematical genius Noam Himmel. While Renee copes with the all-too-familiar struggle of graduate school, Noam's career falls apart as does their personal and physical relationship.

In Marge Piercy's *Small Changes*, one of the main characters, Miriam Berg, is a computer science student at MIT, who leaves before completing her Ph.D. as she marries and begins work for a small computer company. She hopes that she can "sneak off to work on her thesis," but soon immerses herself in family life. However, her circle of strong and more unconventional women friends lend her support as they struggle together in a world dominated by men. This book is a strongly-stated depiction of female subjection and personal and political struggle for freedom and fulfillment.

Lynne Sharon Schwartz's *Rough Strife* concentrates on the intensities of the life of a mathematician, Caroline (a topologist at a New York university), and her demanding and conflicting roles as wife and mother. The main focus is on her life and marriage, but the reality of her career is an important background for her personal growth — this book rings true, complete with a sabbatical separated from her family at a "north woods college."

Many of us have read the book (by Scott Turow) or seen the movie *Presumed Innocent*. Barbara Sabich is a graduate student in mathematics, struggling to finish her dissertation and to escape the boredom of suburban living with a much absent and increasingly distant husband. The latter is the leading character, an over-worked, county chief deputy prosecutor in a midwestern city, who is assigned to the murder case of his former lover, with whom he had been unable to break off his obsessive affair. The book contains a well-written combination of Chicago-style politics, suspenseful detective work, and courtroom fencing.

Charles Baxter's *First Light* is an insightful study of the life of Dorsey Welch who grows up in a small Michigan town as a mathematical prodigy, succeeds with the challenges of mathematical physics at a leading university, and becomes an eminent astrophysicist, leading a consistently exceptional life. The novel is a study of contrasts with her car-salesman brother, her brilliant and eccentric Ph.D. advisor, her artistic husband, and her deaf son.

Sara Maitland's *Three Times Table* has been recommended to me as a novel that focuses on a woman who leaves mathematics; her mother is a respected paleontologist. There are probably many other such fictional examples of women leaving mathematics; another is Alice in *Dreams of Sleep* by Josephine Humphreys, a book depicting Alice's many failures and frustrations in life. Not surprisingly, few black scientists are portrayed in popular fiction, but in Michael Crichton's *Sphere*, a black male mathematician, Harry Adams from Princeton, plays a central role.

Short stories also present female mathematicians, ranging in profession from high school teacher to statistician and research mathematician. It is not always clear why a mathematician is included, though common stereotypes prevail in older stories. There must be many more, but a sampling includes "A Matter of Numbers" in J. Rule's *Inland Passage*, "Witness" in J. L'Heureux's *Desires*, and "The Tale of Happiton" by Douglas Hofstadter in *The Mathenauts* (Rudy Rucker, ed.). In older books there is J. B. Cabell's "Jurgen proves it by mathematics" and H. G. Wells's "Peter Learns

Arithmetic" in *Fantasia Mathematica* and M. Clifton's "Star, Bright" in *The Mathematical Magpie* [Ref.: Clifton Fadiman, ed., Simon and Schuster, 1958, 1962, respectively]. T.L. Thomas's "The Weather Man" [Ref.: *Time Probe: The Sciences in Science Fiction*, Arthur C. Clarke, ed., Dell Co., 1966] is a futuristic account in which a female mathemeteorologist skillfully produces a snowstorm in southern California.

I expect there is a variety of mysteries featuring the logical, deductive skills of persons in our profession. I have recently read *Murder Misread* of the Maggie Ryan series by P. M. Carlson; Maggie is a psychologist who specializes in mathematical and statistical work. I have been told of Marcia Muller's *The Shape of Dread* in which Laura Kostakos, the mother of the missing victim, is a Stanford mathematician, and of Agatha Christie's *What Mrs. McGillicuddy Saw!* (a.k.a. *The 4:50 from Paddington*). Anyone interested in this genre should read about the (male) mathematician detective in Erik Rosenthal's *The Calculus of Murder* and *The Advanced Calculus of Murder*. Of course, mathematicians make appearances in many academic murder stories; there is a very brief scene with a woman mathematician in Amanda Cross's *Sweet Death, Kind Death*, a mystery that features many women academics as Kate Fansler investigates a drowning at a New England women's college.

And last, but not least, are the many science fiction and fantasy novels. In many futuristic books, all characters are "scientists," conversant with computers and technology. At times the depiction of women is discouraging, rather than hopeful, about the future role of women in an increasingly scientific world. For example, in both Carl Sagan's *Contact* and Issac Asimov's *I, Robot*, the main character is a female scientist who finds herself at the end of her life with a successful career, but bereft of personal fulfillment and supportive relationships. In Arthur C. Clarke's *Imperial Earth*, Grandma Ellen lives out her life as a disappointed, unhappy woman; in his *Ghost from the Grand Banks* Edith Craig's life ends even more unhappily. There are positive portrayals, however, in Ursula K. LeGuin's *The Dispossessed* where Mitis, a strong woman physicist, is a principal force in the main character's educational past, and in Robert A. Heinlein's *The Number of the Beast* in which Deety is a beautiful and brilliant mathematician/computer expert assisting on trips through the universe. There are energetic and realistically portrayed computer programmers/systems analysts in Barbara Hambly's *The Silent Tower* and *The Silicon Mage*, in R. A. MacAvoy's *Tea with the Black Dragon* (though the protagonist here becomes enmeshed in crime), and in C. J. Cherryh's *Cyteen* series. *The Eight* by Katherine Neville is a long, action-filled fantasy chase around the globe for missing pieces of an old and power-filled chess set; the chase is ably managed by Catherine Velis, a computer expert. Clifford D. Simak's *Why Call Them Back From Heaven?* features the rebellious mathematician Mona Campbell.

There could be some very interesting analysis and discussion of the portrayals of these women mathematicians, scientists, and would-be scientists. Instead I'll close with some suggestions for another summertime activity, movies featuring women scientists. For a start try "It's My Turn," "Real Genius," "Insignificance," "Roxanne," and "A Hill On the Dark Side of the Moon."

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SLOAN NOMINATIONS

Nominations for candidates for Sloan Research Fellowships are due by September 15. Candidates must be members of the regular faculty at a college or university in the United States or Canada and must be at an early stage in their research careers. For information write: Sloan Research Fellowships, Alfred P. Sloan Foundation, Suite 2550, 630 Fifth Avenue, New York, NY 10111.

EDUCATION COMMITTEE

This column concerns educational activities in Mississippi and Georgia. Helen Purks (Executive Director, Columbus Regional Mathematics Collaborative) wrote part 1, an article on a summer program, PRIME, and A. Louise Perkins (Institute for Naval Oceanography) wrote part 2, a report from Mississippi.

PRIME: Positive Reinforcement in Mathematics Education

"The young women in my classes are some of my best students — there just aren't enough of them!" lamented Dr. Kitt Lumley, Associate Professor of Mathematics at Columbus College in Columbus, Georgia. She and Helen Purks, Executive Director of the Columbus Regional Mathematics Collaborative, were meeting in the fall of 1989 to brainstorm about ways to increase the number of female students of mathematics. Both Kitt and Helen reflected that they were "into math" because they enjoyed "doing math" and received encouragement early in their lives to want to excel in mathematics. So, armed with research that supports the importance of early intervention (specifically before the teen-age years), the recently published NCTM *Standards*, and the dream to provide a program of "Positive Reinforcement in Mathematics Education," PRIME was born.

PRIME is a summer day-camp experience in mathematics for preteen girls. PRIME participants are nominated by their fifth, sixth, or seventh grade mathematics teachers as girls who have the potential for improvement in mathematics. PRIME is not a remedial program, however. It is designed for girls of average ability in mathematics who may profit from positive reinforcement and special encouragement to continue to try to excel in mathematics.

Twenty-five girls meet daily for one of three weeks at the "Rainbow House" (the Alumni Conference Center at Columbus College and the former residence of the college president). The rainbow theme is borrowed from the song "I Missed the Last Rainbow" from the stage play "Billy" that Helen had seen in London. The message for the girls is that sometimes they may feel that they have "missed the last rainbow" because others in their classes are faster or seem smarter in math than they are. PRIME encourages the girls to keep trying to improve because soon they will find a new "rainbow," and they will want to get on the rainbow "the next time around." PRIME activities enable the girls to learn some mathematics that perhaps no one else in their classes knows about so that their confidence levels will have a head start as they go into their math classes in the coming year.

One enters the PRIME Rainbow House under a large rainbow to ten rooms decorated as a math fun-house. The *power room* has computers, the *red room* features mathematical games and puzzles, an *in-between room* serves as a small-group activity room, the *marine room* features activities with water, and the popular *eyeball room* is filled with optical illusions and related activities. In addition, the *rainbow room*, with tablecloths in prime colors, is used for large-group instruction.

Separate weeks are planned for girls entering sixth, seventh, and eighth grades. Each week of PRIME provides both small-group and large-group activities that encourage girls to investigate some of the "fun" mathematical relationships while utilizing cooperative learning. Girls explore geometric properties by origami construction of platonic solids and their stellated counterparts. Experience with blowing bubbles permits the awesome exploration of minimal surface areas while trying to create a bubble cube within a bubble cube. Metric Olympics games provide opportunities for girls to apply metric measurements. Girls connect geometry, measurement and aerodynamics by making tetrahedral kites that actually fly. Combinations and permutations are introduced with activities using "cutie" dolls, kaleidoscope explorations use mirrors to examine symmetries, and LOGO computer projects enable the girls to design their own T-shirts.

