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Two Mathematicians Awarded National Medals of Science

Karen K. Uhlenbeck of the University of Texas at Austin and John G. Thompson of the University of Florida at Gainesville are among the winners of the National Medal of Science announced by President Clinton on November 17. The medals were conferred to the awardees at a ceremony on December 1, 2000. The National Medals of Technology were awarded at the same ceremony, which was webcast on the web page of the White House Office of Science and Technology.

The National Medal of Science was established by Congress in 1959 and is administered by the National Science Foundation. It is awarded for contributions to scientific knowledge in various areas. Including this year's recipients, the Medal of Science has been awarded to 386 distinguished scientists and engineers. Besides Thompson and Uhlenbeck, this year's twelve winners include behavioral scientists, biologists, chemists, engineers, and physicists. More information about the National Medal of Science is available on the web at http://www.nsf.gov/nsb/awards/nms/.

The National Medal of Technology was established by Congress in 1980 and is administered by the Department of Commerce. It recognizes "technological innovation and advancement of the nation's global competitiveness, as well as groundbreaking contributions that commercialize a technology, create jobs, improve productivity, or stimulate the nation's growth and development in other ways." Four medals will be awarded this year. More information about the National Medal of Technology can be found at http://www.ta.doc.gov/Medal/.

John Griggs Thompson

John Griggs Thompson is considered one of the foremost group theorists of all time. His name is associated with one of the monumental mathematical achievements of the 20th Century: the classification of all finite simple groups, to which he made a number of crucial contributions. More recently, Thompson has worked on coding theory and on the inverse Galois problem. Thompson has been awarded many prizes for his mathematical work, including the Fields Medal in 1970. He was elected to the National Academy of Sciences in the United States in 1971 and the Royal Society of London in 1979.

Karen K. Uhlenbeck made pioneering contributions to global analysis and gauge theory that resulted in advances in mathematical physics and the theory of partial differential equations. She is considered a founder of geometry based on analytical methods. She received a MacArthur Fellowship in 1983, was elected to the American Academy of Arts and Sciences in 1985, and was elected to the National Academy of Sciences in 1986. In addition to her scientific work, she has also been a leader in encouraging young women to study mathematics. Uhlenbeck is a member of MAA, AMS, and the Association for Women in Mathematics. ■

Karen K. Uhlenbeck
Photo by Marsha Miller

Kirwan Article Considers the Future of Mathematics Departments

William E. Kirwan gave the annual Leitzel Lecture at the Los Angeles Mathfest last August. Those who attended the lecture gave it rave reviews. Several felt that it should be brought to the attention of all MAA members. This month, the *American Mathematical Monthly* will be carrying the full text of the lecture, entitled *Mathematics Departments in the 21st Century: Role, Relevance, and Responsibility*.

In his article, Kirwan considers what opportunities exist for mathematics departments to create their enrollments and their role in the larger agenda of our universities. He argues that this question deserves the serious attention of every mathematics department in the nation.

"For, like a sequence of comets striking the Earth, external and internal factors are combining to alter the environment in which mathematics departments operate. Under these new conditions, we can either meet the fate of the dinosaurs, or we can adopt new strategies and thrive in the coming decades. We need to address the challenges of the new academic environment, we need to adapt in order to survive, and we need to broaden the role and mission of our departments."

The article will appear in the January issue of the *American Mathematical Monthly*. In order to give the article the widest possible distribution, it will also be posted on **MAA Online**, at http://www.maa.org/features/kirwan.html. ■

Coming to a Network Near You: The Mathematical Sciences Digital Library

By Doug Ensley

A year ago, the NSF issued a call for proposals toward an "online network of learning environments and resources for science, mathematics, engineering, and technology education at all levels," namely, a National Science Digital Library. As part of this effort, the MAA was awarded $854,000 last fall to develop the Mathematical Sciences Digital Library (MathDL).

Tina Straley

MAA Executive Director Tina Straley stressed that the award is evidence that the mathematics community has uncommon insight into educational issues and that The Mathematical Sciences Digital Library will be one of the most important projects in the MAA's history. MathDL will enable the MAA to extend its leadership in undergraduate mathematics to the world of electronic communications by providing a central Internet site for resources for teaching undergraduate mathematics. MathDL will have an easily searchable collection of listings of resources available commercially and freeware found on-line. Each entry will be conveniently described, reviewed, and accompanied by a discussion site. The Library will have a scholarly journal devoted to teaching with on-line materials. The end result will be an incredible amount of easily found and useful information for faculty designing courses and searching for materials for student learning. MathDL will be a tremendous resource and a great benefit to the entire mathematics community.

The Principal Investigator of the MathDL grant, Lawrence Moore of Duke University, is no stranger to technology-based learning resources or to the NSF. Dr. Moore, who is perhaps best known in this arena for his work with David Smith on Project CALC (Calculus as a Laboratory Course) and the Duke Connected Curriculum Project, indicated that the first goal of the MathDL project is to "promote the development and use of high quality online interactive learning materials in undergraduate courses in the mathematical sciences." Both the Journal of Online Mathematics and Its Applications (JOMA) and the Digital Library's collection of reviewed online materials will "provide a reliable source of such materials for faculty who want to transform and enrich the learning environments of their students. I believe that MathDL, because of its association with the MAA, will play a major role in setting standards for online materials in the mathematical sciences."

Lawrence Moore

A second valuable resource in the Digital Library will come from the Library of Commercial Products (LCP), a comprehensive listing of commercially available materials for undergraduate courses in the mathematical sciences. Don Albers, who is co-PI on the grant and MAA Director of Publications and Electronic Services, believes this part of the library will change the way faculty design or redesign mathematics courses. "The Library of Commercial Products will be a boon to faculty, publishers, and students," Albers predicts. "To be able to find basic information, including reviews, about all commercially available learning materials in the mathematical sciences in one location will enable faculty to make more informed choices of course materials for their students. The Library of Commercial Products will be the first place that faculty go to when seeking information about available learning materials. Publishers, authors, and software manufacturers are very excited about the opportunity to exhibit their books, videos, software and other learning materials. This new library of the MAA will contribute in significant ways to improving learning in the mathematical sciences."

Another reason for the excitement surrounding MathDL comes from the MAA's partner in the endeavor, The Math Forum. Moore notes that The Math Forum was the "obvious choice to develop the software and host the MathDL site. The Math Forum has proven that they can develop a site of this complexity, and they have wide recognition within the mathematical community." In addition, Frank Wattenberg who recently became Director of The Math Forum, has been an advocate of the digital library project from his days at the NSF, and he is now in a unique position to lead the development of the tools to implement it.

Announcing JOMA Volume 1, Issue 1

David Smith

The Journal of Online Mathematics and its Applications (JOMA) serves a very real need in the mathematics community, according to MAA Director of Publications and Electronic Services, Don Albers. JOMA is a "grand addition to the MAA's family of journals," asserts Albers. JOMA is a key component of the MAA's extension into the new high technology millennium and a "wonderful continuation of the MAA's mission to advance the mathematical sciences in our colleges and universities. The standards for contributions will, of course, be at the high levels that members have come to expect from all of our journals."

JOMA differs from other MAA journals in its electronic format and in its immediate applicability to the readers' classrooms. Albers claims that JOMA is "one

of the most exciting developments in the history of scholarly publishing." JOMA's first editor is David Smith of Duke University, a longtime advocate of the use of technology in the teaching and learning of mathematics. Smith contends that JOMA addresses the goals of the MAA: "Through publication of active learning materials that students can use online or offline the relevant student interests are addressed indirectly. And through participation in MathDL, JOMA plays a role in influencing public perceptions of mathematics, thereby having an indirect influence on policy as well."

JOMA publishes research articles on student learning via technology-rich environments, innovative class-tested web-based learning materials, articles on the design and use of online material, surveys and reviews of existing online material, and high quality mathlets. Mathlets are essentially self-contained dynamic, single-purpose learning tools, the term for which is derived from ìmathematical applet. Gene Klotz, founder of The Math Forum, explains the history of mathlets as follows:

"I had become delighted with some applets I'd seen but was frustrated by finding too many available when you tried any search engine, together with the low general quality of what you found. I thought that developing an applet section of JOMA would be quite worthwhile. Frank Wattenberg gave a talk at an MAA section meeting at Villanova in the spring of 1998 and we chatted a bit about my idea, which he warmly endorsed. Consequently, I got together a group of interested folks to help figure out how to provide good things for teachers and students, while also providing needed support for developers."


Tom Roby

The Mathlets Section, edited by Tom Roby of California State University, Hayward, will be a prominent feature of JOMA. In fact, the first issue of JOMA is primarily devoted to these technological gems. The review process for these applets was one of the many things that had to be created specifically for this innovative publication. According to Roby, "We are looking for small interactive tools that are useful in teaching. They could be ones students would use on their own, or in a lab situation, or that an instructor might use for a classroom demonstration. We do not restrict our attention to applets written in Java, but expect that any mathlet we publish can be used without the user paying for any specialized software."

Roby provides this preview of the mathlets to be featured in the first issue of JOMA:

"The mathlets cover a wide range of topics. One gives animations of the terms of a sequence of functions. Another computes the center of mass of a region (of uniform density) bounded by two functions and plots both region and centroid. A third acts as a graphing calculator, displaying user-defined functions on graphs that may be panned, zoomed, and recentered. Others compute and display Riemann sums for functions. On the differential equations end, there is one that uses Mathematica to determine the type of an ODE and another that simulates a predator-prey system of foxes and rabbits over time."

Roby's involvement in the project is an outgrowth of a long term interest in visualization of mathematics, both in mathematics teaching and research. "When the opportunity to become part of the JOMA team came along," Roby said, "I jumped at the chance to learn more about what other people were doing."

Jerry Porter of the University of Pennsylvania has been one of the main forces behind the establishment of JOMA. "The main advantage of this online journal is the fact that it will be refereed," said Porter. "This will provide a level of quality assurance that is not currently present on the web. In addition, the authors will be able to receive acknowledgment of publication for their materials in a manner that is currently impossible." A major motivation for the new journal is the dissemination of high quality technology based material. Moore and Smith's work on the Duke Connected Curriculum Project impressed upon them the potential of online materials for "creating a much richer and more exciting learning environment for all students."


Jerry Porter

Porter had a similar experience. When faced with dissemination issues with the NSF funded Middle Atlantic Consortium for Mathematics and Its Applications Throughout the Curriculum, Porter realized that a new approach was needed for the shorter modules and exercises that could not be effectively shared through the traditional publication model. Porter remembers, "With this realization, in January 2000 we convened a broader group including David Smith and Lang Moore of the Connected Curriculum Project, Gene Klotz of the Applet Project, myself, Don Albers of the MAA and the PIs on several other projects who eventually may participate in JOMA. The timing, it turned out was fortuitous. The NSF was seeking proposals for digital library projects and the JOMA group became the core for the MAA project under Lang Moore's leadership. The rest, as they say, is history."

