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Inside

Cover image of Peter Lax courtesy of the NYU Office of Public Relations.

FOCUS Deadlines

	August/September	October	November
Editorial Copy	June 8		September 16
Display Ads	July 10	August 20	September 24
Employment Ads	June 11	August 13	September 10

Moody's Foundation Will Support the MAA's National REU

The MAA has received a grant for $144,000 from The Moody's Foundation of New York to support the expansion of SUMMA's National Research Experiences for Undergraduates Program. The National REU Program, which was described in the November issue of FOCUS (pages 27–28), is conducted by the MAA Office of Minority Participation to encourage mathematical sciences faculty to oversee research by small groups of minority students. The grant will support student research at up to five sites.

"Mathematics education is a key focus of The Moody's Foundation," said Frances G. Laserson, the foundation's president. "We have a keen interest in programs that may encourage women and minorities to pursue careers in financial services. We believe that partnering with MAA's National Research Experiences for Undergraduates Program will further that goal."

"The need for increased participation of U.S. citizens in the mathematical sciences requires that students from under-represented groups be identified and nurtured, both to serve as professional mathematicians and to serve as role models and mentors for future generations," said Michael Pearson of the MAA. "The grant from The Moody's Foundation enables MAA to support faculty mentors and the focused peer-group experience shared by the student researchers, thus encouraging broadened participation of these students in graduate studies and careers in mathematics."

By supporting faculty at a diverse group of institutions to direct undergraduate summer research, the National Research Experience for Undergraduates Program simultaneously supports the development of a community of skilled faculty mentors expected to lead to ever-increasing opportunities for undergraduate research by all mathematics students. Grants for partial support of this program have also been received from the National Security Agency and the Division of Mathematical Sciences of the National Science Foundation.

The Moody's Foundation is a charitable foundation established by Moody's Corporation (NYSE: MCO), the parent company of Moody's Investors Service (a leading provider of credit ratings, research and analysis covering debt instruments and securities in the global capital markets) and Moody's KMV (the leading provider of market-based quantitative services for banks and investors in credit-sensitive assets serving the world's largest financial institutions). The corporation, which reported revenue of $1.4 billion in 2004, employs approximately 2,500 people worldwide and maintains offices in 18 countries. Further information is available at http://www.moodys.com.

Peter Lax Wins the 2005 Abel Prize

The Norwegian Academy of Science and Letters announced that the Abel Prize for 2005 will go to Peter D. Lax of the Courant Institute of Mathematical Sciences, New York University. The Abel Committee said that it was awarding Lax the prize "for his groundbreaking contributions to the theory and application of partial differential equations and to the computation of their solutions."

The official biography released by the Abel Committee describes Lax as "the most versatile mathematician of his generation." It highlights his ability to work in both pure and applied mathematics, combining a deep understanding of analysis and a talent for finding unifying concepts with the ability to identify problems that are of direct interest in applied mathematics and contribute towards their solution. They also note his personal influence, both as a teacher and as an author.

Lax's writing has been twice been honored by the MAA with a Lester R. Ford award: in 1966 for "Numerical Solutions of Partial Differential Equations" (*American Mathematical Monthly* **72** [1965], Part II, 78–84) and in 1973 for "The Formation and Decay of Shock Waves" (*American Mathematical Monthly* **79** [1972], 227–241). The latter also won him the Chauvenet Prize in 1974. His skills as a speaker were recognized when he was invited to be the Hedrick Lecturer at the MAA summer meeting in 1972.

Lax's work has been recognized by many other honors and awards, including the National Medal of Science in 1986, the Wolf Prize in 1987, and the American Mathematical Society's Steele Prize in 1992.

See page 4 for more on Lax and the Abel Prize.