A PRIME week hears lots of giggles, wows, and awesomes. The families are not excluded from the PRIME experience. Each week the PRIME girls can invite their families and regular classroom teachers to the Rainbow House for a hot dog supper. Over 100 visitors are given tours by the PRIME girls on each Family Night. The PRIME teachers use this opportunity to alert parents to the importance of their continuing the positive reinforcement during the school year. Follow-up sessions during the school year bring the girls back to Columbus College to encourage them further to stay interested in mathematics.

Minority girls are encouraged to participate, and ample scholarship opportunities are offered by the Board of Directors of the Collaborative to cover the $100 tuition. In the first two years of the PRIME program over 70% of the one hundred participants were minority and/or economically disadvantaged students.

The 1992 summer is the third year for PRIME, and its success has been the catalyst for the development of a teacher education component. The resultant project COMPOSITE (#ONE, PRIME, FACTORS) began in 1991. Dr. Mary Montgomery Lindquist, president of the National Council of Teachers of Mathematics (NCTM) and Callaway Professor of Mathematics Education at Columbus College, has been instrumental in the evolution of COMPOSITE. Area school systems nominate teachers to be prepared to teach in PRIME. COMPOSITE teachers have the opportunity to examine new instructional strategies that implement the NCTM *Curriculum and Evaluation Standards for School Mathematics*. Each COMPOSITE teacher then teaches one week in the comfortable, non-threatening environment of the summer camp.

PREP PRIME is an extension of the PRIME experience to include male as well as female students who would benefit from positive reinforcement and extended readiness activities for high school mathematics study. PREP PRIME students are also nominated by their teachers as students who would benefit from additional preparation for the study of algebra. The plans calling for "Algebra for Everyone" make the pre-algebra experience more crucial than ever. PREP PRIME will provide four dynamic weeks of exploring data, utilizing technology to solve problems, and activities to enhance the mathematical maturity of the students. Additionally, the PREP PRIME students will be monitored and mentored for their first three years of high school in order to assure them of opportunities for a successful career in high school mathematics.

PRIME and PREP PRIME are two efforts to increase the female populations in Kitt Lumley's college mathematics classes!

The COMPOSITE project is supported in part by grants from the Dwight D. Eisenhower Program for the Improvement of Mathematics and Science Education (Higher Education), the participating local educational agencies, local businesses, and private foundations.

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Mississippi State Report

Although Mississippi is a small state, it is attempting to do big things in education. It is on track with the nationwide "Project 95." They are establishing bridge classes for pre-algebra high school students who have conceptual problems. The purpose of the bridge classes is to determine where each individual student is "stuck" and why, and then to devise innovative ways to explain that specific concept. They have increased the number of Carnegie mathematics units required for graduation, and the soon to be adopted graduation requirements will include both algebra and geometry. They are also establishing an integrated K–12 curriculum.

Mississippi has a high school dedicated to math and science. They also have a mandate to establish a program for academically and intellectually gifted students for the 92–93 school year. The advanced mathematics high school course typically has as many girls as boys, according to the Mississippi State Department of Education.

A teacher-led math and science teacher network is currently under development. There is a Women in Science Technology conference in Jackson, the state capitol, but currently this is the only one in the state, and it is only for high school girls. In 1992 Mississippi held a conference on Expanding the Pipeline: Women in Science. The conference was well attended by many high school science and mathematics teachers, and lively discussions on how to overcome the social barriers for women unique to the south were covered in detail. The most innovative idea was a call to establish an "anti-nerd" media image for female scientists that would appeal to the "Southern Woman," who is, historically, interested in beauty pageants, marriage, and being pretty (these were the feelings of a large majority of the attendees). Many female Mississippi science teachers attended the conference, and their contributions to the state's educational system seemed to be a huge resource. Indeed this is probably why the Mississippi state department of education is so busy organizing them into larger cooperative groups.

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A NEW PERSPECTIVE ON WOMEN'S MATH ACHIEVEMENT: Part 1

This article presents an examination of the little noted sex-related difference in classroom grades. In contrast to standardized measures of mathematics achievement, girls receive better math grades than do boys. Three hypotheses are proposed to account for this difference. The first hypothesis proposes that boys' greater math experience facilitates their performance on standardized tests. The second hypothesis proposes that math learning styles account for the observed differences. Autonomous learning behavior is presumed to facilitate performance on standardized tests, whereas rote learning is presumed to facilitate performance on classroom exams. The third hypothesis proposes that boys and girls respond differently to novel and familiar achievement situations. It is hypothesized that girls do better when dealing with familiar situations such as classroom exams, whereas boys do better when dealing with novel situations such as standardized tests. Theoretical and empirical evidence consistent with each hypothesis is reviewed, and directions for further research are explored.

The traditional view of sex-related differences in mathematics achievement has focused on non-classroom measures of mathematics achievement, usually a standardized test. The conclusions from this literature are reasonably consistent. Sex-related differences do not reliably appear until the junior high school years; when they appear, they almost always favor boys, and differences are greater for very bright adolescents.

One question has been thoroughly explored in the literature: When do sex-related differences favoring boys appear? Up until junior high school, sex-related differences are rare. The most common finding is that sex-related differences do not occur (Armstrong, 1981; Boswell, 1985; Connor & Serbin, 1985; Fennema, 1974, 1980, 1983; Fennema & Carpenter, 1981; Fennema & Sherman, 1978; Holloway, 1986; Moore & Smith, 1987; Pallas & Alexander, 1983; Parsons, Adler, & Kaczala, 1982; Sherman & Fennema, 1978; Swafford, 1980). When sex-related differences occur in samples of young children, girls often score better on tests of computation (Armstrong, 1981; Fennema, 1974; Fennema & Carpenter, 1981; Fennema & Sherman, 1978; Fennema & Tartre, 1985; Marshall, 1984; Threadgill-Sowder, Sowder, Moyer, & Moyer, 1985), and boys score better on tests of problem solving, applications of mathematics, and math reasoning (Armstrong, 1981; Fennema, 1974; Fennema & Sherman, 1978; Marshall, 1984). In one study, Grade 8 girls did better than boys on a test of math concepts (Sherman, 1983). Occasionally, one sex will do better on an overall math test. Hilton and Bergland (1974) found that Grade 5 girls did better on one test, whereas Grade 7 boys did better on another test. Using the highly select Study of Mathematically Precocious Youth (SMPY) sample, the Johns Hopkins research group found that boys consistently did better in Grades 7 and 8 on the Scholastic Aptitudes Test–Quantitative Subscale (SAT–M; Benbow & Stanley, 1980, 1983b; Fox & Cohn, 1980).

Beginning in Grade 8 or 9, sex-related differences occur fairly consistently, and when they occur they almost always favor boys (Armstrong, 1981; Backman, 1972; Benbow & Stanley, 1982a; Burnett, Lane, & Dratt, 1979; Connor & Serbin, 1985; deWolf, 1981; Fennema, 1980; Fennema & Carpenter, 1981; Fennema & Sherman, 1977; Fox, Brody, & Tobin, 1985; Hanna, 1986; Hilton & Bergland, 1974; Kissane, 1986; Moore & Smith, 1987; Mura et al., 1985; Pallas & Alexander, 1983; Pattison & Grieve, 1984; Perl, 1982; Sawada, Olson, & Sigurdson, 1981; Weiner & Robinson, 1986; Wise, 1985). Male superiority does not appear in all samples, however. Most studies (Armstrong, 1981; Fox et al., 1985; Hanna, 1986; Hanna & Sonnenschein, 1985; Perl, 1982) report no differences on tests of algebra skills using high school students. Sometimes sex-related differences are found for some but not all of the classrooms or schools studied. Fennema and Sherman (1977) found no sex-related differences in math achievement in two of the four schools they studied, and Mura et al. (1985) found a significant sex difference for only one of three schools studied. Collins (1985) found no sex-related differences in math achievement for a highly select sample of Grade 12 students comparable to the Benbow and Stanley sample. Occasionally, differences are found that favor girls. Pattison and Grieve (1984) found that Grade 10 and 12 girls performed significantly better on tests of logic and geometric reasoning, whereas boys performed better on tests of scale and three-dimensional solid geometry.

Sex-related differences vary among different ethnic and national samples. Schratz (1978) found that among Black and Hispanic high school students, girls scored higher than boys. In a recent study

(Brandon, Newton, & Hammond, 1987) of Grade 4–10 students in Hawaii, girls outperformed boys in all groups, although the female advantage was significantly larger in Filipino, Hawaiian, and Japanese samples than in the Caucasian sample. In contrast, Jones (1987) found that for both Black and White students, girls scored lower than boys at all levels of mathematics course taking. Moore and Smith (1987) found the largest sex-related differences favoring boys among White and Hispanic students and the smallest among Black students. Wagner and Zimmerman (1986) found somewhat smaller sex-related differences for a high-achieving German sample than have been found for similar U.S. (Benbow & Stanley, 1980) or Australian (Kissane, 1986) samples.

The presence of a significant sex-related difference does not necessarily mean that the difference is large or meaningful. In an attempt to examine the size of sex differences in the area of quantitative skills, Hyde (1981) found that the percentage of variance accounted for by sex ranged from .5% to 17%. She also used *d* or the proportion of the standard deviation by which the sexes differed as a measure of the size of the sex difference. The median *d* for math studies was .43. From this review, Hyde concluded that sex-related differences in math were relatively small. Rosenthal and Rubin (1982) analyzed the same data base and noted that *d* values were more likely to be available for studies that reported a significant difference than for those reporting no difference. Thus the average *d* reported by Hyde (1981) would be biased toward overestimating the size of the sex difference. Furthermore, the *d* values for quantitative studies differed significantly among themselves. In a further analysis of effect size, B. J. Becker and Hedges (1984) found that the size of sex-related differences in quantitative ability reported by Maccoby and Jacklin (1974) varied by both date of publication and sample selectivity. Larger differences were reported in older studies and in studies with more select samples. That the size of the difference should increase with an increase in sample selectivity is not surprising, because even small mean differences will generate larger differences at the tails of the distribution (Hyde, 1981). The difference related to date of publication is more puzzling; however, it might reflect an increase in the number of courses taken by young women or a lessening of the tendency on the part of young women to stereotype math as a male domain with the result that they are more motivated when taking the tests. It is also possible that this decrease reflects a change in publication policy. With the recent increase in the reporting of analyses for nonsignificant as well as significant sex-related differences, there would be a decrease in average effect size. However, because the research considered in all of the meta-analysis studies (B. J. Becker & Hedges, 1984; Hyde, 1981; Rosenthal & Rubin, 1982) was published between 1966 and 1974 (Maccoby & Jacklin, 1974), it is less likely that changes in reporting of data would account for the difference than if the studies considered were a more recent sample.