JOMA Volume 1, Issue 1 is due to be released later this winter. That issue will contain information about submission and review criteria for articles, modules and mathlets. The announcement will be displayed on MAA Online, or you can find the journal directly at joma.org. ■

Doug Ensley teaches at Shippensburg University in Pennsylvania where he advocates those uses of technology that advance student learning. He has been a Visiting Mathematician at the MAA during the formative months of MathDL. His e-mail address is densley@maa.org.

In Focus:
Preparing Future Mathematics Faculty

Annika Haglund, a graduate student in the Arizona PFMF program 1999–2000, teaches calculus at Scottsdale Community College.

What should mathematics departments be doing to prepare their graduate students for their future role as mathematics faculty? A program entitled "Reshaping the Preparation of Future Science and Mathematics Faculty," sponsored by the American Mathematical Society and the Mathematical Association of America and funded by the National Science Foundation, is seeking to develop answers to this question. Four US mathematics departments (Arizona State, SUNY Binghamton, Virginia Tech and University of Washington) received funding beginning in 1999–2000. Each department works with a cluster of partner departments at nearby colleges and universities. The objective is to provide graduate students direct experience of faculty work in different kinds of post-secondary institutions. The year-long program typically has two stages: a semester long exploratory phase, characterized by campus visits, lectures and panel discussions, followed by a participatory semester where students do projects representative of faculty work at the partner campuses. The four articles that follow are reports, from a variety of points of view, on two of the PFF programs. ■

PFMF at Arizona State University

By Dieter Armbruster

The Department of Mathematics at Arizona State University is one of four US math departments to receive 1999–2001 funding under the program "Reshaping the Preparation of Future Science and Mathematics Faculty". The program at ASU is known as "Preparing Future Mathematics Faculty" (PFMF). It cooperates with ASU's university-wide "Preparing Future Faculty" (PFF) program through joint campus visits and some workshops.

The Arizona PFMF group for the academic year 2000–2001.

We finished our first year in the summer of 2000. Five students participated for the whole year and got an excellent overview of faculty roles in a Research I University (ASU), a Community College (Scottsdale Community College), a private Liberal Arts College (Grand Canyon University) and a Comprehensive University (ASU West). They experienced the challenges of running a summer Research Experience for Undergraduates (REU) program at Northern Arizona University and were introduced to the issues facing Minorities in Mathematics through the Institute for Strengthening Understanding of Mathematics and Science at ASU (SUMS Institute).

Since the ASU Math Department has a thorough ongoing TA training program, the Research I University component of the PFMF project could afford to de-emphasize teaching issues and instead focus on professional issues. These included the job search (application, CV and portfolio development, hiring and mock interview), professional Masters degree developments, and grant writing. The workshop on research funding and grant writing included an assignment to write a proposal related to the student's current situation. As a result, two of the students received support to attend a conference and another one secured a summer internship. Another outstanding participa-

tory project was Tim Lant's attempt to develop a new course with the intent of replacing the mathematics requirement for first-year business students. His report on what happened illustrates the issues that young and enthusiastic faculty members need to be aware of when they take on the task of reforming large service courses. Specifically, it is important to take into account the history of the discussion and the fact that many different groups who have a stake in the teaching outcomes of such a course will apply different measures of success. Both of these are crucial in "selling" a new course.

In general, the participants in the program had very good things to say about it. Some of their reports and feedback can be found on our website at http://math.la.asu.edu/grad/pff.html. As a result the program has grown and we started the second year with seven students. The challenge for the coming year is to institutionalize the program beyond the lifetime of the current grant. ■

Dieter Armbruster is Professor of Mathematics at Arizona State University. He is the PI of the NSF grant to ASU that funds the Preparing Future Mathematics Faculty Program.

The Business of Mathematics: A New Course

By Timothy W. Lant

While a second year graduate student at Arizona State University, I asked to develop a new course with the intent of replacing the standard mathematics requirement for first-year business students. Currently, the required course is a standard "Brief Calculus." I spoke with several faculty and administrators, and their responses were varied. Some told me that they read my proposal and were interested. Others told me they would prefer to avoid involvement with politics. A couple, perhaps my true friends, reminded me that I am a graduate student and should focus on coursework, exams, and research. They all acknowledged that Brief Calculus may not be the best mathematics course for business students, but that it serves well to "weed out" students from the business program.

I hold degrees in both Mathematics and the Actuarial Sciences. I have also served in industry positions as an actuary and an investment banker, two positions for which I would classify the primary responsibility as being the application of mathematics to business situations. Mathematics in the business world begins with data that is inherently reported in discrete time, not the continuous-time setting of calculus. Compound interest and discrete probabilities make up the theoretical foundations, while quantitative reasoning and modeling with spreadsheets are equally important. In this setting, a student or professional must take actual data, make future sales projections, optimize production parameters, estimate cash-flow and its value, and make risk-based adjustments to determine monetary value. The end result should be a coherent quantitative model that answers questions about many factors in a typical "business question" rather than arriving at a single answer I proposed to build a course around this process.

Although some of the mathematical theory necessary to perform "business math" is presented in most first-year business math courses, it is presented in a fragmented and incomprehensible way that does not allow for students to put the mathematical pieces together. The truth is that they cannot apply what they learn beyond problems in a math book. The "theorem-proof" methodology that many of us consider to be our bread and butter is, simply put, not appropriate for teaching first-year students to think quantitatively. Instead, it pushes them away from ever attempting to do any calculations, because they are difficult. Consider how many people have a tax expert prepare their taxes each year. Any business math student should be capable of filling out these most basic of "business math" forms. Instead, we leave this type of problem solving to upper division accounting classes.

My proposal would have been dismissed out of hand if it were not for the Preparing Future Mathematics Faculty pilot program at Arizona State University. The objective of the program is to remove the shroud from the mysteries of tenure, research, service, funding, and other nuances of academic life. Additionally, and more importantly, it provides graduate students with a venue to engage in exactly this type of work and then report our experiences. What I now bring to the discussion table are the experiences of a young, and perhaps naive, teacher working within a major research university to create a better curriculum.

There is a bit of irony in the observation that a course of this nature must be "sold" to three distinct groups of people: the Department of Mathematics, the College of Business, and the students. Each group presents different challenges. Ideally, the mathematics department strives for valuable and practical mathematics taught in an effective way. The ideal College of Business would like prepared students with a strong quantitative background with underpinnings in mathematical theory. Students ideally strive to learn for the sake of learning and to obtain the best tools for a future career. Unfortunately, and somewhat obviously, it doesn't actually happen this way.

My first taste of rejection came from the Director of Undergraduate Mathematics. The verdict was that compound interest and probability are already taught in the university's Finite Mathematics course, so there is no purpose or reason to introduce a new course covering these topics again. Furthermore, the College of Business uses student performance in Brief Calculus as a key indicator of success in the university's business school. The conversation was closed. There were other conversations, but they all ended the same way. What I ended up with was an offer from the department chair to teach the class as an elective.

In hindsight, I see that I made several er-

A New Course continued on page 8

rors in "selling" the course. My proposal was not different enough from the standard syllabus to warrant a new course. I placed the merit of my ideas directly in competition with the established Business Calculus course, calling into question the work the Mathematics Department and the Business College had already accomplished when they put this course into place. In short, I ignored the politics. My proposal was viewed as that of a naive graduate student walking into the middle of a discussion that was already far advanced. It was therefore dismissed summarily with a few token gestures of interest.

What I have learned above everything else is that it takes time for changes to be made to the curriculum. These changes come slowly, not necessarily because of opposition, but because of the inability of a university to modify its operations quickly, mostly due to the large volume of students that pass through the system. Change is difficult, and the time requirements make the effort of developing and teaching new courses a large career risk. This is true even when the proposal contains very good and potentially successful ideas.

On the other hand, there are cracks in the system that can easily be exploited. There is definitely opportunity to teach experimental classes. The results may not be perfect, of course. In my case, I was offered the opportunity to teach a class that very few, if any, students would want to take. Nonetheless, it still seems that the best way to demonstrate the merit of ideas is to test them.

Unfortunately I have no real conclusions on this issue. As a mathematician, I hope to be able to contribute my expertise and knowledge, as well as my love for mathematics, to the massive sea of knowledge already present. As a teacher I have learned that this type of effort is not possible without a lot of support from other individuals. Rallying the support necessary is a very big task. Nonetheless, I do believe that good ideas will spread if we share them. ■

Timothy W. Lant was a participant in the Arizona State University PFMF program in 1999–2000.

PFF: Building Your Future While a Graduate Student

By *Joseph Evan, Friedrich Kluempen, and Denise Reboli*

The Department of Mathematical Sciences at the State University of New York at Binghamton has recently established a Preparing Future Faculty (PFF) program in order to help graduate students prepare for careers in academia. Each of the authors served as graduate student coordinator for such a program at SUNY-Binghamton. As a result, we probably received more "P" for "FF" than anyone. Here we will limit our discussion to the benefits that any graduate student conscientiously participating in PFF (such graduate students are called PFF fellows) should be able to reap.

The Binghamton program has four major components: mentoring, undergraduate talks, seminars and workshops, and attendance at professional meetings.

The mentoring component provides an opportunity for frank discussions about teaching with an experienced professor. Each fellow is paired with a faculty member from SUNY-Binghamton. The mentor attends a few of the PFF fellow's classes, and then they discuss the fellow's strengths and weaknesses in teaching. They may also talk about a variety of issues that arise in the classroom. After these discussions, the PFF fellow finds it easier to write the philosophy of teaching statement needed for job applications. The mentor may also be in a position to write a letter of recommendation for the fellow that addresses teaching. The mentoring experience also prepares the fellow for future performance reviews by the chair and the dean.

Visits to partner institutions are some of the most enjoyable PFF events. Broome Community College, Ithaca College, King's College, and SUNY-Oneonta join SUNY-Binghamton as partners in the PFF program. Each semester, every partner institution invites a PFF fellow to give a talk for undergraduates. This gives the fellow experience developing and fine-tuning a talk at the undergraduate level. This talk may later be used during the interviewing process. The visit also provides an excellent opportunity to learn about the culture of other departments. Discussion with the partner school faculty allows the student to learn of the expectations of new faculty at different types of institutions. Often these visits give PFF fellows a better idea of the type of school in which they would like to work.

Of course, being a faculty member involves more than teaching. Seminars and workshops, which are often presented by faculty from partner institutions, attempt to address issues that are faced both in and out of the classroom. Weekly "issues seminars" give new graduate students advice on day-to-day teaching matters. On the other hand, professional seminars provide insight into the concerns of faculty members. We have had presentations concerning expectations of research, service responsibilities, and the tenure process. Additionally, workshops provide hands-on experience. For example, last spring, two three-hour Saturday morning workshops explored the use of technology in the classroom.