Gibbs & von Neumann on Postage Stamps

Two mathematicians appear among the four American scientists honored on stamps released in May by the United States Post Office — though one of them might be claimed by physics as well. John von Neumann is described as a 'mathematician' and Josiah Willard Gibbs as a 'thermodynamicist.' The other two scientists are physicist Richard Feynman and geneticist Barbara McClintock. On the back of the stamps are short descriptions of each scientist's work. John von Neumann is said to have made "significant contributions in both pure and applied mathematics, especially in the areas of quantum mechanics, game theory, computer theory and design." About Gibbs, the text says only that he" formulated the modern system of thermodynamic analysis." Mathematicians, of course, remember Gibbs for his creation of the modern form of vector calculus and for his work on statistical mechanics. More about the stamps, including images, can be found at http://www.usps.com/communications/news/stamps/2004/sr04_076.htm.

Peter Lax: Pure and Applied

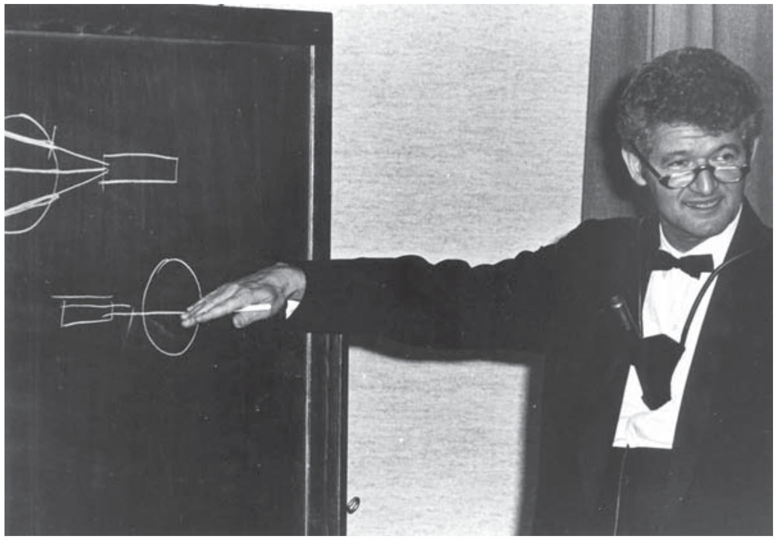
By Don Albers

Peter D. Lax of the Courant Institute of Mathematical Sciences, New York University, has been awarded the Abel Prize for 2005 in recognition of "his groundbreaking contributions to the theory and applications of partial differential equations and to the computation of their solutions."

Fifteen-year old Lax, a child prodigy in Hungary, sailed from Lisbon with his father, mother, and brother on the fifth of December, 1941, two days before the Japanese attacked Pearl Harbor that brought the United States into World War II. Upon the advice of John von Neumann, he enrolled at Stuyvesant High School in New York for a year to improve his English and then entered NYU, where he immediately started taking graduate courses. In a course on complex variables, he met Anneli. A few years later, they were married. Anneli, after finishing her doctorate under Richard Courant, spent the rest of her career at NYU. For thirty-eight years, until her death in 1999, she served as Editor of the MAA's New Mathematical Library.

In 1944, Lax was drafted into the Army; in 1945, he was sent to Los Alamos, where work on the first atomic bomb was moving into the testing phase. In the fall of 1946, he returned to NYU, and earned his Ph.D. in 1949. He has been a member of the NYU faculty ever since, and spent ten summers consulting at Los Alamos.

Lax insists that he is both pure and applied. In an earlier interview, he said "In applied mathematics you are very much aware of where the question comes from and also where the answer is going. After all, when a mathematician says he has solved a problem, that doesn't have a definite meaning — rather it means usually that he has understood something about the problem. So the kind of understanding that you need to be able to say you have solved the problem as an applied problem is different from the kind of understanding you need to be able to make the same statement about a problem in pure mathematics." In the end pure and applied are labels, and probably not too important.



Lax does not always lecture in a tuxedo.

The following interview took place in New York City on April 8, 2005.

Don Albers: Peter, you recently won the Abel Prize. What was your reaction to winning it?

Peter Lax: It was a bit dream-like, but certainly very nice. It won't make much difference in my life.

DA: Was it a big surprise?

PL: Well, certainly not a thing I counted on. I knew that I had been nominated, but I put it out of my mind so the announcement came as a big surprise.

DA: How were you informed?

PL: I was called at 5:30 in the morning.

DA: That's not a good time to call people.