Several specific studies that use comparable samples report smaller sex differences over time. None of them report significance tests for these differences, so they must be treated as descriptive data. Feingold (1988) reported a decrease in the effect size of the male advantage on Preliminary Scholastic Aptitudes Test–Quantitative Subscale (PSAT–M) scores for Grade 11 students from .34 in 1960 to .12 in 1983. However, the effect size for SAT–M scores for both Grade 11 and Grade 12 students has remained constant (around .40) since 1960. It is interesting to note that the PSAT–M norms are based on representative national samples in contrast to the SAT–M norms, which represent a volunteer college-bound sample. Fennema (1980), in comparing a 1960 sample with a 1975 sample, found that the difference between the boys' and girls' scores was smaller in 1975. Fennema and Carpenter (1981) found that although there were no clear patterns for 9- and 13-year-old children, for 17-year-old adolescents, sex-related differences were smaller in a large national sample tested in 1978 than they were in a similar sample tested in 1973.

A similar decrease occurred in the highly select SMPY sample over the same time period. In 1972, 19% of the boys scored higher than the highest scoring girl on the SAT–M. By 1976 this figure was 2%, and in 1979 only one boy scored higher than the highest scoring girl (Fox & Cohn, 1980). This decrease in differences between the highest scoring boys and girls is also shown by comparing the highest scoring individual of each sex. In 1972 the highest boy's score was 790, and the highest girl's score was 600. In 1976 the highest girl's and boy's scores were 610 and 780, respectively. However, by 1979 this gap had narrowed considerably, with the highest scoring girl receiving 760 and the highest scoring boy 790 (Benbow & Stanley, 1980). Group measures of the size of the sex-related difference also tend to decrease. For example, using w^2 for the combined samples for the years 1972, 1976, and 1979 shows values of .08, .05, and .04, respectively. Similarly, the d values for the 1972, 1976, and 1979 samples were .61, .46, and .39, respectively.[1] Benbow and Stanley (1983b) reported data for samples of select junior high students tested with the SAT–M in 1980, 1981, and 1982. The size of the sex-related difference with these samples ($d = .37$ and $w^2 = .034$) is quite similar to that reported for the 1979 sample (Benbow & Stanley, 1980). The Fox and Cohn (1980) figures for percentage of boys scoring higher than the highest scoring girl and the Benbow and Stanley reports of the highest scoring individuals show the most dramatic decrease. This may reflect an increasing willingness on the part of the most gifted girls to participate in these math contests.

Sex-Related Differences: Alternative View

When sex-related differences in mathematics achievement are measured using grades in mathematics classes, the results are opposite to those found using standardized achievement tests. When differences are found, they almost always favor girls, and these differences are quite consistent across samples of varying selectivity for junior high through university mathematics courses.

During the junior high and high school years, the most common finding is that girls achieve significantly better math grades than do boys. This is true for specific courses (Benbow & Stanley, 1982a; Hanna & Sonnenschein, 1985) and for overall mathematics grade point averages (Benbow & Stanley, 1982a; Casserly, 1980; Deboer, 1984; deWolf, 1981; Pallas & Alexander, 1983; Stockard & Wood, 1984). Other studies have found no differences in mathematics grades (Collins, 1985; Parsons, Adler, et al., 1982; K. Peterson, Burton, & Baker, 1984). Either female superiority or no sex-related differences in mathematics grades continues at the university level. Female superiority has been reported both for precalculus courses (Llabre & Suarez, 1985; MacDonald, 1980; Struik & Flexer, 1984) and for overall math grade point averages (Deboer, 1984). For calculus the results are more mixed. Some studies (Ernest, 1976; Struik & Flexer, 1977) report no sex-related differences in elementary calculus courses. Ferrini-Mundy (1987) reported no difference in an overall calculus grade but reported female superiority on one unit requiring high visualization. Boli, Allen, and Payne (1985) found that boys received higher grades than girls in an introductory calculus course. However, when subsamples of students from the course were compared, it was found that boys' and girls' grades did not differ when students were equated on the SAT–M (high or low) or on high school calculus (taken or not taken). In two studies of graduate statistics courses, either no sex-related differences were found in final grades (Woehlke & Leitner, 1980) or women received higher grades (Elmore & Vasu, 1986).

The contrast between sex-related differences in performance on standardized tests and classroom grades is best illustrated with the studies that report both kinds of measures for the same samples. These studies illustrate for specific samples the same pattern that is found in the preceding comparisons among different studies. Using the highly select SMPY sample, Benbow and Stanley (1982a) found a significant sex-related difference favoring boys on the SAT–M taken in both Grade 7 and Grade 12. They also reported significant sex-related differences in high school math grades in favor of girls. Using less select samples, deWolf (1981) and Pallas and Alexander (1983) also reported that girls receive higher grades, whereas boys score higher on standardized mathematics achievement tests.

The size of the sex-related difference favoring girls is difficult to assess, because 53% (9 out of 17) of the studies reporting either no sex-related difference or female superiority in grades do not report sufficient descriptive data to determine effect size. Of those that do, the size of the female advantage ranges from .09 to .35. The male advantage in the one study reporting boys' significantly higher calculus grades was .21. From the available literature it would appear that the size of the female advantage in grades is smaller than that of the male advantage in standardized tests. However, the study of sex-related differences in grades has until this point been very unsystematic, whereas the study of sex-related differences in standardized tests has been highly systematic. Thus the size of the female advantage in math grades cannot be determined with the same degree of accuracy as the size of the male advantage in standardized tests. It may also make a difference how the sex-related differences in grades are calculated. For example, Benbow and Stanley (1982a) reported in the text of their article that the female advantage in grades resulted mainly from the greater tendency of girls to receive A grades.

The chi-square testing of this difference results in a large effect size ($q = .41$). I calculated effect sizes from the tables reported in their study that give an average grade for three cohorts of boys and girls in 10 high school math classes. These 28 effect sizes range from –.10 to .77.[2] The weighted average (Hedges & Becker, 1986) for all 28 comparisons was .09 ($Z = 4.8$, $p < .001$). Calculated in this way, the effect sizes, although consistently favoring girls and significantly different from zero, would be considered small.

Other questions of interest — in particular, the possible variation of effect sizes over dates of publication, age of the sample, or selectivity of the sample — are similarly difficult to determine. Of studies reporting sufficient data to calculate effect sizes, the range of publication dates is 1980–1987, a small time range with no consistent pattern of results. Whether the effect sizes change with age or selectivity of the sample is also difficult to determine from the small sample of studies reporting sufficient data. Some of the largest differences are found with university samples (.35 for college algebra and trigonometry [Struik & Flexer, 1984]; .34 for college algebra [Llabre & Suarez, 1985]). However, these are studies of precalculus courses. The most general finding for calculus is that of no difference (Ernest, 1976, .12; Ferrini-Mundy, 1987; Struik & Flexer, 1977) and the one finding of male superiority is for calculus (.21; Boli et al. 1985). An analysis of the effect sizes for grades reported by Benbow and Stanley (1982a) reveals some support for a relationship between effect size and level of high school mathematics course for a highly talented sample. The effect sizes across all the courses do not form a homogeneous group ($H_T = 41.28$, $p < .05$).[3] However, if the courses are divided into lower level courses (algebra, plane geometry, and trigonometry) and higher level courses (analytical geometry, calculus, probability and statistics, and elementary functions), a clear difference emerges. The average effect sizes for the lower level courses ($x = .05$) and the higher level courses ($x = .19$) are both significantly different from zero (lower, $Z = 2.18$, $p < .02$; higher, $Z = 5.33$, $p < .001$), and they are also significantly different from each other ($H_B = 23.089$, $p < .001$). Furthermore, the effect sizes are homogeneous within each of the subgroups (lower, $H_W = 7.47$, $p > .05$; higher, $H_W = 10.71$, $p > .05$). Thus for these data the girls' advantage in course grades is significantly greater for more advanced courses.

It is difficult from these data to conclude whether effect size increases with age or not. Although the Benbow and Stanley (1982a) data would suggest that it might, one confounding variable is that for more advanced students, especially those in a university, men may have had more math courses than women. Thus if women achieve better grades, it would be relevant to calculate effect sizes not only for the raw scores but also with math background held constant. By systematically examining sex-related differences in classroom achievement, researchers should be able in the future to answer a number of these important questions concerning the variability of effect sizes across ages, types of samples, types of math courses, or differing classroom instructional styles.

Are Girls a More Select Sample?