Attendance at professional meetings is another major component of the program. Obviously, this provides an opportunity for PFF fellows to network with active members of a profession that they wish to join, and this is beneficial in the job search. Even more, professional meetings usually come with a variety of talks and presentations that address issues facing faculty members. When PFF fellows reach the promised land of a new job, they may very well be immediately faced with new course preparations. At professional meetings, fellows might attend presentations that provide ideas about how to approach these courses, making it easier to positively adjust to the new job. Such experiences would hopefully continue throughout the fellows' careers.

The Preparing Future Faculty program allows fellows to begin to establish their careers while they are graduate students.

First, they can improve their teaching and presentation skills during graduate school. Additionally, there is obviously a pragmatic advantage when it is time to look for a job. Yet PFF is perhaps most important because it enables a young faculty member to almost immediately make a positive contribution to the profession.

Joseph Evan and Denise Reboli were graduate student coordinators of the SUNY Binghamton PFF program and are now faculty members at King's College. Friedrich Kluempen is the current graduate student coordinator of the program.

Preparing Future Faculty: The Partner Institution's Role

By Denise M. Reboli

Preparing Future Faculty (PFF) is a program for graduate students designed to introduce and prepare them to be faculty members in various types of educational institutions. Each PFF program involves a graduate program and four other partner institutions, chosen to give the graduate students an opportunity to explore various types of institutions. Our cluster, centered around SUNY-Binghamton, includes King's College, Ithaca College, Broome Community College, and SUNY-Oneonta. While every program is different, each tries to prepare its students to be contributing faculty members wherever they teach.

Our PFF program has many activities designed to help each graduate student explore his/her role as a teacher of mathematics. These include a speaker series for undergraduates, a mentoring program, professional seminars, workshops, and attendance at professional meetings. The graduate students decide which and how many of these activities they would like to take part in.

While this program is focused on the graduate students, there can be numerous benefits for the faculty and students of partner institutions. At King's, this was one of our main reasons for getting involved. One of our main activities has been the speaker program. Each semester, a graduate student presents a talk on some facet of mathematics, often in an area that is not covered in a traditional curriculum. The topics presented often mesh in interesting ways with the material I develop in class. Seeing other applications of ideas from their courses gives my students a better perception of why they are important. Our mathematics club hosts the talk. They review a list of abstracts of possible talks and request the speaker. The club also provides refreshments and helps to recruit other students to build an audience. After the talk, an informal gathering gives the graduate students a chance to talk to our students about life at a liberal arts college and the courses they are taking. Similarly, the undergraduates have an opportunity to explore graduate school by talking with people who are living that experience. Afterwards, the faculty of the partner institution joins the visitors for a meal where we discuss what it means to be a faculty member at our institution. These discussions are important to me as a faculty member at a partner school because I have been able to stay in touch with the trends in graduate education. This helps me advise students who are considering graduate school.

Additionally, the program creates professional development opportunities for the partner faculty. We have been speakers at the professional seminars and workshops for the graduate students, highlighting innovations in our classrooms. Last year we discussed technology in the classroom. While SUNY-Binghamton does not currently use graphing calculators or computers in their undergraduate math classes, our workshops introduced the graduate students and faculty to different packages and showed how they can be used effectively in the classroom. Being a part of PFF also builds contact with mathematicians at neighboring schools, allowing each department to learn about the other departments' curricula and giving us the opportunity to connect with researchers in our own fields.

The professional seminars cover many of the issues that the graduate students will deal with in the near future. Topics have ranged from the job search to academic honesty, from developmental mathematics, to general advice to young faculty. There are additional opportunities to discuss topics such as service, advising, and the great juggling act.

PFF benefits everyone involved. The experience is constructed for the benefit of the graduate students; however, the undergraduates involved have seen new applications of mathematics and have started to think of their own careers. Perhaps the most valuable piece of the program for all involved is the opportunity to be part of a group that is concerned with the future of the teaching profession. More information on our cluster's activities can be found on the web: see http://www.math.binghamton.edu/pff/index.html. For information on starting your own PFF program, see http://www.preparing-faculty.org/. ■

Denise M. Reboli teaches at King's College in Wilkes-Barre, PA, one of the partner institutions in the PFF program at SUNY-Binghamton.

Bumps in the Road from School to College Mathematics

By Bernard L. Madison[1]

The road through school and college mathematics was once well marked, smooth, and without forks. There was essentially one sequence of courses in school and college and methods of instruction varied little. Now, things are different.

Over the past decade, school mathematics has changed, both what students learn and how they learn it, in large measure due to the NCTM Standards[2]. College mathematics has become much more diverse, partly because of reform movements, and partly because of the creation of many new curricular options. As a result, the road that was once clear and smooth has become bumpy, especially at the point of transition from school to college.

In October 1999, MAA President Tom Banchoff appointed a *Task Force on Articulation* to advise the MAA on courses of action the Association can follow to resolve some of the issues in the various mathematical transitions, especially that from school to college. This article provides some of the flavor of the recently-completed report of the Task Force, as well as reports on other activities important to the collegiate mathematics community.

The principal cause of the transition problems in US mathematics education has been described as the lack of an intellectually coherent vision of mathematics among the professionals responsible for mathematics education. The sometimes heated and often public disagreements about the nature of mathematics as well as effective ways to teach it have led to a bewildering variety of curricular and pedagogical approaches.

There is certainly extensive variety. The NCTM Standards provide guidance for school mathematics, and, if that guidance prevails, school mathematics will become more uniform from grade to grade and from school to school. In comparison, collegiate mathematics is anarchical, with individual departments and faculty having considerable independence. These differences matter, since college graduates teach in schools and school graduates enroll in colleges. Most of the recent discussions of articulation have been on the latter transition, students from school to college, but the other transition, teachers from colleges to schools, also needs to be easier to understand and smoother. Repairing the potholes in one direction should give guidance for repairing them in the other.

There are also problems in transition from two-year to four-year colleges. These are more likely to hinge on transfer credit, but there can be differences in curricula and pedagogy. Two-year college mathematics probably has more uniformity than is found in four-year colleges, perhaps due in part to the AMATYC[3] Standards for college mathematics before calculus. Also, preserving transferability of credit tends to curb variety.

Many college mathematics faculty members disagree with parts of the NCTM Standards and AMATYC Standards. One point of disagreement is on the use of technology. The NCTM Standards place a major emphasis on using technology, to the point of making it one of six principles. AMATYC lists Teaching with Technology as the first of five standards for pedagogy. The use or non-use of calculators in mathematics courses can be a major bump in the transition from school to college. Anecdotes abound about required calculator usage in school and banned calculator usage on college placement tests or in college courses. Advanced Placement (AP) calculus requires graphing calculators and allows some models with computer algebra systems, but many college calculus courses do not use any technology; some simply ban all calculators and computers. Because of this variation in college calculus courses, the AP calculus examination is split: approximately half with calculators and half without. Maybe AP calculus is more challenging because of its calculator and non-calculator approaches, but could it be better with both feet in one of the two worlds?

Anecdotes also abound about entering college students lacking basic algebraic manipulation skills. Furthermore, these students may have learned in high school in a variety of modes – team projects; independent study; explore, conjecture and test; model building, or computer simulation – while their college classroom is a traditional lecture setting.

College mathematics placement tests are the focus of much strong criticism – mainly because technology is often banned and the test content is different from much of school mathematics. Many dispute the validity of assessment by tests that focus on traditional algebraic skills while the students have studied a broader array of mathematical subject matter – including probability, data analysis, and finite mathematics – using the calculator as a problem-solving tool.

Many college faculty members remember more demands on their algebraic skills, and identify lack of such skills as a weakness. Hart's *College Algebra* (1938) textbook was more demanding than more recent textbooks, but Chrystal's *Algebra* (1889) was remembered fondly as a higher standard in the heyday of Hart. Passions are strong on the various sides of this issue, and no resolution is in sight.

Some variety—in both curricula and pedagogy—is desirable. Certainly, we have developed different curricular routes for students aiming at different goals. Further, some argue that students become better learners when exposed to different learning environments and pedagogical approaches. Bumps in the road may make better drivers as long as the wheels stay on.

[1] The author was Chair of the MAA Task Force on Articulation

[2] *Principles and Standards for School Mathematics*, National Council of Teachers of Mathematics, 2000.

[3] *Crossroads in Mathematics*, American Mathematical Association of Two-Year Colleges, 1995.

Uniformity can stifle experimentation and improvements, even prohibit them. Indeed, articulation agreements for large systems of institutions can preclude innovations and make changes of any sort difficult. Changes in curricula will be necessary, and articulation agreements need to address how changes can be made and coordinated throughout the affected system.

Lack of definition complicates the transition from school to college. Where does it begin and where does it end? If there is good articulation the answer matters little. If there is not, then it matters more. There is extensive teaching of courses for college credit in schools and–on the flip side–teaching of school courses in college, some for credit and some for remediation. This cross teaching is growing, certainly in the schools. AP has been growing by about 10% per year for the past twenty years, and if the goal[4] of AP-in-every-school is realized, AP will double or triple in the next ten years, perhaps reaching three million students each year. AP now offers thirty-two course descriptions and national examinations, including statistics, and computer science, and two in calculus (AB and BC). Participation in AP statistics, first offered in 1997, has grown very rapidly, reaching 34,118 examinations in 2000. Students who participate in AP courses in school are the strongest cohort of potential college students, so a smooth college-entry road for these students will be doubly important.

Concurrent enrollment has been expanding by leaps and bounds. The expansion is fueled by a relatively recent concurrent enrollment model typified by this scenario: A two-year college enters into an agreement with a high school to give college credit to school students for specified courses taken in the school for school credit. Agreements of this type have been made for college credit in most disciplines. In mathematics credit is being awarded in courses from beginning algebra up through calculus. These agreements are generating considerable college credit in courses taught in high schools by high school teachers, and most concurrent enrollment programs have nothing like the AP examinations to validate the credit. Standards for this practice are needed, lest we push the line between college and school mathematics well below what it should be.

During the year the Task Force on Articulation worked, several other activities related to articulation were in process.

• The Mathematical Sciences Education Board (MSEB) at the National Research Council (NRC) sponsored a workshop on articulation, held in February 2000. In addition to MSEB members and staff, representatives of MAA, AMATYC, NCTM, AMS, and other organizations with interests in articulation helped plan and execute the workshop.

• The College Board, under new leadership, became much more aggressive and has expanded its role in the school to college transition. The Board's Commission on the Future of the Advanced Placement (AP) Program finished its deliberations and will issue its final report, *Access to Excellence*, early in 2001.

• The NRC Committee[5] on Programs for Advanced Study of Mathematics and Science in American High Schools is studying high school courses that carry college credit, namely AP, International Baccalaureate, and concurrent enrollment courses.

• Bob Orrill, Executive Director of the National Council on Education and the Disciplines, is directing a project to address the following three questions: (1) What mathematical experiences are most valuable to students in the early years of college? (2) Does the judgement of mathematicians about what is most essential argue for modification of the traditional calculus-driven curriculum? (3) How do we construct a learning continuum that would resolve the problems in the school-college transition?

• The MAA appointed a Task Force on the First College Mathematics Course, which at this point appears to be interpreted as a version of college algebra.