One possible explanation of girls' higher math grades is that because fewer girls continue in math, they may constitute a more select sample. Logically, if this were true, one would expect girls not only to receive better grades but also to perform better on standardized tests if they had taken the same number of elective math courses. However, as will be shown below, controlling for number of advanced math courses taken does not produce female superiority on standardized math tests (Armstrong, 1981; deWolf, 1981; Ethington & Wolfe, 1984; Fennema & Sherman, 1977; Pallas & Alexander, 1983; Wise, 1985). One would also expect that earlier achievement measures should relate to later mathematics course taking for girls, that is, the brightest girls should take the most courses. Wise (1985) did find that girls taking more math had higher Grade 9 achievement scores. In contrast, other studies have found that girls who continue to take math in high school (Sherman, 1981) or who plan to take advanced math (Stallings, 1985) do not constitute a more select sample on the basis of earlier achievement measures. In addition to this indirect evidence, a number of the studies demonstrating female superiority in grades offer direct evidence that argues against this explanation. In one case, female superiority occurred for Grade 9 algebra grades (Hanna & Sonnenschein, 1985). Because all students at this level are required to take algebra, greater female selectivity could not account for the difference in grades. In studies involving more advanced mathematics, several authors report that girls receive better grades even though there are no sex-related differences on SAT–M scores (Llabre & Suarez, 1985; Struik & Flexer, 1984) for the same sample. Other studies find that female superiority in grades remains after performance on various standardized tests or number of courses taken have been covaried out or controlled for in regression equations (Deboer, 1984; Ferrini-Mundy, 1987; Pallas & Alexander, 1983). Thus the balance of evidence clearly does not support the explanation that female superiority in math grades is due to greater sample selectivity.

Sex-Related Differences in the Classroom

Girls receive their better grades in classroom situations that are less than conducive to their learning math. Although teachers do not play an active role in the generation of stereotypes in their classrooms, they do passively reinforce the different behaviors that boys and girls bring to the classroom (Brophy, 1985; Eccles & Blumenfeld, 1985). Boys receive more of the teacher's attention; teachers interact with boys, particularly high achievement boys, more than with girls, and boys are more active in providing answers, particularly unsolicited answers, than are girls (Brophy, 1985, 1986; Eccles & Blumenfeld, 1985; Fennema & Peterson, 1985; Good, Sikes, & Brophy, 1973).

Although there are very few studies of elementary and secondary school mathematics classes, differential treatment of the sexes appears to increase with age (Brophy, 1985). Beginning with studies of elementary school mathematics classrooms, results are mixed. Leinhardt, Seewald, and Engel (1979) found that Grade 2 girls received less academic contact than boys during math lessons. The authors estimated that over a year, this difference amounted to 6 hours of instruction. Examining a Grade 6 classroom, Leder (1987) found that girls received more engagement and attention time than did boys on product questions and that the reverse was true for process questions. In a study of academic feedback, Dweck and her colleagues (Dweck, Davidson, Nelson, & Enna, 1978) found that Grade 4 and 5 girls received a higher percentage than did boys of negative feedback related to the intellectual aspects of their work. This study examined student-teacher interaction over a range of subjects, and results are not reported separately for mathematics instruction.

Other studies involving elementary and middle school children (Grades 5 to 9) have found very few overall differences in mathematics classrooms either in the way boys and girls were treated or in the way teachers responded to them (Heller & Parsons, 1981; Hudgings, 1985/1986; Parsons, Kaczala, & Meece, 1982). However, when Parsons and her colleagues looked at classrooms in which boys' math expectancies were higher than those of girls and compared these classrooms to those where there was no sex-related difference, interesting results emerged. In classrooms where students' expectancies did not differ, girls interacted more with the teacher than did boys and received more praise. The reverse was true in the classrooms where boys had higher math expectancies than girls. Even more importantly in the classrooms with no differences, high-achievement (as measured by teacher expectancies) boys and girls received more attention and praise than low-achievement students of each sex. However, in the classes with sex-related differences in student expectancies, high-achievement boys and low-achievement girls received the most attention, with high-achievement girls receiving the least (Eccles & Blumenfeld, 1985). Furthermore, in classrooms where boys had higher math expectancies than girls, there was a more competitive atmosphere with greater teacher criticism, more public recitation, and less private teacher-student interaction (Eccles & Blumenfeld, 1985). P. L. Peterson and Fennema (1985) also found results that suggested that a competitive classroom environment was not advantageous for Grade 4 girls' achievement in math.

With older students in high school classes, differences are consistently found. Koehler (1985/1986), in a study of algebra classes, found that boys engaged in or received more of all types of interactions. Stallings (1985) found small but consistent differences in favor of boys. Boys were spoken to more; were called on more (even though the numbers of volunteered answers were equal across the sexes); and received more corrective feedback, social interaction, individual instruction, praise, and encouragement. J. R. Becker (1981) found similar results with another sample of geometry classes. Male students answered open questions, process questions, and call-outs more often than female students, though there were no differences in student-initiated interactions, answers to direct questions, and answers to product questions. Although there was no difference in student-initiated interactions, 63% of the teacher-initiated academic contacts were with boys. In nonacademic contacts, boys also predominated, taking part in 74% of the conversations and 72% of the joking and receiving 61% of the praise and 54% of the discipline. There was also a large sex-related difference in the teachers' use of comments that encouraged or discouraged academic abilities and pursuits. Girls received 30% of the encouraging comments and 84% of the discouraging comments. Furthermore, teachers showed a strong tendency to persist longer with boys than with girls. Boys received 70% of the persistent interactions, and all of the contacts lasting more than 5 minutes were with boys. Clearly, the girls in these geometry classes experienced a different learning environment and one that would not encourage their math achievement. In classroom observations in high schools in Quebec, Mura and her colleagues (Mura et al., 1985) found that in one of the three classrooms studied, the teacher engaged in more nonacademic contact with the boys, particularly in discussions of hockey. In all of the above studies in which both male and female teachers were studied, there were no effects of the sex of the teacher; that is, both male and female teachers gave more attention to boys.

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Girls also do not receive as much information from peers, particularly male peers, in small work groups within math classes. Wilkinson, Lindow, and Chiang (1985) studied Grade 2 and 3 students working in small groups on money and time problems. When there were disagreements about who had the right answer, boys' answers were more likely to prevail than were girls' answers even though there were no sex-related differences on the achievement test over the assigned information. Boys were more likely to make requests to other boys for action or information, whereas girls did not discriminate in their requests. Webb and her colleagues (Webb, 1984; Webb & Kenderski, 1985) found that for high-achievement Grade 8 students, girls were at a significant disadvantage in working on math problems in small mixed-sex groups. In particular, the girls were less likely to receive information and explanations in response to their requests, especially the requests they directed to boys. When the behavior of the students was analyzed according to the balance within the groups (one girl and three boys; two girls and two boys; three girls and one boy), the unbalanced groups were found to provide the least information to girls because of the girls' tendency to direct attention and information disproportionately toward the boy or boys present and to receive disproportionately less help from the boy or boys present.

Girls' experience in the classroom appears from the preceding review to be one of relative deprivation when compared with boys' experience. Given that girls receive better math grades, it would appear that they do so in spite of classroom experiences that might be expected to correlate negatively with their performance. However, it is important to look more closely at possible relationships between what happens in the classroom and students' math achievement. Most of the studies examining teacher-student interaction do not also correlate interaction patterns with math achievement. Dweck et al. (1978), in an experimental study examining the effect of differential feedback on verbal tasks, found that failure feedback similar to that given to boys in the classroom produced different attributions than the failure feedback that girls more typically received. It would be interesting to see if this generalized to a mathematics task. In a more direct test of the relationship between interaction patterns and math performance, P. L. Peterson and Fennema (1985) found that Grade 4 girls' and boys' math achievement was related to classroom variables. In general they concluded that girls' math achievement was positively related to a cooperative atmosphere and negatively related to a competitive one, and boys' high-level math achievement was negatively related to a cooperative classroom atmosphere. Koehler (1985/1986) found no relationship between the differential treatment of the sexes in algebra classrooms and algebra achievement. Reuman (1986) found that within-classroom ability grouping in mathematics was particularly detrimental to the math self-concept of high-ability girls.

In a study of peer-helping behavior, Webb and Kenderski (1985) found that both sexes' math achievement was positively related to receiving explanations and information and negatively related to the failure to receive explanations and information. Furthermore, in Webb's (1984) analysis of small group composition, the only groups in which boys did significantly better than girls were those consisting of three girls and one boy. In these groups the single boy received more explanations and information and was asked more questions than would have been expected by chance.

Overall it appears that when classroom interactions and achievement are studied with the same sample, patterns of interaction are related to math achievement. Sometimes the pattern is similar for both sexes (Webb, 1984; Webb & Kenderski, 1985), whereas in other studies the pattern of relationships is different for girls and boys (P. L. Peterson & Fennema, 1985). More work is needed, particularly in more advanced math courses, that directly relates classroom interaction patterns with achievement on a variety of achievement measures, including classroom exams and standardized tests.

Explanations of Sex-Related Differences in Grades

The female superiority in math grades is often ignored or dismissed in the literature on sex-related differences in mathematics achievement. Usually, math grades are not reported, and if they are, the differences are often downplayed. For example, in discussing the superiority of the SMPY girls' math grades, Benbow and Stanley (1982a) reported that girls receive more As in their coursework. They reported a chi-square of 20.5, $p < .001$, with a large effect size. They went on to say of this difference: "Thus, it was accepted that SMPY girls reported receiving somewhat better grades in their mathematics classes than their male counterparts reported" (p. 604). In contrast, the sex-related difference in Grade 7 and 8 SAT–M scores, which they state revealed on average medium effect sizes, is described as follows: "Thus the sex difference on SAT–M was considered important" (p. 603). A large effect size for grades is reduced to "somewhat better," and a medium effect size for SAT–M scores is "important."

When differences in mathematics grades are reported, they most often go unexplained. If they are explained, it is usually in terms of girls' better behavior in the classroom. Benbow and Stanley (1982a) explained the SMPY girls' better math grades as due to "sex differences favoring girls that have been found in conduct and demeanor in school" (p. 617). The references used to support this assumption are to research with young elementary school children. It is hard to believe that receiving more As in advanced high school mathematics is solely or even primarily due to these highly talented girls' better conduct and demeanor. Several authors propose that girls' greater dependency in the classroom, or their presumed greater reliance on rote learning of mathematics, is responsible for their lesser achievement on standardized tests (Fennema & Peterson, 1985; Ridley & Novak, 1983). Although these authors do not deal directly with girls' better math grades, one might hypothesize that if math grades reflect rote learning more than standardized tests do, such learning patterns might be used to explain women's better math grades. This possibility is discussed in more detail below in the section dealing with explanations of the differing achievement patterns of boys and girls.

Another possible explanation of the sex-related differences in mathematics grades may be differential teacher expectations. If math teachers expect less of their female students than of their male students, then it may be easier for girls to surpass these expectations when their actual performance is equal to or even below that of the boys. This possibility is not likely, given that teachers do not have lower expectations of their female students in their current math classes (Eccles, Adler, & Meece, 1984; Lorenz, 1982; Mura et al., 1985), although they do expect female students to do less well in future math courses (Mura et al., 1985). However, it would be interesting to know how teachers' expectations do relate to grades they give as well as to achievement on standardized tests. Kissane (1986) found that teachers were much less accurate in nominating girls who would do well on the SAT–M than they were in nominating boys who would do well.

Although there is ample evidence of young women's superior math achievement when grades are used to measure achievement, they have not been considered seriously in the literature on mathematics achievement. I am proposing that it is important to begin to take them seriously. Although I am not arguing that grades can or should replace standardized achievement tests, I would urge researchers and educators to consider examining and using grades as well as standardized achievement tests to evaluate knowledge of math. There are a number of reasons why this is important. First, as scientists, we are interested in puzzles. The reversal of sex-related differences using the differing measures is an interesting puzzle, but only if we take young women's superior grades seriously. I have proposed in the following section three possible explanations for the different findings using standardized achievement test and classroom grades. All of these are testable and may reveal different aspects of the process of learning mathematics that are not revealed by a focus on standardized measures only.

Currently, there is very little evidence that examines correlates of classroom measures of achievement. Two studies provide some evidence about the relationship of math grades to other attitudes or performance. Eccles et al. (1984) found that earlier math grades did not predict enrollment plans but did predict actual Grade 12 enrollment for both sexes. Value of math, which was a strong predictor of both enrollment plans and actual enrollment, was significantly related to the previous year's math grade for boys but not for girls. Sherman (1979) examined the reverse relationship, that is, how attitudes and achievement measures in Grade 9 predicted later math grades. She found that Grade 9 achievement measures and confidence predicted grades in Grade 10 geometry classes for girls. For boys, achievement measures and usefulness were predictors. Interestingly, usefulness was negatively correlated with geometry grades. For Grade 11 math grades, there were no predictors. For Grade 12 girls, Grade 9 attitude toward success in math was negatively related to their math grade.

The female superiority in math grades is often ignored or dismissed in the literature on sex-related differences in mathematics achievement. Usually, math grades are not reported, and if they are, the differences are often downplayed.

By systematically examining sex-related differences both in classroom achievement and on standardized exams, researchers will be able to answer a number of important questions that cannot be answered at this time because of the unsystematic inclusion of grades as an achievement measure in the existing literature. These questions include, (a) How do grades compare with standardized tests in predicting later course enrollment and career choices in math and science? (b) How do grades and standardized test performance correlate with or predict attitudes toward math, particularly confidence and attributions? (c) Do sex-related differences in grades differ by student age or content of math classes? Each of these questions should be examined separately by sex.

The second reason for taking sex-related differences in mathematics classroom grades seriously is that grades offer one of the best ways to ensure that boys and girls have comparable prior experience. Because only classroom learning is tested, experiences in other courses or outside the classroom potentially do not influence the results as much as when a standardized test is used. The third reason is a practical one. The information that girls are not at a disadvantage and actually have an advantage in many courses in terms of class grades could be most useful in increasing girls' confidence in their own math abilities. Furthermore, counselors could use this material to encourage individual girls to go on to advanced math courses without fear of lowering their grade point average. If more young women are to enter the scientific professions, they must first take math courses. Doing well in math courses is ultimately more important for scientific career training than is one's score on the SAT–M.

Notes

1. The original data from Benbow and Stanley (1980) were used. Means and standard deviations were combined for the Grade 7 and Grade 8 samples in 1972 and 1976. The formulas for d and w^2 were the same as those used by Hyde (1981) except that the correction factor for d reported by Hedges and Becker (1986) was used.
2. Because the numbers of students in Cohorts 1 and 2 taking elementary functions were so small (seven boys in Cohort 1 and three boys in Cohort 2; six girls in Cohort 1 and two girls in Cohort 2), the three cohorts were combined, and a single effect size was calculated for this course. Computer science was not included as a mathematics course for this analysis.
3. Formulas for all effect size calculations reported here are from Hedges and Becker (1986).

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GRADUATE EDUCATION IN TRANSITION

Introduction

Background

In the last few years, both activity and urgency of reform efforts in mathematics education have increased dramatically. There is widespread agreement that the mathematics education system, from elementary school through graduate school, needs to be greatly improved, and that the changes required to bring about this improvement will not come easily or quickly, but will require a continuing commitment of time and effort. At the school and collegiate levels, the mathematical sciences community has refocused its attention on teaching and the needs of today's students. The Mathematical Sciences Education Board and the CBMS member societies are now working to implement the vision of school mathematics presented in the NCTM *Standards*. Undergraduate mathematics education is the focus of major programs in the National Science Foundation and in many of the mathematics professional societies. At both the school and collegiate levels, there is increasing emphasis on changing the culture and priorities of the mathematical community to promote the importance of teaching.

In contrast to this, no comparable national effort or leadership has emerged as yet in the mathematics graduate education enterprise. Despite an apparent mismatch between the needs of the nation and much of the current practice in graduate programs, relatively little attention has been given to post-baccalaureate education in the mathematical sciences.

The CMBS Conference

In order to promote serious discussion of the issues of graduate education and to move the mathematical sciences community to action, the Conference Board of the Mathematical Sciences organized a three-day conference on "Graduate Education in Transition" held in Washington, DC, May 4–6, 1991. At this meeting, leaders of various segments of the mathematical sciences community were asked two key questions: what are the nation's needs and how can the community best respond?

Twenty-four individuals participated in the conference. Among them were seven current presidents and six former presidents of CBMS member societies....

The participants were formed into three working groups: the Doctoral Group, the Master's Group, and the Professional Development Group, corresponding roughly to the three types of post-baccalaureate education in mathematics. Throughout the working sessions and general discussions, the participants were asked to identify the national needs in post-baccalaureate education in the mathematical sciences and to recommend what actions should be taken, and by whom, to make the graduate education enterprise more responsive to those needs....

The Conference Board of the Mathematical Sciences would like to express our gratitude to the Exxon Education Foundation for their support of this conference.

Discussion of the Issues

Introduction

The amount of national attention now given to educational reform in mathematics is staggering. Can anyone recall an American president addressing a meeting of mathematics educators, as George Bush did recently at the National Summit on Mathematics Assessment?

The report of the Federal Coordinating Council for Science, Education, and Technology (FCCSET) accompanying the President's 1992 budget both deplores the present state of science and mathematics education and proposes objectives and priorities to guide future federal activities. Recommended budget increases run 28% at the precollege level, 14% at the undergraduate level, but only 2% at the graduate level.

Unlike the post-Sputnik reform which was driven by military needs, the present effort is driven by economic concerns. The government sees leadership in science and mathematics as a critical element to regain American competitiveness in the international arena.

Many reports have analyzed aspects of mathematics education and have proposed remedies (see, for example, [1], [2]). Member societies of CBMS have played important parts in writing these reports and translating them into action. The two Boards of the National Research Council (the Mathematical Sciences Education Board and the Board on Mathematical Sciences) have provided both stimulus and coordination for many of these projects. The mathematical community has generally participated with energy and enthusiasm in these studies and plans for action. Indeed, in a speech delivered at the International Congress of Industrial and Applied Mathematics in July 1991, D. Allan Bromley, Assistant to the President for Science and Technology, praised the mathematical community for its leadership in educational reform.

It is not surprising that relatively little is said concerning graduate study in most of these reports since the most pressing needs are clearly in school education and in undergraduate education (see, however, [3], [4], [5]). Now that a concerted effort is being made at these levels, we submit that *without reform in graduate education no lasting change in school or undergraduate education is likely*. Short-term intervention programs in the schools will yield some temporary benefits but the attitudes and skills of school teachers are, in the long run, molded in colleges and universities where these teachers are instructed by the products of our graduate schools. One does not have to subscribe to a domino theory to see that all parts of our educational system are interdependent.

There is also a more direct reason for suggesting changes in graduate education in the mathematical sciences. Although our graduate programs have brought U.S. mathematics to world leadership in research, they have been less successful in preparing students for college teaching and for positions in industry.

What are the features of graduate education in the mathematical sciences that need attention? *The main problem is the mismatch between graduate programs and the existing job market.* The gap is even wider if we take into account potential, unexploited markets. The Ph.D. program in mathematics (the use of the singular is appropriate in view of the considerable similarities among programs), culminating as it does in a research dissertation, is intended principally to prepare students for careers on the faculty of research universities. This narrow focus has led to a very strong community of research mathematicians in the U.S., despite the fact that nearly 80% of Ph.D.'s publish little after receiving their degrees. Most mathematics Ph.D.'s spend their careers in comprehensive universities and colleges, where the mission of the institution and the role of the faculty is much broader than simply producing research. The importance of all the roles of the faculty — research and graduate education, undergraduate education, service to a broad set of client disciplines, community outreach, service to the department, the university, the local community, and the profession — must be recognized and some preparation for these roles should begin in graduate school.