• The Pew Trust has funded a study of concurrent enrollment in US schools and colleges. The report should be available early in 2001.

Several examples of programs that smooth the transition from school to college were described to the Articulation Task Force. Some of these were statewide articulation agreements, and some were university-based efforts.

The Ohio Early Mathematics Testing Program was created at Ohio State University by Bert Waits in 1978. The program has now become a statewide program, and more than a half-dozen other states have initiated similar programs. Basically, the program provides college placement tests for high school sophomores and juniors and gives them advice on what mathematics to take based on their projected college placement. The program provides strong communication between colleges and schools, elucidating standards and expectations in both directions.

The Indiana University-Bloomington mathematics placement test has not changed for fifteen years, but careful monitoring of the results of placing students using this test has led to a very effective placement process.

These examples smooth the transition from school to college – repairing some of the potholes. Evidently, more roadwork is needed. The report of the Articulation Task Force suggested ways the MAA might proceed with some of this work. Evidently, to be successful, we need better consensus on an intellectually coherent vision of mathematics education. Our differing views of what mathematics should be taught and how it should be taught can cause more bumps for our students and perhaps even wash out a bridge or two. ■

[4] This goal was stated by Secretary of Education Richard Riley and was subsequently adopted by the College Board.
[5] The Co-chairs of this committee are Philip Curtis (Emeritus Professor of Mathematics, UCLA) and Jerry Golub, (Professor of Physics, Haverford College).

Organizing an Undergraduate Math Conference

By David Finn and Tanya Leise

We are the organizers of this year's (18th annual) Rose-Human Undergraduate Math Conference. The conference will take place on March 16th and 17th, 2001, but like most conferences its success depends on the preparations leading up to the conference. This is the subject of our story. Given the growing interest in undergraduate research and undergraduate conferences, we hope our insights and experiences will be helpful to others.

Student speakers at the big book giveaway.

Our work as this year's organizers began immediately following the previous conference. The organizers for our department-sponsored conference are usually volunteers. Typically one is an experienced organizer and the other is new to the task. The first event in the organizational process is a wrap-up meeting with the previous set of organizers and the department's office manager, during which the torch is passed and changes are suggested based on the previous conference. By this meeting or soon after, most of the work of organizing and arranging the facilities will be done. This efficiency is a result of years of organizing the conference. Some of the work is now routine, requiring just notification to the affected parties.

The main work for the organizers is to invite the speakers, maintain documentation (the conference website) and troubleshoot as the conference nears, since problems inevitably arise as events proceed. To aid the organizers and provide some guidelines, the department has developed a "tickler" sheet that is supposed to tickle the little gray cells of the organizers, warning them when something needs to be done. For the organizers, this results in short bursts of activity that typically coincide with specific "low" points in the academic year at Rose-Hulman.

The major components in the tickler sheet are organizing and arranging the facilities, advertising the conference, soliciting and inviting speakers, and maintaining documentation. The interaction with the registrar's office (to arrange for classrooms and lecture halls), food service (to arrange for meals and refreshments), and facilities (to arrange for registration desks, signs, and refreshment tables) is all done by our office manager, Patti Staggs. She also organizes housing for students attending the conference, and coordinates the activities of all the students helping with the conference. We doubt the conference would be such a success year after year without her support. In fact, the conference organizers' job would be nearly impossibly difficult without her.

Frank Morgan announces the proof of the double bubble conjecture.

The first duty of the organizers is to select the two (sometimes three) invited faculty speakers. All of the other speakers at the conference are undergraduates. This is because we wish to focus on work done by undergraduates. Ideally, the organizers will never have to say "no" to an undergraduate who wishes to speak at the conference. Our space and time constraints are primarily due to the conference starting on Friday afternoon while classes are in session and ending on Saturday morning with lunch. This conference structure was chosen in order to allow travel time for the participants and to allow social interaction for the participants on Friday night.

According to the tickler sheet, the invitations for the invited speakers are to be sent by late spring or early summer. The goal is to have confirmation, titles, and abstracts early in the fall. The selection of the invited speakers is quite important, because it is essentially the only method the organizers have to shape the conference. The rest of the conference is a result of the students who come and participate. We start the selection process by soliciting suggestions from other faculty, both at Rose-Hulman and elsewhere, to create a list of high-quality speakers. This year we made a concerted effort to choose at least one woman who would speak on a topic in applied mathematics. This was particularly important to us, since Rose-Hulman only recently became coed, and we wanted to provide our students with at least one example of a woman who is succeeding in a scientific career. We are very pleased to have two exceptional speakers for this year, who both happen to be women working on applied problems: Suzanne Lenhart of University of Tennessee at Knoxville and Oak Ridge National Lab, and Linda Petzold of University of California at Santa Barbara.

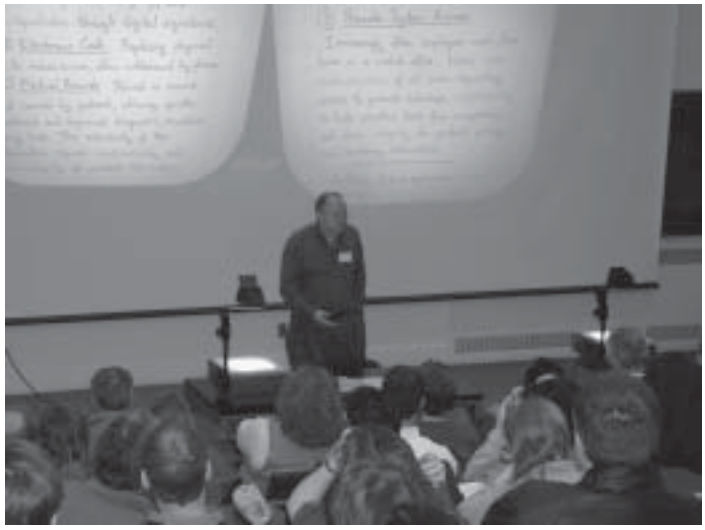
When the speakers have been selected and confirmed, our first task in the fall is to start advertising the conference. Most of the advertising is done through the Web. Updating and maintaining the conference web page and providing links to the conference web page from exterior sources is one of the main chores. In addition, we

send a flyer to all of the local colleges and make an announcement during the fall meeting of the Indiana section of the MAA to advertise the conference. When possible, the advertisements include the titles and abstracts for the invited talks.

After the advertisements and announcements are made, the calm before the storm begins. There is little to be done until the registrations and abstracts start arriving. They normally start arriving a few weeks before the conference is held. During this time, the only real work is contacting our book representatives asking for donations to use as prize books; every undergraduate speaker at the conference is given a book. Last year, there was the added task of contacting the Director of Communications at Rose-Hulman to coordinate the press release for the announcement of the solution to the Double Bubble Conjecture, which was made at our conference by Frank Morgan, just before it was announced worldwide.

The weeks immediately preceding the conference become more and more hectic. As the abstracts and registrations arrive, they must be separated and tallied to gain an accurate count for the amount of food to order, and the number of students who need to be housed. The more hectic part is arranging the program, and transcribing it to the webpage. Part of the problem in this is making sure the abstracts are well-constructed and web-compatible. The other part of the problem is waiting for abstracts. To fill out the program, we ask students at Rose-Hulman to speak.

It can be frustrating to arrange the schedule, trying to make sure that it is balanced and that all speakers' talks are well attended. The number of undergraduate talks at our conference has ranged from twelve to more than twenty; the number of participants ranges from sixty to about one hundred. This means that potentially we could have a single student talk running at a given time. The main problem with this is that the typical classroom at Rose-Hulman comfortably seats about thirty with a maximum capacity of approximately forty. Other problems that arise are arranging the equipment needed by both student and faculty speakers. Transportation to Rose-Hulman can also pose a problem, since our campus is an hour away from a major airport and there is little public or private transportation to and from the airport. This has sometimes caused problems for students attending the conference.



Nigel Boston speaks on Cryptography and the Benefits of Ignorance.

Soap bubble geometry contest.

The conference itself is both a hectic and a rewarding time for us as organizers. It is hectic, because we are normally running around trying to make sure everything is in the right place at the right time, and every time you turn around there is something else to be done. It is also rewarding, with the immediate reward coming when you see the students' enjoyment and thrill when giving a talk and answering questions of the participants. But the biggest thrill comes during the book giveaway, when we award prize books to all the student speakers and pass out the pictures taken during the conference. This happens at lunchtime in the closing ceremonies on Saturday.

All the work involved in organizing the conference pays off. The students who present talks, the professors who have mentored undergraduate research, and the conference participants all benefit from the conference. The students get the experience of presenting a talk and listening to others speak on a wide variety of research topics at an accessible level. The professors and student mentors get the opportunity to chat with other supporters of undergraduate research and to find out about the programs at other schools, possibly gaining new problems to give to students. We as organizers get a chance to interact with our invited faculty speakers, and with talented up-and-coming mathematicians. All of the attendees are rewarded by the energy and excitement of sharing research in a friendly atmosphere of mathematics camaraderie. ■

Information on this year's Rose-Hulman Undergraduate Mathematics Conference can be found on their web page, at http://www.rose-hulman.edu/Class/ma/HTML/Conf/UndergradConf.html.

Statistical Evidence Justifies Innovative Calculus Formats

By L. Hirsch and C. Weibel

Many universities, including Rutgers, have recently introduced new formats for calculus courses. Anecdotes abound to the effect that these new methods yield positive results. Fortunately we at Rutgers were in a position to do a statistical analysis of the effect that our new "Workshop" formats had on student performance, treating the standard (old format) sections as a control population. Our results may be summarized as follows. After adjusting for prior skill, the students in the Workshop formats outperformed their peers in the standard sections by slightly more than one letter grade (e.g., from C to B or B+).

Neil Shah acting as Peer Mentor in the Rutgers "Workshop" Calculus Course. Photo by Charles Weibel.

In slightly more detail, all calculus students at Rutgers take a common Final exam, which was our measure of student performance. It is well known that the best a priori predictors of the Final exam score are measures of "prior skill." In our case the best predictor was the score on our pre-calculus placement exam (which is correlated with the Math SAT and High School rank), at least when we restricted our study to first year students. Without adjusting for prior skill, the first-year students in the Workshop sections outperformed their peers in the standard sections by half a letter grade (e.g., from C to C+). After adjusting for prior skill level, they outperformed their peers by slightly over one letter grade (e.g., from C to B or B+).

The control group consisted of first-year students in our standard 4-credit Calculus course. This class meets twice a week in 80-minute lectures, and once a week in a 55-minute review of homework run by a graduate student. The 5-credit workshop sections meet in an additional 55-minute class dedicated to problem-solving in small groups, facilitated by the lecturer and an undergraduate mentor. Each week one workshop problem is written up and graded for both mathematics and exposition. Thus there are several possible explanations for the improvement we found, ranging from increased student-lecturer contact to training in out-of-the-box thinking.

We did a separate study in another calculus sequence (for Engineers and Science majors). There we compared the 5-credit workshops to 4-credit versions in which the workshops and homework review were combined into one 80-minute class. In that study we found a difference of half a letter grade on the common final (after adjusting for prior skill level). This suggests that even combining homework review with a workshop improves final exam scores, and that the new formats are indeed an improvement upon the old standard teaching format.

The results of our study are available from the authors in two documents called "Effectiveness of Rutgers Calculus Formats" I and II. They are available in html format off of the website at http://math.rutgers.edu/~weibel web page. This study also analyzes a stepwise linear regression using other factors such as High School rank, SAT, etc. We also determined that many factors were not statistically significant, including gender and the choice of lecturer. ■

L. Hirsch and C. Weibel teach at Rutgers University.

Short Takes

Algebra for All

A recent study concluded that taking algebra in high school is a good thing for all students, regardless of race, gender, or mathematical skills. The study, entitled "Algebra for All: Benefits of College-Preparatory Mathematics for Students with Diverse Abilities in Early Secondary School," was published in the fall issue of *Educational Evaluation and Policy Analysis*. According to one of the authors of the study, the conclusions indicate that "general math" classes should be eliminated, because even the weakest students learn less from such classes than they would if they took an algebra class.

Mathematical Card Tricks

An interesting article on "Mathematical Card Tricks," by Colm Mulcahy, has appeared in the AMS web site at http://www.ams.org/new-in-math/cover/mulcahy1.html. Six card tricks are discussed in detail. Several of the tricks go back to the writings of Martin Gardner, but at least one is new. In each section, Mulcahy describes the effect first, then explains how the trick is done, and finally discusses the underlying mathematics. Much of the material in the article goes back to an MAA short course called "An Introduction to Mathematical Card Tricks," offered by Mulcahy and Jeffrey Ehme at a meeting of the Southeastern Section of the MAA. The article is part of the AMS What's New in Mathematics site at http://www.ams.org/new-in-math.

A Web Site on Erdös Numbers and Mathematical Collaboration

Erdös numbers have been part of the folklore of mathematics for many years. The late prolific mathematician Paul Erdös has Erdös number 0, his co-authors (of which there were over 500) have Erdös number 1, their other co-authors have Erdös number 2, as so on. The Erdös number can be thought of as measuring the connectivity of the "collaboration graph," the graph you get when you make each mathematician a vertex and connect two vertices if the two mathematicians in question have written a paper together. Jerry Grossman of Oakland University maintains a web site at http://www.oakland.edu/~grossman/erdoshp.html with all sorts of information on Erdös numbers and mathematical collaboration. He has found, for example, that about two thirds of the 337,000 authors listed in Mathematical Reviews are in Erdös's connected component of the collaboration graph. Grossman's data show that finite Erdös numbers range as high as 15, but the median is only 5, and 98% of them are less than 8. The maintainers of the site offer to help you compute your own Erdös number if you can't find your co-authors on the site's list of the 6400 people with Erdös number 1 or 2. The site also has information and links about Paul Erdös himself, as well as on related topics such as publication patterns and research on collaboration. Their research shows that the median number of papers per mathematician is two, but the mean is about seven.

Nominations for Fields Medal and Nevalinna Prize Sought

Philip Griffiths, Secretary of the International Mathematical Union, has asked for suggestions of candidates for the Fields Medal and the Rolf Nevalinna Prize to be awarded at the 2002 International Congress of Mathematicians. Nominations, together with a brief justification, should be sent to Prof. Philip Griffiths, Institute for Advanced Study, Einstein Drive, Princeton, NJ 08540, or by email to imu@ias.edu. They will be forwarded to the chair of the appropriate IMU committee.

Mid-Atlantic Center for Mathematics Teaching and Learning is Formed

The University of Delaware, the University of Maryland, and The Pennsylvania State University have received a grant from the National Science Foundation to create a consortium of universities and school systems that will offer collaborative doctoral and post-doctoral studies in mathematics education and develop model programs for content preparation and professional development of mathematics teachers. The resulting entity is called the Mid-Altlantic Center for Mathematics Teaching and Learning. Among other things, the Center offers fellowships for doctoral and post-doctoral study. For information, visit their web-site at http://www.education.umd.edu/mac-mtl or contact the Center by e-mail at mac-mtl@umail.umd.edu. MAC-MTL can also be reached by mail, c/o Center for Mathematics Education, University of Maryland, College Park, MD 20742-1175.

Teachers Teaching with Technology International Conference

Teachers Teaching with Technology will hold an international conference in Columbus, Ohio, on March 16–18, 2001. The conference is co-sponsored by the Ohio Council of Teachers of Mathematics, the Ohio Section of the MAA, the Ohio Mathematics Association of Two-Year Colleges, Columbus State Community College, and Texas Instruments. The conference will focus on enhancing teaching and learning of mathematics and science from K to 14 through the use of educational technology. Ex-Senator John Glenn, who is chair of the National Commission on Mathematics and Science Teaching for the 21st Century, will give the opening keynote address. The conference organizers expect over 3000 teachers from many countries and nearly every state to attend. To find out more, visit http://www.t3ww.org/t3/confoverview.htm.

Cinderella Wins Software Award

The geometry program *Cinderella*, written by Jürgen Richter-Gebert and Ulrich Kortenkamp, won the European Academic Software Award 2000, in the category "innovative teachware" According to Ed Sandifer's review on **MAA Online**, "Euclid said that there is no Royal Road to Geometry. Euclid was right, but good software helps. *Cinderella* is very good." For the full review, see http://www.maa.org/reviews/cinderella.html.

How We Get Our Students to Read the Text Before Class

By Matt Boelkins and Tommy Ratliff

When students read the text before class, the fundamental nature of class meetings is changed. When students arrive in class, they are already familiar with basic concepts and definitions, which provides more class time to address the major ideas and subtleties of the mathematics. In addition, the instructor is no longer viewed as the sole source of content for the course, and this encourages greater independence, and more lively interactions, among students. The challenge, of course, is getting students to consistently read the text before class for the entire semester. In this article, we describe how email-based reading assignments have transformed a broad range of our courses, including Introductory Statistics, Single and Multivariable Calculus, Linear Algebra, and Geometry.

Unfortunately, few of our students have experience reading a math text, and most treat the book as a reference to use after the professor has presented new material. To counter these habits, one approach is to simply give a reading assignment for each class meeting. In our experience, most students are unlikely to read consistently for the entire semester unless there is some form of direct evaluation to keep them accountable. Since any assessment during class interferes with the main goal of freeing class time to discuss mathematics, it is important that such a method use alternate means to promote the activity of reading.

Our goals for individual students on a day-to-day basis are quite modest. We want them to be familiar with past and upcoming terminology and to have a rough idea of the basic concepts from each section. We believe that if each student spends some time reading and preparing then the larger goal of using class time more efficiently can be accomplished. In our experience, most students are unlikely to read consistently for the entire semester unless there is some form of direct evaluation to keep them accountable. Since any assessment during class interferes with the main goal of freeing class time to discuss mathematics, it is important that the assessment be independent of our meeting times with students. Furthermore, we desire to reward our students for their effort, while making sure that the approach to reading is perceived as reasonable by both student and instructor.

We place daily reading assignments on a course web page, usually in month- or week-long segments. The posting lists the specific section(s) to read, which parts should be emphasized, and which can be skipped, if any. There are also several basic questions that the student should be able to answer after completing the assignment. The questions serve to focus the students' reading and give them feedback on their level of comprehension; students email their responses to the instructor prior to the following class meeting. This gives the instructor feedback on the level of the students' understanding before class and allows the instructor to make adjustments as necessary.

As an example, the following is an assignment from Calculus II; the course text was [1].

For February 17

Section 3.8 Inverse Trigonometric Functions and Their Derivatives

To read: All, but you can skip the section on Inverse Trigonometric Functions and the Unit Circle

Reading Questions:

What is the domain of the function arccos(x)? Why?

Why are we studying the inverse trig functions now?

Find one antiderivative of $1/(1+x^2)$.

We have found that a binary grading scheme works well for the assignments: a student earns a 1 for sincerely attempting to answer the questions (independent of whether the answers are correct), or receives a 0 if no such attempt is made. In addition, the assignments count 5% of a student's final grade in the course. This assessment method has several advantages. First, it emphasizes that a major point of the assignments is making an honest effort. Further, this scheme makes the grading fairly easy for the instructor. For a class with 30 students, it takes approximately 20 minutes to read and record a given day's responses. Another effective tactic has been to require the students to enter a specific subject line in their email messages. The instructor can then use a filter to move messages with that subject line into a specific folder and generate an automatic response, letting the student know that the assignment has been received.

The student responses are always informative and often provide an excellent starting point for class discussion. We choose several of the best responses to each assignment and place them on a temporary web page. By displaying these responses at the beginning of class, students can compare their own thoughts on the reading, as well as see the work of some peers. This activity sparks both questions and responses, often resulting in discussion of key subtleties in the material. By archiving these web pages, students are also able to view the responses after class at any point later in the term.

In our calculus sequences, we do not cover inverse trigonometric functions until Calculus II. The sample assignment above came after we had discussed numeric integration but before we had covered any techniques of antidifferentiation.

The student responses displayed during class were:

The domain of the arccos(x) is [-1,1], because the range of the cos (its inverse), is [-1,1]. —A.V., First-Year

We are studying inverse trig. functions now because by knowing the derivatives

of these functions, we will be able to calculate more definite integrals using the FTC (Fundamental Theorem of Calculus). —A.C., Sophomore

One antiderivative of $1/(1+x^2)$ is arctan(x) + 3. —M.K., First-Year

These answers all show that the students understand the fundamental issues raised by the questions. A.V.'s response shows an understanding of the relationship between the range of a function and the domain of its inverse. A.C. gives a nice justification for why we are introducing the inverse trigonometric functions at this point in the course, and M.K. demonstrates the important point that the antiderivative is not unique. Obviously, not all students gave such precise answers to every question. In fact, M.K. completely missed the motivation for studying the inverse trigonometric functions. However, most students' misunderstandings were minor and were cleared up at the beginning of the class. This allowed enough time in a 50 minute class to derive the derivatives of arcsin(x) and arctan(x) and to give the students 15 minutes of in-class work. Without knowing the students' level of understanding before class, it is highly unlikely that we could have accomplished as much in one class meeting. This is but one of a host of examples we could have selected for demonstrating the depth and quantity of mathematics we are able to cover in this approach. That the method adds insight to how our students think is simply an additional bonus.

We have observed that most students, even those quiet in class, are not shy about providing lengthy exposition in response to the reading questions. Their responses shed light on how they interpret notation, think about key concepts, and endeavor to communicate their understanding.

We have conducted supplementary anonymous evaluations in each class where this approach has been used. In general, students agree that the reading assignments were helpful in understanding course material, in preparing for class reading, and in helping them focus their reading. In addition, most students indicated that they would not have read the text without the email assignments.