The success of the Ph.D. program in producing a cadre of strong researchers must be balanced against weaknesses in the preparation for college teaching and other careers. There is the cost of unfulfilled obligations and missed opportunities. Programs in mathematics (unlike those in other mathematical sciences such as statistics and operations research) often are held in splendid isolation without stressing, or sometimes even mentioning, connecting strands to other sciences. The emphasis on individual, independent research is often exaggerated; whether in the real world or even in academic research, there is considerable need for teamwork either within or across disciplines.

One unfortunate consequence of the parochialism in graduate mathematics education is that much of industry and business still regards mathematicians with some suspicion. Few industries have career paths for mathematicians; contributions of a mathematical nature are often not recognized as such because they are made by physicists, engineers and computer scientists.

An interesting case in point is given by the list of the ten greatest engineering achievements of the past quarter century as compiled by the National Academy of Engineering: the moon landing, application satellites, microprocessors, computer-aided design and manufacturing, the CAT scan, advanced composite materials, jumbo jets, lasers, fiber-optic communications, and genetically engineered products. Each of these spectacular engineering achievements has a strong mathematical component identifiable (and acknowledged) by engineers but not by the general public.

We also believe that industry does not take full advantage of the potential of mathematics. Although part of the reason lies with the attitude and training of some mathematicians, equally important factors are some shortsighted business practices that have become prevalent in recent years. Policy makers and corporate managers are often so concerned with short-term profit that they do not sufficiently invest in technological development and industrial innovation (see[6]).

In this report we shall make a number of recommendations to departments, scientific organizations, and funding agencies to help bring graduate education in the mathematical sciences closer to the needs of American society. For the past several years, departments of mathematical sciences have faced increasing and more varied responsibilities, often without adequate resources. On some campuses, a favorable climate has made it possible for the faculty to meet the challenges of research, educational reform and service to the institution and community. The time has come for other university administrations, in conjunction with the federal agencies that support mathematics and science, to correct the chronic underfunding of mathematical sciences departments in order that they may achieve the goals and expectations of our society as we move into the twenty-first century.

National Needs

The present demand for Ph.D.'s in the mathematical sciences is generated by several different market segments: university faculty, college faculty, industry and commerce, and government organizations and laboratories. In the five year period 1986–1990, 80% of the new Ph.D.'s in the mathematical sciences employed in the U.S. took academic positions. If the field of statistics is factored out, the percentage climbs to nearly 90% (see [7]). In the existing market, new mathematics Ph.D.'s are employed principally by academic institutions. Although some mathematical scientists move into industry or government after a postdoctoral appointment or junior faculty position, little data are available on this subject. Demographic projections show more faculty retirements in the period 1995–2000 than can be filled by prospective Ph.D.'s at the present rate of production. Although economic strains in many states have caused retrenchment in hiring in 1990 and 1991, many observers expect this to be temporary.

At the Master's level, the market is more difficult to pinpoint. It is clear that the industrial, business, and government share of the market is much more significant here than at the Ph.D. level (see [8], [9]). Two-year colleges and secondary schools are major employers and there is also evidence that much of pre-calculus teaching at colleges and universities is provided by Master's degree faculty.

Recent reports have considered the preparation of prospective teachers in schools [10], [11], in two-year colleges [12], and in four-year colleges [13]. This workshop strongly supports the recommendations in these reports. In particular, we endorse the key principles of the Mathematical Association of America Committee on Preparation for College Teaching [13], namely that doctoral programs should prepare students to meet a wide range of professional responsibilities and should not be limited to specialization in narrow areas, and should give systematic attention to promoting excellence in the teaching of mathematics.

The mathematical sciences have yet to find their proper place in industry. We consider the mathematical sciences as an important, if partially untapped, industrial resource. A recent National Research Council report, *Mathematical Sciences, Technology, and Economic Competitiveness* [14], points out some of the vital contributions that have been made by the mathematical sciences to technology but also challenges the U.S. mathematical community to speed the transfer of new technologies to the production line.

Mathematics as an industrial resource needs both greater acceptance and further development. Graduate programs with an industrially oriented point of view are relatively rare. To paraphrase J. R. Ockendon [15], such programs should instill a professional attitude toward real-world problems. This means that mathematicians must be fully prepared to accept the responsibility of familiarizing themselves with the methodology for analyzing practical problems, whether expounded by chemists, engineers, biologists, or economists. There are a few excellent applied mathematics programs in the U.S. and elsewhere that provide this orientation; they deserve to be publicized and could serve as models (with local variations) for the education of industrial mathematicians. Goals and standards for such programs should be promulgated by professional societies as they have been for teacher preparation.

At the same time, many small and medium size industries have been slow in adopting mathematical modeling and computational mathematics. One reason is the lack of properly trained applied mathematicians with an interest in industrial problems. Another is industrial inertia and perhaps even some residual distaste for mathematics in management. The pressure on near-term corporate profits and the lack of a government industrial policy also have serious consequences for American economic competitiveness. Michael Schrage has pointed out how "mathematics remains a crucial — and misapplied — key to economic edge" [6]. Believing as we do in the potential effectiveness of the mathematical sciences in industry, we must make a concerted effort to demonstrate this to industry. A possible approach is to organize academic-industrial centers on the model of the European Consortium for Mathematics in Industry.

The continued technological and economic health of the U.S. depends on maintaining at least the present supply of graduate-level mathematical scientists. In recent years, half of our Ph.D.'s have been foreign, and most have entered the American job market. This ratio does not seem appropriate for the steady state. American women and minorities, who will be a large fraction of the new entrants in the work force by the year 2000, have traditionally not been attracted in sufficient numbers to careers in the mathematical sciences. No doubt some are merely expressing their free choice, but others may have been kept away for lack of encouragement. We propose a number of remedies: active recruitment, a supportive environment, and a better balance between competitive and collaborative activities in graduate programs. A supportive and nurturing atmosphere, which is helpful to all students, is essential for recruiting and retaining students from underrepresented groups.

In examining present post-baccalaureate education, one cannot help but observe the lack of postdoctoral opportunities in the mathematical sciences as compared to physics or chemistry, for instance. Opportunities for later career development also seem to be minimal. As mathematics expands, so often does its circle of applications. There is a need to respond to individual demand for specific courses and to present advances in mathematics that can be expected to be important in applications. School and college teachers will also profit from "updating" their education, both to keep them intellectually active and to enable them to incorporate new ideas into their teaching.

Design of Graduate Programs

We strongly advocate greater diversity among graduate programs to take advantage of existing and potential career opportunities as described in the previous sections. As pointed out in the Board on Mathematical Sciences report [4], graduate and postdoctoral programs offered by mathematical sciences departments are the key to successful renewal of the profession and reform of mathematics education. There is a need for programs that are sensitive to the needs of individual students and that recognize broad options for different career paths, i.e., the personal mix of research, teaching, outreach, service, and other professional activities that each student chooses.

The first step in designing or reforming a graduate program is a realistic assessment of resources. What are the talents and interests of the faculty? Are there prospects for regional cooperation with industry, business, government, and colleges? Does the university possess strengths in other areas that could lead to interdisciplinary or joint programs? What is the department's track record in recruiting and placing students? What financial support is available for prospective students through teaching assistantships, research assistantships, or internships?

Answering these questions, exploring opportunities, forging links, and enlisting administration support will take faculty energy and dedication, but it is the best way to create a viable program. Even established institutions with a strong record of sending graduates to the faculties of research universities also place other of their graduates at comprehensive universities, four-year colleges, and in industry. We hope to influence them to reexamine their programs and become more aware of the diversity of their mission. For universities whose niche is less secure and for others contemplating new programs, we urge them to strive for individuality and to try to meet some well-defined market needs. After a department has selected its goals, it must design a program that will realistically take into account the potential careers of the students.

For a master's program in industrial mathematics, for example, one would include, in addition to some core mathematics, courses in modeling, in probability and statistics, in computational mathematics, and in optimization. Clinics, seminars in industrial mathematics, case studies, and internships are all possible "practical experiences" that could be part of the program. Such a program could perhaps share some offerings with operations research or statistics programs based in other departments.

A Ph.D. program to prepare for college teaching would stress broadly based scholarship rather than narrowly focused research and would pay careful attention to curricular issues and to the goals of undergraduate education. The relations between the branches of mathematics and between mathematics and other disciplines would be emphasized to enable prospective college teachers to meet a wide range of professional responsibilities.

Values and Attitudes

We must convey to students (and to the public at large) that mathematics is a lively, dynamic, and varied profession that has attracted inquisitive minds since the birth of civilization. It is important that both principal aspects of mathematics be appreciated: its useful, indispensable role in science and technology, and its continuing intellectual fascination over the ages.

Students entering graduate school in the mathematical sciences are presumably already interested in the subject and exhibit some talent for it. The graduate experience should build on these advantages by further stimulating the students' enthusiasm, and by both widening and deepening their mathematical knowledge.

One important issue that always surfaces in reports such as ours in the balance between research and teaching. Some years ago, the scales may have tipped toward research, but they have begun to swing back to a proper appreciation of both aspects of the profession. Advocates of better balance urge that research be interpreted more broadly to include other types of scholarship as well as specialized research [16]. The need for educational reform has also given more importance to collaborative activities, to more stimulating presentation of undergraduate courses, to the inclusion of computation (symbolic, numerical, and graphical), and to emphasis on communication skills. These latter skills are equally important in industry. In [17], Fan Chung of Bellcore makes that point forcefully:

> An industrial researcher interacts with a wide variety of people including engineers, computer scientists, physicists, chemists, and business people. The effectiveness of one's work depends on the ability to convey the power and impact of mathematics as well as its beauty and elegance. It is quite possible to explain mathematics in general terms to non-experts. Even a good colloquium talk involves several different levels of depth. Successful communication not only transfers knowledge and insight helpful to others but also brings up good problems, new directions, and interesting ideas. Of course, not everyone is gifted with good communication skills. However, preparation and work can help make up the difference.
>
> For foreign students, it is particularly important to try as early as possible to gain proficiency in English, both in speaking and writing. Although it is desirable to preserve and cherish one's own ethnic heritage, it is essential to avoid cultural isolation and to thrive in both worlds when planning a career in this country.