Not only did students believe that the reading assignments were a good idea, they actually did the reading! Overall, students reported spending about 30 minutes on a given reading assignment, and consistently at least 75% of each class completed and responded to a particular set of questions. In addition, most students completed the vast majority of the assignments. While we would prefer that every student complete every reading assignment, we consider the approach very successful when 80% of the students in an Introductory Statistics course spend, on average, more than 30 minutes reading the text before the material is discussed in class. (More specific data on these student evaluations is available in the longer version of the article.)

Finally, it is students' own words that offer so much evidence of their satisfaction regarding these assignments:

"I firmly believe I would not have read as thoroughly and would not have been as prepared for class were it not for the reading questions. They weren't a big deal to complete at all, and I feel they were vital in my understanding of the course.'
— *Geometry*

"I felt they were very helpful considering I tend to struggle with math courses. A very good idea!!" —*Statistics*

"Good stuff, helps to at least get a feel for the material before it is covered, allows a slightly faster pace." —*Linear Algebra*

"I felt the reading questions made me concentrate more on what I was reading and (I) got more out of the reading than I otherwise would have."
— *Calculus II*

"They were quite helpful. But it was sometimes frustrating if I didn't understand the material to have to wait until class to finally see how to do it."
—*Calculus II*

The last quote demonstrates what we are striving for: students who are thinking about mathematics, working on mathematics, and cannot wait to get to class.

As with any modified approach to teaching, there are issues one must carefully address. Items like the time and effort to construct reading questions, text selection, student workload, and student access to the Internet are important to consider beforehand. Some additional perspective from our experience in these areas is available in a longer version of this article; here it suffices to say that the moderate additions to the instructor's workload are well worth the effort for the results they generate.

We find the overall atmosphere in our classes exciting with this approach. Students read to learn mathematics; They explain their mathematical ideas in prose; Discussions become more lively; The instructor gets individual feedback on each student's understanding of concepts; Class time is spent more efficiently; Deeper mathematics is considered; Students even profess to like the assignments.

It sounds like everyone is winning! The approach has changed the fundamental way we direct our students in learning mathematics, and does so in a way with many important benefits. For all these reasons, we hope that other instructors will join us in the endeavor. The reader is encouraged to take a look at how an entire semester develops in this approach by visiting our courses on the World Wide Web at http://acunix.wheatoncollege.edu/tratliff/ or http://www2.gvsu.edu/~boelkinm. ■

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Matt Boelkins (boelkinm@gvsu.edu) *teaches at Grand Valley State University in Allendale, Michigan. Tommy Ratliff* (tratliff@wheatonma.edu) *teaches at Wheaton College in Norton Massachusetts.* *A longer version of this article appears as a feature article on MAA Online, at* http://www.maa.org/features/readbook.html.

Applying for Tenure-Track Positions at Community Colleges

By Andrew Nestler

Much has been written about the process of applying for jobs at universities and four-year colleges. This spring I interviewed mainly at two-year schools (community colleges), and was amazed at how different this process is from that at four-year schools. This article summarizes my experiences and impressions.

I found job notices by using the California Community Colleges Registry and JobBank, which is located at http://registry.yosemite.cc.ca.us/. This free service allows an applicant to search for full- and part-time positions in any field at two-year colleges throughout the state, and by registering one's name, field and contact information on the site, you can receive in the mail job notices from individual colleges. Also there are CCC job fairs held in northern and southern California several times a year, and school districts post position announcements on their web pages.

In addition to the usual package of application materials, these schools require a school district application form. They also require several essays on topics such as teaching a diverse population of students and the use of technology in the classroom. Schools contact applicants by phone or mail for a first round of interviews. The school assigns the applicant a time and date for the first on-campus interview, which lasts an hour at most. In general, there are no reschedulings: if you cannot make the appointment given to you, then you are out of luck. A doctorate is not required for a position at a two-year school, only a Master's degree or equivalent state credentials.

When I arrived at most of my first-round interviews, I was given one half-hour to review a sheet of paper that contained the questions that the committee would be asking me. All schools asked me what background and experiences I have that enable me to be an effective teacher of a diverse student population, and they also all asked about my use of technology in the classroom. Other questions concerned the role of public education and hypothetical classroom situations. After reviewing the questions, I was brought before the committee, and we were all seated at a large table. They read a prepared statement, such as, "Hello, and welcome. Your credentials are impressive and we are very happy to interview you today." Apparently these schools are required to try as hard as possible to make all the interviews identical, so that no applicant is shown any preference. Then the committee members took turns reading the questions off of the paper, and I gave my responses, and they took notes. It was extremely formal. In general, committee members may nod and smile, but do not ask follow-up questions or comment on responses to the questions. At the start, I was told how long this part of the interview should last, and that I should take that into account as I gave my answers. Some committees even set a clock in front of me on the table.

After this 30- to 45-minute interview was done, I went to the board to give my previously prepared 10- or 15-minute lecture on a topic of undergraduate mathematics, such as shared work problems, the fundamental theorem of calculus, and linear independence. The topic or choice of topics is given in the packet sent with the interview offer. Usually these lectures are to be prepared as though the audience is comprised of students taking that course. At some schools, committee members may ask questions as instructors, as well as while pretending to be students. During my lecture at one school, one of the committee members asked an innocent mathematical question about something I had written, and the other members immediately yelled out his name, apparently trying to remind him that the interviews must be kept uniform.

Afterward, there often was time for the applicant to ask any questions they may have. Questions seemed genuinely welcome, although the committees were working on tight schedules. A couple of times I wrapped up my questions rather quickly, when I could sense that they wanted to move on.

From those interviewed, usually three finalists are chosen for a second on-campus interview, usually with the president, a vice-president and the chair of the mathematics department or division. This time there is a bit more freedom with the choice of appointment time, although again they try to have the appointments within a week or so. Community colleges often hire 30 or more tenure-track people each year, and the president and vice-president (or dean) must interview three or so finalists for each of these positions. This second interview may be as formal as the first, or it may be much more relaxed.

Throughout the interview process at nearly all of the schools, there was no opportunity to meet with mathematics faculty who were not on the committee, or to chat informally with committee members, or even to visit the department or tour the campus in general. Clearly this is very different from the process at four-year schools. I was one of seven finalists at one community college outside of California, which paid for my travel and arranged an all-day interview that included lunch, a tour and much informal discussion. This was quite an exception.

My advisor wrote a separate letter for community colleges, stressing teaching and very much reducing the amount of space dedicated to my research. I think that having a Ph.D. is a double-edged sword when applying to these colleges: departments and colleges like to boast of the number of their Ph.D. recipients, and yet someone with a doctorate will automatically be at the high end of the pay scale. I recommend that anyone interested in applying for a full-time position at a community college try to get a part-time job at one first, for the experience. Though I did not have such experience, I believe that the school that hired me, Santa Monica College, was impressed by my letters of recommendation and by my having attended and taught at schools with which SMC has special relationships. ■

Andrew Nestler is Assistant Professor of Mathematics at Santa Monica College. A longer version of this article appeared in the Concerns of Young Mathematicians

In Memoriam: Paul Klein Rees

Paul K. Rees, professor emeritus at Louisiana State University and a longtime member of the MAA, passed away on November 25, 2000, at the age of 98. Rees joined the Association in 1924 as a graduate student at the University of Texas. As he told it, one of his professors brought some application forms to class and told each student to fill one out and return it to him. It worked. Over the years, Rees was a member of the Texas section, the Southwestern section, and the Louisiana-Mississippi section. His son, Charles S. Rees, who is also a mathematician and an active MAA member, estimates that his father attended some 54 section meetings during his life. The Sections are the heart of the MAA, and Rees's continued interest and active participation in them long after his retirement and so late in life is truly remarkable and shows how important the MAA was to him. "He loved to attend the meetings and go to the opening and closing sessions," says his son, "even when he had trouble hearing. In between, he would stay close to the coffee pot and talk to anyone and everyone about mathematics, people, books, the good old days, sports, LSU, Ole Miss, politics, the weather, coins, flowers, genealogy, clocks. And of course he always had several good jokes." At the time of his death, Rees was in his 77th year as an active member of the MAA. ■

An Extra Knight At the Round Table

By Matt Jones

When I received an invitation to attend the August 2, 2000 MAA Board of Governors meeting as the historic first graduate student guest, I gladly accepted, but I didn't know what to expect. In my mind, I imagined a meeting of about a dozen of the association's officers reviewing budgets and membership numbers.

I was shocked as I walked into a meeting room set up for 60 people. Accompanying the large assembly was an appropriately large agenda, something which would stretch the definition of the word "pamphlet." In the agenda were items that showed the broad scope of the MAA, from awards and honors to the International Mathematical Olympiad to the MAA web page and other member services. Two very interesting items stood out: a deficit budget and an update of the 1993 *Guidelines for Programs and Departments in Undergraduate Mathematical Sciences.*

My guide for the day, MAA Second Vice-President Frank Morgan, helped me keep up with everything that went on. The budget was the highlight of the morning, and it was expected that there would be some opposition to the budget. The deficit was a result of plans to change how the MAA operates its database, from the old system in which they use an outside company, to a new system which would be run by the MAA itself. However, the committee members who were involved in studying the new system made a very effective presentation and the budget was passed without much fanfare.

Even lunchtime is utilized effectively at the meeting. The board is divided into several tables of seven or eight and given issues to discuss over the meal. This day, the issues were how to increase MAA voter participation and whether the MAA meeting could be moved to increase convenience to members with respect to the timing of the academic calendar. Here, in small group format, I was able to share my own personal opinions. I was also chosen to present our table's opinions at the general assembly at the end of lunch.

During the afternoon portion of the meeting, the update of the Guidelines was hotly debated. Perhaps fueled by our delectable lunch in the Southern California afternoon sun, a raucous debate erupted over the wording of several sections. All parties eventually agreed that the Guidelines were substantially acceptable, but that some passages would undergo revision to improve their clarity.

I went home exhausted, having thoroughly enjoyed my day. My MAA membership application is in the mail. ■

Matt Jones is a graduate student at UCLA

EMPLOYMENT OPPORTUNITIES

ARKANSAS

ARKANSAS GOVERNOR'S SCHOOL
Apply for Arkansas Governor's School faculty positions. Employment period is June 11 – July 28. Deadline for submission is January 5. Call (501) 682-4224 or online applications at www.hendrix.edu/ags/.

CALIFORNIA

CAL STATE POLYTECH. UNIV., POMONA
Department of Mathematics
Two tenure-track positions
Appl.Math/Stat. (Asst/Associate Prof) Teach major and service courses in appl math or stat, advise graduate students. Preference will be given to applicants with expertise in one or more of: differential equations, modeling (deterministic and stochastic), random processes, estimation theory, numerical analysis, or operations research. Min qual: Ph.D. in math or stat or related area.

Statistics (Asst/Associate Prof) Teach graduate stat courses, undergraduate and service courses in stat or math; advise graduate students. Preference given to applicants with expertise in one or more of: statistical modeling, multivariate stat, biostatistics, design of experiment, estimation theory, statistical consulting. Min qual: Ph.D. in stat or math or related area.

For both positions: Rank and Salary dependent on qualifications. Required: evidence of teaching excellence, ability to direct master's theses, potential for conducting scholarly activities. Completion of terminal degree by Sept. '01. Submit application form (with name of position),vitae, transcripts, and min. of 3 reference letters to Faculty Search Committee, Math Dept., CSPU Pomona, 3801 W. Temple Ave, Pomona, CA 91768-4007; Phone:909-869-4008; email: lmborchert@csupomona.edu. Fax: 909-869-4904. Initial review of applications begins 2/2/01 and continues until position is filled or closed. AA/EEO.

See http://www.csupomona.edu/~math.

SAN JOSE STATE UNIVERSITY
Department of Mathematics
and Computer Science
Two tenure track positions in Mathematics Education at the rank of Assistant Professor and one at the rank of Assistant or Associate Professor for the 2001-02 academic year. Candidates must have a PhD in Mathematics Education by August 2001, math background equivalent to a masters degree and K-12 experience. Preference will be given to candidates with at least 1 year of teaching experience in US K-12 schools, ability to develop teachers of English language learners, familiarity with the use of technology as a tool in teaching mathematics, and commitment to quality teaching. Application deadline is February 2, 2001. Applicants should send vita, transcripts, and 3 letters of recommendation to Dr. Michael Burke, Dept. of MathCS, San Jose State University, San Jose, CA 95192-0103. EOE/AAE PVIN:SCI 01-049A,B.

CONNECTICUT

WESLEYAN UNIVERSITY
The Department of Mathematics and Computer Science invites applications for the following positions in Mathematics to begin in the academic year 2001-2002. Candidates for these positions must have a Ph.D. in Mathematics and are expected to have strong records in both research and teaching.

Assistant Professor of Mathematics: We seek candidates for two tenure-track assistant professorships, one in analysis and the other in algebra. These positions are most suitable for candidates with an established research program, typically with some postdoctoral experience. For the analysis position, we are especially interested in probability theory, Lie groups, or geometry with connections to dynamics; for the algebra position, we are especially interested in arithmetic or algebraic geometry, number theory, algebraic groups, commutative algebra, or algebraic combinatorics. Outstanding candidates in any area of mathematics are encouraged to apply.

Teaching duties for each of the above positions are two courses per semester.

Wesleyan University is committed to increasing the diversity of its faculty and is an equal opportunity/affirmative action employer.

Applications must be submitted by January 29, 2001. Applicants should arrange for at least four letters of recommendation, including one which evaluates teaching, to be sent to the address below.

All correspondence and applications should be submitted to:

Mathematics Search Committee
Department of Mathematics
and Computer Science
Wesleyan University
Middletown, CT 06459

E-mail enquiries may be directed to mathjobs@wesleyan.edu; please mention that you are enquiring about the assistant professorships.

More information concerning the Department of Mathematics and Computer Science and about Wesleyan University can be found via http://www.math.wesleyan.edu/.

GEORGIA

VALDOSTA STATE UNIVERSITY
Department of Mathematics
and Computer Science
Applications are invited for a tenure-track position beginning fall semester 2001 at the rank of Assistant Professor. Candidates must have a Ph.D. in mathematics or a closely related field to be conferred no later than August 1, 2001, and the equivalent of a masters degree in mathematics. Special consideration will be given to candidates who can teach lower division courses in computer science or statistics.

Applicants should have a commitment to undergraduate teaching and research. The typical teaching load is 12 semester hours and includes both service courses and major courses. Other responsibilities include continued professional development and service to both the department and the university.

Send a letter of application, resume, statement of teaching philosophy, three letters of recommendation, and unofficial transcripts of undergraduate and graduate work to:

The Mathematics Screening Committee
Department of Mathematics
and Computer Science
Valdosta State University
Valdosta, GA 31698-0040

The review of applications will begin on December 1, 2000, and will continue until the position is filled. Valdosta State University is EOE/AA.

HAWAII

UNIVERSITY OF HAWAII AT HILO
Assistant Professor of Mathematics
(2 Positions): Position Numbers 82381 and 82801, College of Arts & Sciences, general funds, full-time, tenure-track, nine-month appointment, to begin approximately August 2001, pending position clearance and funding. DUTIES: Teach courses in mathematics, including evening and distance-learning; advise students; engage in scholarly activities, and/or creative endeavors which contribute to the mission of the University. MINIMUM QUALIFICATIONS: Ph.D. in Mathematics or related discipline from an accredited college or university; evidence of commitment to excellence in teaching; ability to communicate clearly in written and spoken English, evidence of commitment to research. DESIRABLE QUALIFICATIONS: Evidence of successful undergraduate teaching in a multicultural setting, area of professional specialization in applied statistics, functional analysis, or math education. SALARY: Commensurate with training and experience. APPLICATIONS: Submit letter of application, vita, and three (3) current letters of reference to: Dr. Carole Miura, Chair, Mathematics Dept., College of Arts & Sciences, University of Hawaii at Hilo, 200 W. Kawili St., Hilo, HI 96720-4091. INQUIRIES: (808) 974-7321 or email cmiura@hawaii.edu. DEADLINE: Review of applicants will begin January 31, 2001 and continue until position is filled. An EEO/AA Institution.

ILLINOIS

DEPAUL UNIVERSITY
Applications and nominations are invited for the position of chair of the department of mathematical sciences at DePaul University. Candidates should have a Ph.D. in the mathematical sciences, distinguished research credentials, an excellent teaching record, and a history of university and professional service, with strong interpersonal skills and demonstrated administrative abilities. For more information on this position, the department, and application procedures, see http://www.depaul.edu/~math/chair.htm .

ILLINOIS STATE UNIVERSITY
Mathematics Position
The Mathematics Department at Illinois State University is seeking applications for one tenure track position in mathematics at the Assistant Professor rank beginning August 2001. Applicants should have a Ph.D. in Mathematics by August 2001 with a research focus in functional analysis, specifically operator theory or operator algebras; the ability to teach a wide range of mathematics courses; an active research program; and a commitment to quality teaching. Send application letter, curriculum vita, and three letters of recommendations to: Lotus Hershberger, Chairperson, Illinois State University, Department of Mathematics, Campus Box 4520, Normal, IL 61790-4520. Closing Date February 1, 2001.

See description at www.math.ilstu.edu. e-mail: mathchair@math.ilstu.edu. AA/EO Employer.

THE UNIVERSITY OF ILLINOIS
AT CHICAGO
Department Head
Department of Mathematics,
Statistics, and Computer Science
The Department of Mathematics, Statistics, and Computer Science at the University of Illinois at Chicago is seeking a Department Head.

UIC is a Research I University with 16,000 undergraduates, 6,500 graduate, and 3,000 professional students. It is located in the heart of Chicago and is the largest university in the greater Chicago area.

The Department of Mathematics, Statistics & Computer Science is a group 1 research department with programs in pure and applied mathematics, statistics, mathematical computer science and mathematics education. There are 61 faculty and 202 graduate students.

The Head is the chief administrative officer of the department with responsibilities for recruitment, instructional programs, administrative, budgetary and promotion decisions, and for providing leadership in the development of research, teaching, and public service. The successful candidate will have an outstanding research program, a strong commitment to teaching, demonstrated leadership and administrative skills, and will be eligible for appointment as a full professor.

Although the search will continue until the position is filled, applications should be received by February 23, 2001 to receive fullest consideration. Applications from women and minorities are particularly encouraged. Applications and nominations should be sent to:

Professor David Marker
Search Committee for Head of Mathematics, Statistics, and Computer Science
College of Liberal Arts and Sciences, M/C 228
The University of Illinois at Chicago
601 S. Morgan Street
Chicago, Illinois 60607-7104

UIC is an Affirmative Action/Equal Opportunity Employer.

KANSAS

TABOR COLLEGE
Mathematics and Computer Science
Description: Full time position in Mathematics and Computer Science, starting Fall 2001. Responsibilities include teaching courses in the Mathematical Sciences majors, and in the general education courses offered by the department, supervising senior theses, and advising students majoring in the Mathematical Sciences.

Qualifications: Prefer doctorate earned or in progress in Mathematics or Computer Science. Candidates with a master's degree in one field with strong background in the other will be considered. Suitable teaching experience required. Candidates must understand and support the mission and goals of Tabor College, as an evangelical Christian college. Must be able to articulate his/her personal Christian commitment and be prepared to be a positive role model for students, in keeping with the lifestyle guidelines included in the college catalog.

Rank: Dependent on experience and qualifications.

Salary: Competitive with Kansas private colleges.

Closing Date: Applications will be accepted until March 1, 2001.

Application Process: Send vita, transcripts, and the names of three references who can be contacted to: Dr. Howard Keim, Dean of the Faculty, Tabor College, 400 South Jefferson Street, Hillsboro, KS 67063-1799. (E-mail: howardk@tabor.edu; FAX 316-947-2607).

Equal Opportunity: Tabor College continues to provide equal opportunity, without regard to race, color, gender, ethnic or national origin, disability, or age. Minorities and women are especially encouraged to apply.

For further information about Tabor College, see the Tabor website: www.tabor.edu.

KENTUCKY

NORTHERN KENTUCKY UNIVERSITY
Chair, Department of Mathematics and Computer Science
Applications are invited for the position of department chair, beginning July 1, 2001. NKU is located in the Cincinnati metropolitan area and serves approximately 12,000 students. The Department offers undergraduate study in mathematics, statistics, computer science, and mathematics education. A master's degree program in computer science has recently been initiated.

There are about 75 mathematics, 300 computer science, and 25 mathematics education majors. The department has 26 full-time tenure-track positions, all requiring the doctorate. Full-time lecturers and numerous part-time faculty members assist in serving roughly 3200 students per semester. Developmental mathematics is a separate program.

The Department is a component of NKU's Center for Integrated Science and Mathematics (CINSAM), one of the Commonwealth of Kentucky's Programs of Distinction. CINSAM provides support for faculty involved in undergraduate research or projects with schools or high-technology companies in the area.

The appointment will be at the rank of Professor or Associate Professor. The position requires instructional, administrative, and leadership effectiveness as well as strong communication and interpersonal skills. A doctorate and a record of teaching, continuing scholarly activity, and service appropriate to the rank are required. Quality teaching is the department's highest priority.

For further information about the Department, the University, or the position, see http://www.nku.edu/~math/.

Applicants should provide a letter of application, a current curriculum vita, and three letters of recommendation to: Chair Search Committee, Department of Mathematics and Computer Science, Northern Kentucky University, Highland Heights, KY 41099. Additional materials may be requested. Review of applications will begin January 16, 2001, and continue until the position is filled.

NKU is an equal opportunity/affirmative action employer.