Graduate students, both domestic and foreign, are supported in large measure by teaching assistantships. Universities have the clear responsibility to carefully train and supervise all teaching assistants, and, for foreign students, to also make sure that they speak English well and are sufficiently familiar with the sociology of the American classroom. Many of our universities already have such programs in place. But, beyond this — to paraphrase the Mathematical Association of American report [11] — universities should reward teaching assistants and junior faculty who are performing well and should help those who are teaching inadequately. Although university teaching is done largely by the lecture method, alternative approaches encouraging student initiative and collaborative learning are being adopted successfully in many different settings. Such approaches can also be introduced on a limited scale in the graduate curriculum. Graduate students, being more mature and motivated than the average undergraduate, do respond to well-organized lectures presented in a challenging manner. Room can be made, however, for some problem-oriented seminars in which students participate actively and give oral presentations of projects. Working in small groups also has benefits: it develops comradeship among students and prepares them for the team approach encountered in most research groups in industry, government, and even universities.

Recommendations

Mathematical Sciences Departments

- Review existing and prospective graduate programs, taking into account the potential job market, faculty skills, and available resources (including possible connections with other academic departments and with local industry, school districts, and other academic institutions).
- Expose graduate students to some collaborative projects with oral presentations; prepare all students to become effective teachers or communicators of mathematics.
- Elevate Master's programs to professional status with well-defined goals related to specific

market needs. Examples include preparation for teaching in two-year colleges and for industrial employment.

- Provide a supportive learning environment for all students, with the particular goal of encouraging and retaining underrepresented groups.
- Include computational mathematics as a component in all graduate programs.

Universities

- Provide adequate resources to chronically underfunded mathematical sciences departments.
- Establish a climate in which a broad spectrum of contributions by the faculty is recognized and valued. Consider adopting guidelines such as those described in Boyer's *Scholarship Reconsidered.*

Professional Studies

- Establish standards and goals for graduate programs. Develop a list of existing programs with their special features.
- Provide a wide range of opportunities for continuing professional development, occasionally in cooperation with societies in other fields. Include programs relating to new technologies, to new fields of application, and to recent mathematical developments. Provide programs for school teachers, college and university faculty, and for those working in industry and government. Involve regional chapters of professional societies in these efforts.
- Jointly develop and disseminate career information for graduate students. Provide an information service for currently available jobs and potential jobs. Investigate the possibility of a placement office.
- Develop and publicize a list of mathematical contributions in industry and government. Promote the industrial use of mathematics, mathematical models, and computational mathematics. Develop an industrial liaison group to help industry find appropriate specialists for particular problems.
- Organize workshops and conferences that bring together prospective industrial employers and university faculty to discuss industry needs.

Government

- Provide stable funding for Ph.D. students by balancing teaching, fellowship, and research support.
- Expand postdoctoral programs at government laboratories and help to fund postdoctoral programs in industry and academic institutions. Establish postdoctoral programs that combine research with preparation for teaching.

Industry

- Establish internships for mathematics similar to those available in statistics. Expand summer employment programs. Provide appropriate postdoctoral opportunities.
- Cooperate with professional societies and universities to communicate the mathematical needs of the workplace and to develop suitable programs in industrial mathematics.
- Recognize the industrial role of computational and applied mathematics and help establish industrial career paths for mathematical scientists.
- Change managerial attitudes and financial practices to take into account the long-term advantage of industrial innovation and technological development in achieving economic competitiveness.
- Cooperate with academic institutions and professional societies in the continuing professional development of employees.

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The Report of a Conference Sponsored by The Conference Board of the Mathematical Sciences (CBMS)
Reprint permission granted, CBMS.

BRIEF NOTES

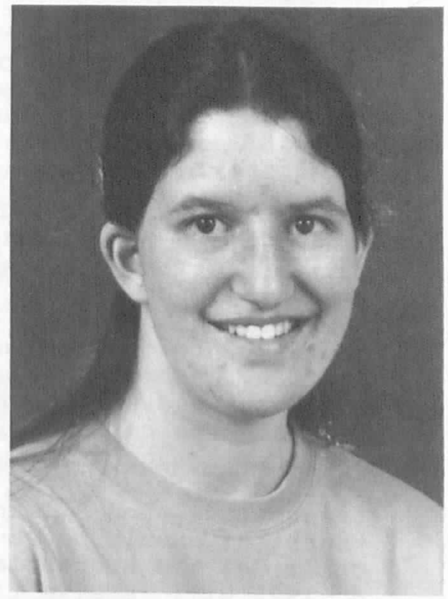
The spring issue of *The Elementary Mathematician*, a COMAP publication, is devoted entirely to kites. The material is geared toward grades three through six, but also includes instructions for adapting the lessons for grades K through two. It includes the history of the kite and several lessons based on ideas which come up while making kites. The issue was written by Nancy Ann Belsky, a mathematics teacher at Westmoreland Elementary School in Westmoreland, NH. She received the NCTM Presidential Award for Excellence in Mathematics Teaching at the state level in 1990 and 1991 and at the national level in 1991. She won the national award for her kite lesson.

The American Woman 1992–93: A Status Report is the fourth in a series of reports prepared periodically by the Women's Research and Education Institute (WREI) to document the status of women in America. It contains four chapters on women in their roles as political players: as candidates, as officeholders, and as voters. More than 200 pages of data present a statistical portrait of American women today. The publisher is W.W. Norton & Company, Inc.; the book is available in both hardcover and softcover versions.

Female-Friendly Science: Applying Women's Studies Methods and Theories to Attract Students by Sue V. Rosser is a 1990 publication of Teachers College Press. A review in *Choice Magazine* said: "Rosser not only accomplishes the task suggested by her subtitle, she also provides a comprehensive overview of the current feminist critiques of science as compared with critiques from African-American, Marxist, and non-Western perspectives. It is a well-written, informed, and authoritative discussion of the content and teaching of science at the college and university level, the critiques of this curriculum and instruction, and the alternative ways of knowing and teaching science.... Since a severe shortage of U.S.-trained scientists is predicted for the mid-1990s, and women and minorities are the most likely source of replenishment, this book is both timely and admirably executed."

SCHAFER PRIZE WINNER AND RUNNER-UP

Zvezdelina E. Stankova



Julie B. Kerr

DEPARTMENT CHAIRS COLLOQUIUM

The 1992 Mathematical Sciences Department Chairs Colloquium will be held in Arlington, Virginia on October 16–17, 1992.

The theme of the 1992 colloquium is "Chairing the Changing Mathematical Sciences Department of the 1990s." The keynote speaker will be D. Allan Bromley, Assistant to the President for Science and Technology. The speakers and panel members at the Colloquium will include chairs of mathematical sciences departments, university administrators who come from the mathematical sciences community, staff from the House Science Subcommittee, representatives of the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET), and representatives of federal research and education programs.

The goal of the Colloquium is to provide department chairs and candidates for appointment as chairs with current information on the changing interaction between research and education in core mathematics, applied mathematics, statistics, and operations research and on the trends in Washington that affect mathematical sciences departments.

For information, contact the Board on Mathematical Sciences, National Research Council, NAS 312, 2101 Constitution Avenue, NW, Washington, DC 20418; phone: (202) 334-2421, FAX: (202) 334-1597, BITNET: bms@nas.bitnet, INTERNET: bms@nas.edu.

Announcement

SEMINAR: MATHEMATICS AND MOLECULAR BIOLOGY III "Computational Approaches to Nucleic Acid Structure and Function", Santa Fe, N.M., November 7-11, 1992. Sessions include" Structural Correlates of RNA Function, Simulations of DNA Structure, Simplified Models of DNA, Computation of DNA Structures, Measures of Molecular Evolution, RNA Conformations, Structural Theory, and Graphics Programs. Limited travel funds available and students have priority. Abstract deadline: September 15th. For information contact: PMMB, 103 Donner Laboratory, Univ. of California, Berkeley, CA 94720. Fax: (510) 642-4071. sylviaj@violet.berkeley.edu

Advertisements

DAVIDSON COLLEGE - DEPT. OF MATHEMATICS, PO Box 1719, Davidson, NC 28036, E-mail: math@apollo.davidson.edu - Applications are invited for an entry level tenure track position in the Mathematics Department beginning August 1993. Completion or near completion of PhD is required. A candidate must be committed to outstanding teaching and continuing scholarly activity. Some computer science background is desirable. Teaching load will average 5.5 courses per year. Davidson is a liberal arts college with a Presbyterian heritage. Applications consisting of a statement of professional aspirations and goals, resume, graduate and undergraduate transcripts, and 3 letters of reference (at least one about teaching) should be sent to the attention of Prof. L.R. King, Chair, at the address above. Applications received by December 4, 1992 will receive first consideration. Davidson College is an Equal Opportunity Employer; women and minorities are encouraged to apply.

MICHIGAN STATE UNIVERSITY - Department of Mathematics. The Department is seeking applicants for several tenure track positions: openings are available at each of the Assistant, Associate, and Full Professor levels. Preferred areas are: "Partial Differential Equations", "Algebraic Geometry", and "Lie Groups, Algebras, and Representations." Strong candidates in other areas will also be seriously considered. Excellence in research and teaching is essential, and two or more years of experience beyond the Ph.D. will generally be expected. Please send a resume and arrange to have three letters of recommendation sent to HIRING COMMITTEE, Department of Mathematics, Michigan State University, East Lansing, MI 48824-1027: e-mail 21144hiring@msu.edu. It would be helpful if resume included (if possible) an electronic address. Applications received by Dec. 1, 1992 will be given more attention. Women and minorities are strongly encouraged to apply. Michigan State University is an affirmative action/equal opportunity employer.

MICHIGAN STATE UNIVERSITY - Department of Mathematics, East Lansing, MI 48824-1027. Professor Richard E. Phillips, Chairperson. One or more Postdoctoral fellowships in Mathematics. The appointment is for two years. Duties include teaching three (3 credit) semester courses each year with the expectation that the fellow will devote remaining time to research. These fellowships are normally offered to persons (regardless of age) who have had their doctorate less than two years. There will be some instructor positions available also. Please send a resume, a brief statement of research interests and arrange to have three letters of recommendation sent to: THE HIRING COMMITTEE, Department of Mathematics, Michigan State University, East Lansing, MI 48824-1027: e-mail 21144HIRING@MSU.EDU. Application deadline, December 1, 1992. MSU is an Affirmative Action/Equal Opportunity Institution.

OFFICE OF NAVAL RESEARCH - RESEARCH MANAGER - PROBABILITY, STATISTICS, SIGNALS ANALYSIS - The Office of Naval Research (ONR) is seeking a qualified individual to plan, manage, and direct a sponsored research program in the fields of probablility, statistics, and signal analysis with particular emphasis on stochastic processes, time series, random fields, spatial processes, spectral analysis, and signal processing. The sponsored research is conducted principally at universities and government or industrial laboratories by leading scientists in the field. This is a Civil Service position at the GM-13/14/15 level ($46,210-$83,502), depending on individual qualifications.

The majority of research is directed to developing fundamental understandings of random signals and noise. This includes, for example, characterization of nonstationary and nonlinear stochastics processes in the spectral domain. The program emphasizes methods based on mathematical statistics and applied probability. Simulation/experiment and other engineering approaches are not preferred.

The incumbant will identify new research opportunities, communicate ONR interests to the scientific community, evaluate and select research proposals for funding, manage available resources, and represent the program within the Navy and DoD. Perhaps the most important aspect of this position is to conceive, develop, and communicate new research ideas to higher Navy management. Thus, this position provides the challenge and opportunity to have a creative and significant impact on the direction and quality of research conducted at the national level. Additionally, the opportunity exists to establish or maintain an individual research program at an academic institution or government laboratory.

Applicants must have one year of specialized experience although a Ph.D. or equivalent in mathematics and/or statistics is preferred. This experience must have been at a level of difficulty and responsibility equivalent to that of the next lower grade level in the Federal Service. A background in the following is also preferred: (1) basic research experience with relevant research publications, (2) management experience in directing/executing research, (3) knowledge of one or more of the following areas: stochastic processes, time series, random fields, spatial processes, spectral analysis, and signal processing, and (4) ability to interact with senior scientific and managerial officials.

Interested persons should submit a resume, a list of publications and a standard Form 171, Application for Federal Employment (available at federal Job Information Centers or from the following address), to: OFFICE OF THE CHIEF OF NAVAL RESEARCH, Civilian Personnel Division, Attn: Announcement #92-12 (AWM), 800 North Quincy Street, Arlington, Virginia 22217-5000.

Applications will be accepted through 8 July, 1992 and must be received by that date. Applicants ar requested to complete the appropriate supplemental forms. for further information and supplemental forms, please call (703) 696-4705 or TDD (telecommunication device for the deaf) (703) 696-2681.

U.S. Citizenship required Equal Opportunity Employer

STATE UNIVERSITY OF NEW YORK AT BUFFALO - The Department of Mathematics anticipates the appointment of several tenured or tenure-track faculty members beginning September 1, 1993. Salary will be competitive. We seek applicants in all areas with excellent research accomplishments/potential and a strong committment to teaching. Applicants should send supporting information, including a c.v. with a list of research interests, and have four letters of recommendation sent to: Search Committee Chairman, Department of Mathematics, SUNY/Buffalo, 106 Diefendorf Hall, Buffalo, New York 14214. The deadline for applications is November 1, 1992. Late applications will be considered until positions are filled. SUNY/Buffalo is an Equal Opportunity/Affirmative Action Employer. We are interested in identifying prospective minority and women candidates. No person, in whatever relationship with the State University of New York at Buffalo shall be subject to discrimination on the basis of age, creed, color, handicap, national origin, race, religion, sex, marital or veteran status.

TEXAS A&M UNIVERSITY - HEAD, DEPARTMENT OF MATHEMATICS - Texas A&M University is a major coeducational institution, serving over 40,000 students, and ranks in the top ten nationally in research funding, number of National Merit Scholars, and value of its permanent endowment. The College of Science has a research and teaching budget of approximately $40,000,000 and comprises the Departments of Biology, Chemistry, Mathematics, Physics, and Statistics and the Cyclotron Institute. The Mathematics Department is large, energetic, and committed to excellence. Its dynamic faculty, representing pure and applied mathematics, is actively involved in research and both graduate and undergraduate education. The position of Head will be filled by a person with an outstanding record of achievement in research and teaching and with demonstrable administrative skills. Effective communication, a talent for management , and ability to provide visionary leadership are especially important. Applications, consisting of a resume and the names of five persons from whom we may request letters of reference, will be accepted until November 1, 1992, or until the position is filled. Women and minorities are expecially encouraged to apply. Texas A&M University is an equal opportunity, affirmative action employer. Respond to: Dr. Jon Pitts, Chair, Mathematics Department Head Search Committee, College of Science, Texas A&M University, College Station, TX 77843-3257, Phone: 409-845-7361, Fax: 409-845-6077, E-Mail: search@math.tamu.edu

THE UNIVERSITY OF THE SOUTH - DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE: Tenure-track position in mathematics, to begin Fall 1993, at a highly selective church-related (Episcopal) liberal arts college of 1100 students located on a 10,000-acre forested domain in the Tennessee uplands. Applicant should have an appreciation for the liberal arts and some interest in computing. Applications from women and minorities are especially encouraged. The position is at the level of assistant professor, with excellence in teaching and continued interest in research expected. A complete application will include a letter stating one's professional aims, a resume, graduate and undergraduate transcripts, and three recommendations. All should be sent to Sherwood F. Ebey, The University of The South, 735 University Avenue, Sewanee, TN 37375-1000. Applications received by November 27 will have first consideration.

Association for Women in Mathematics

Institutional Membership

Date......................19..........

Please fill out this application and return it as soon as possible. Your institution will be updated on our membership list upon receipt of the completed application and payment of member dues or receipt of postal order. See below to determine which membership category you wish to choose. Subscription to the AWM Newsletter is included as part of the membership. Institutional members receive two free advertisements per year. All institutions advertising in the AWM Newsletter are Affirmative Action/Equal Opportunity Employers.

Indicate below how your institution should appear in the AWM Membership List.

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Address change? ____________

Department Telephone Number: ____________________________

Chair: ____
Last name First Middle initial

Telephone number: ____________________________________

Electronic mail address: ________________________________

Membership Categories

Please read below and indicate the category for which you are applying. AWM membership year is October 1 to October 1.

Dues Schedule

Indicate amount enclosed.

______ Sponsoring, Category I (may nominate 10 students for membership): $120

______ Sponsoring, Category II (may nominate 3 students for membership): $80

Please list names and addresses of student nominees on a seperate piece of paper and attach to this form.

Travel Grants for Women

sponsored by
National Science Foundation
&
Association For Women in Mathematics

The objective of the NSF - AWM Travel Grant is to enable women to attend research conferences in their field, thereby providing a valuable opportunity to advance women's research activities, as well as to advance the awareness that women are actively involved in research. If more women attend meetings, we increase the size of the pool from which speakers at subsequent meetings are drawn and thus address the problem of the absence of women speakers at many research conferences.

Travel Grants: The grants will support travel and subsistence to a meeting or a conference in the applicant's field of specialization. A maximum of $1000 for domestic travel and of $2000 for foreign travel will be applied. International travel must be on U. S. carriers.

Eligibility: Applicants must be women holding a doctorate in a field of research supported by the Division of Mathematical Sciences of the NSF (or have equivalent experience). A woman may not be awarded more than one grant in any two-year period and should not have available other sources of funding (except possibly partial institutional support).

Target Dates: There will be three award periods per year, with applications due February 1, May 1, and October 1. Please note the change in dates from previous years. Applicants should send a description of their current research and of how the proposed travel would benefit their program, a curriculum vitae, and a budget to:

Jodi L. Beldotti, Executive Director
Association For Women in Mathematics
Box 178, Wellesley College
Wellesley, MA 02181
(617) 237-7517

NOTE: Please send an original and four copies of your application to AWM.

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Membership categories

Please send the following to determine which membership category you are eligible for, and then indicate below the appropriate category. AWM membership year is October 1 to September 30.

Individual members pay $25 dues. **Family membership:** $40. **Contributing members:** $100. **Students, retired individuals, and unemployed individuals:** $8. Contributions of any size are very welcome.

Dues Schedule

Please indicate amount enclosed.

Individual member	___ $ 25
Family membership	___ $ 40
Contributing member	___ $ 100
Student, retired or unemployed	___ $ 8
Foreign members, other than Canada or Mexico	+ $8 for postage
Prize Fund Add-on	___ $5
General Fund Add-on	___ $10

AWM

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AWM
ASSOCIATION
FOR WOMEN IN
MATHEMATICS

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