MICHIGAN

MICHIGAN TECHNOLOGICAL UNIVERSITY
Department of Mathematical Sciences
Mathematics Education Search Committee
1400 Townsend Drive
Houghton, Michigan 49931-1295
Applications are invited for a tenure-track position at the Assistant Professor level in Mathematics Education starting August 2001. Applicants should have a Ph.D. or Ed.D. in mathematics education with a strong background in mathematics or a Ph.D. in mathematics with a strong background in mathematics education. A commitment to quality teaching and to the development of an active externally funded research program in mathematics education is necessary. Send vita and 3 letters of reference to: Mathematics Education Search Committee, Department of Mathematical Sciences, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931-1295. Michigan Technological University is an equal opportunity educational institution/equal opportunity employer.

UNIVERSITY OF MICHIGAN
Department of Mathematics
The Department seeks candidates for a Lecturer position beginning September, 2001, involving the operation and direction of its introductory program in precalculus and calculus and the training of instructors for these courses. Duties will include the direction of one large multi-section precalculus or calculus course per semester, the teaching of one or two sections of the course being directed, assistance with our program to train and supervise new teachers in the introductory program, and general help with the planning, direction, and administration of the program. Applicants should have demonstrated excellence in the teaching of college mathematics, experience directing multi-section courses in the first two years of college mathematics, and expertise in modern pedagogical methods. Experience in working with outreach programs is also desirable. Those who do not precisely fit this description but who are very strong in sev-

eral of these areas will also be considered. A Doctorate in Mathematics or a closely related area is preferred but all strong candidates will be considered.

Preference will be given to candidates who are also involved in mathematical research or scholarship, including mathematics education. Rank and salary commensurate with experience. Nondiscriminatory Affirmative Action Employer. Applicants should send a cv/bibliography, description of experience, a statement on teaching, and have three letters of recommendation sent to: Professor B.A. Taylor, Chair, Department of Mathematics, University of Michigan, Ann Arbor, MI 48109-1109. E-mail: mathchr@math.lsa.umich.edu. Further information is available on our home page (http://www.math.lsa.umich.edu). Applicants considered on a continuing basis.

MINNESOTA

NORMANDALE COMMUNITY COLLEGE
Mathematics/Computer Science Department
Applications are sought for mathematics instructors beginning in August 2001, contingent upon funding approval. Teach mathematics courses from developmental level through differential equations and linear algebra. Full time day and evening classes. Requires masters in mathematics or a master in a related field with 15 graduate semester credits (23 grad. qurt. credits) in mathematics. Desirable Qualifications: Teaching experience at a community college; knowledge of teaching methods in mathematics courses for elementary teacher preparation; exp. teaching with graphing calculators and computer algebra systems. NCC serves 8,000 students. Starting salary $30,789 and $41,370, depending upon education and experience. The Search Committee will begin reviewing files on February 28, 2001. Send a letter of application, current resume, unofficial copies of undergraduate and graduate transcripts, and the names of at least three references who can address your qualifications. Contact Nella Austin, Human Resources, Normandale Community College, 9700 France Ave. So, Bloomington, MN 55431. Phone 952/487-8269, fax 952/487-8265, TTY 952/487-7032.

NEW HAMPSHIRE

KEENE STATE COLLEGE
Mathematics
Assistant Professor
Tenure Track Position
Beginning Fall 2001
Responsibilities: teach the full range of introductory and advanced undergraduate courses in mathematics. All faculty positions include teaching 12 credits per semester, academic advising, curriculum development, committee service, and scholarly activity.

Qualifications: Doctorate in Mathematics, Statistics, or Math Education, evidence of excellence in teaching mathematics at the college level, a strong commitment to teaching, and excellent communication skills are required. Experience with the use of technology in teaching and/or expertise in Statistics are desirable.

Minimum salary for Assistant Professor: $39,510. Submit a letter of application and include why you are interested in Keene State College, a curriculum vitae, a statement of teaching philosophy, a statement of professional interests, and three letters of reference (at least one of which addresses the candidate's teaching) by January 19, 2001 to, Mathematics Search Committee, Office of Human Resource Management, Keene State College, 229 Main Street, Keene, NH 03435-1604. Keene State College will be represented at the January 2001 AMS/MAA Meetings in New Orleans. Application materials received by January 3, 2001 will be considered in scheduling interviews at the meetings.

Keene State College is a public, liberal arts college of the University System of New Hampshire with an enrollment of 5000 students. The College has been recognized as a leader in American higher education for its commitment to its mission, broad-based strategic planning initiatives, and cohesive sense of community. Located in the southwest corner of New Hampshire, Keene provides traditional New England charm and easy access (2 hrs) to Boston, Hartford, and Albany. To learn more about Keene State College, the University System of New Hampshire, and the Keene Community visit these websites: www.keene.edu/ or www.keenesentinel.com/toplist.shtml.

Keene State College is a member of the Council of Public Liberal Arts Colleges, a national alliance of leading liberal arts colleges in the public sector. As an AA/EEO employer, we actively seek women and minority candidates.

NEW JERSEY

KEAN UNIVERSITY
MATHEMATICS (10 Month Positions)
Tenure track positions (2) available September 1, 2001 at the level of Assistant Professor. Doctorate in Mathematical Sciences or Doctorate in Mathematics Education with the equivalent of a Master's degree in Mathematics required. Three quarters of the assignment will involve teaching and developing innovative curriculum in the Mathematics core of the University-wide General Education program. Responsibilities will include assisting with student placement, curriculum development and program coordination. Ability to effectively teach Mathematics at a variety of levels and experience in the use of educational technology are important requisites. Faculty members share the advisement of students and participate through committee service in governance at the Department, School and University levels. Active involvement in research and/or other professional activities is expected of every faculty member.

Candidacy review begins immediately and continues until appointment is made. Priority consideration given to applications received before January 30, 2001. Send letter of interest; up-to-date resume; names, addresses, telephone numbers of three references. Official transcripts and three current letters of recommendation required before appointment. Salary is competitive and commensurate with qualifications and experience. Comprehensive benefits program included.

Applications should be sent to Prof. Carlon Krantz, Chairperson, Department of Mathematics & Computer Science, Kean University, Morris Avenue, Union, NJ 07083.

Kean University, a comprehensive metropolitan university, is committed to excellence and access and to developing, maintaining and strengthening interactive ties with the community. Kean University takes pride in its continuing efforts to build a multicultural professional community to serve a richly diversified student population of 12,000. Kean University is an AA/EEO institution.

NEW YORK

HUNTER COLLEGE
THE UNIVERSITY OF NEW YORK
Department of Mathematics
and Statistics
Tenure-track Assistant Professor position anticipated for September 2001.
Salary range: $32,703-$57,049 depending on experience. Doctoral degree required. We are interested in mathematicians (all fields). Send C.V. and three letters of references to:

Professor Ada Peluso, Chair
Department of Mathematics and Statistics
Hunter College
695 Park Avenue
New York, NY 10021

Equal Opportunity/Affirmative Action Employer (M/F/D/V).

OREGON

SOUTHERN OREGON UNIVERSITY
Tenure-track Assistant Professor, Southern Oregon University, starting Fall 2001
Application review begins February 15, 2001.
Requirements: Ph. D. in Mathematics, excellent teaching and communication skills, strong commitment to teaching undergraduate mathematics. Applicants must be well qualified to teach upper division Analysis. See http://www.sou.edu/

math/jopen/ for complete position description. Send vita, statement of teaching philosophy, description of professional goals, brief summary of teaching evaluations, transcripts and 3 letters of recommendation to: Personnel Committee, Department of Mathematics, SOU, Ashland, OR 97520. SOU is an Affirmative Action/ Equal Opportunity Employer.

PENNSYLVANIA

UNIVERSITY OF SCRANTON
Department of Mathematics
The University of Scranton anticipates a tenure-track opening in the academic year 2001-02 for an assistant professor of mathematics. Applications are invited from candidates seeking a teaching environment where research is part of faculty responsibilities. Applicants should possess the doctorate in mathematics by June 2001. The department offers undergraduate programs in mathematics and biomathematics and is particularly interested in candidates with background in applied mathematics but will consider strong applicants from all fields. Visit us on the Web at http://academic.uofs.edu/department/math/. The University of Scranton is a Jesuit Catholic institution which welcomes applicants from all backgrounds who can contribute to our unique educational mission (see the Institutional Statement of Mission at http://www.uofs.edu/admin/mission.html). Submit a vita, three letters of recommendation and a statement on teaching and research interests to Mathematics Search Committee, University of Scranton, Scranton, Pa 18510-4666. The University of Scranton is an Equal Opportunity/Affirmative Action Employer and encourages applications from women and minorities.

TEXAS

UNIVERSITY OF NORTH TEXAS
The Mathematics Department expects to have a tenure track position to fill for 2001-2002 pending administrative approval. The department seeks an individual with a strong mathematics background who is actively involved in Mathematics Education Research. Candidate will also be expected to establish strong collaborations with area public education. The teaching load is two courses per semester. The department offers undergraduate and graduate degrees in mathematics including the Ph.D. degree. The search committee will begin reviewing applications around January 1, 2001 and continue to consider applications until the position is filled. The University of North Texas is an ADA/AA/EOE that encourages applications from minority group members and women.

Send vita, three letters of recommendation, transcripts, and cover letter to:
Search Committee
Department of Mathematics
P.O. Box 311430
University of North Texas
Denton, TX 76203-1430

WASHINGTON

UNIVERSITY OF WASHINGTON
Department of Mathematics
Applications are invited for the position of Director of the Mathematics Study Center. The Math Study Center (MSC) provides group study opportunities and assistance for students in precalculus and calculus. The title of the position is Senior Lecturer in Mathematics, and the initial appointment is for a period of three years. Full details about the position are available at http://www.math.washington.edu/~sheetz/Appts/dmsc.htm. Priority will be given to applicants whose completed applications are received by February 1, 2001. Applicants are encouraged to apply online at: http://www.mathjobs.org/. Applications which are not submitted online should be sent to: Appointments Committee Chair (DMSC), Department of Mathematics, Box 354350, University of Washington, Seattle, WA 98195-4350. The University of Washington is an affirmative action, equal opportunity employer. The University is building a culturally diverse faculty and strongly encourages applications from female and minority applicants.

WEST VIRGINIA

BETHANY COLLEGE
Mathematics/Computer Science
The Department of Mathematics/Computer Science at Bethany College, Bethany, West Virginia, invites applications for two tenure-track positions to begin Fall, 2001. Bethany College is a liberal arts residential college of 750 students located 50 miles southwest of Pittsburgh, Pennsylvania (http://www.bethanywv.edu). Responsibilities include strong commitment to teaching (12 hour load), advising, and service in the department and college-wide committees. A doctorate in either mathematics or computer science is required for both positions. Additionally, experiences in curriculum and program development as well as involvement with professional organizations at local and national levels will be viewed favorably. Review of applicant credentials will begin January 31, 2001 and continue until the position is filled or the search is closed. Candidates should send a letter of interest, curriculum vitae, complete transcripts, and the names, mail and e-mail addresses, and telephone numbers of four references to: Dr. Dirk Schlingmann, Chair, Department of Mathematics and Computer Science, Bethany College, Bethany, West Virginia 26032.