PL: It depends on the message.

DA: But generally one would think it's bad news at that time of day.

PL: To me it was a complete surprise, but my son Jim knew about it in advance. The Abel committee wanted to make sure that they would catch me on the day so they contacted Jim a few days earlier. Jim had a dinner party the night before they called to make sure I would be home and said he would come over the next morning to take a blood sample. (Jim is a physician.)

DA: So your son knew before you did? It must have been hard for him to keep his mouth shut.

PL: He kept it completely secret.

DA: Some mathematicians used to argue that it was good in some sense that there is no Nobel Prize in mathematics. There may have been a bit of sour grapes in such statements. Now they have the Abel, which carries a monetary award that is comparable to the Nobel. What do they say now?

PL: Certainly it's a very nice thing for mathematics, and I think it should be judged from that point of view. The *New York Times* did not carry it as a news item, but I think from now on they will. I hope to convince the *Times* to carry a statement from the International Mathematical Union about the Abel Prize each year.

They did print an interview with me in the Tuesday Science Section [March 29, 2005].

DA: Well, if the *Times* covers the Abel Prize each year, you can be assured that other newspapers will do the same, and that's good for mathematics.

PL: Yes.

DA: The Bolyai Prize was established by Hungary very early in the 20th century to honor mathematics.

PL: That's right. Bolyai and Abel were born in the same year, 1802. The Bolyai Prize was established in 1902, the centenary of Bolyai's birth. The Abel Prize also was first proposed in 1902 by King Oscar II of Norway and Sweden. But the plan was dropped when Norway broke away from Sweden in 1905. The first Bolyai Prize wasn't awarded until 1905, four years after the first Nobel Prizes were awarded. The Bolyai Prize was given every five years and had a very distinguished record. The first recipient was Poincaré in 1905 and the second was Hilbert in 1910, and then came the World War.

DA: It's interesting to contemplate what might have been if the Bolyai Prize had continued.

PL: It's also interesting to contemplate what might have happened had there been no First World War! There was a joke among journalists at the end of the First World War in Hungary. Everything was destroyed and there was misery all around. Hungarian journalists were playing various games and one of the games was to construct the most sensational headline. And the winner was "Franz Ferdinand Found Alive – World War Fought in Error."

DA: You have previously won many other prizes that are regarded as very distinguished. Among them are the Wolf Prize, the Wiener Prize, and the National Medal of Science. It's quite a list. Does it feel any different winning this one — the Abel?

PL: The public recognizes only a Nobel Prize. If you introduce anyone to a person who is a Nobel Prize winner, that's a big deal. The Abel has half the aura of the Nobel. I'm not sure how Anneli would have reacted to the Abel Prize. She was puritanical. She thought all mathematicians are foot soldiers in the army of mathematics.

DA: But they're pretty competitive foot soldiers aren't they?

Peter Lax and his wife Anneli, who also spent her career at NYU. She edited the MAA's New Mathematical Library (NML) book series for 38 years until her death in 1999. In her honor, the NML was renamed the Anneli Lax New Mathematical Library.

PL: True. This is an ideal. Inside mathematics these prizes don't matter that much. I think it's public relations stuff for the outside world.

DA: I think it's more than that. I think the recognition, not just of the individuals, but of the field, is good.

PL: Yes, I think this was a boost for applications of mathematics.

DA: You mentioned that your son Johnny would have been happy to see you win the Abel Prize.

PL: He would have been tickled.

DA: I've never asked about him — I guess for obvious reasons. [Johnny was killed in an automobile accident when he was a graduate student.]

PL: It's not a painful subject to me really. He was lovely. He was a historian. He would go to universities to visit libraries and special collections. He looked very much like me and he would drop into the Math Department and ask: Whose son am I?

DA: There are stories about why Nobel did not choose to recognize mathematics. Most of the stories are false and the most notorious is the one about the well-known mathematician Mittag-Leffler romancing Nobel's wife, and that Nobel was afraid that Mittag-Leffler might win a mathematics Nobel if it were to be established.

PL: But Nobel wasn't married.

DA: Yes, so that's a real complication for that story.

PL: Do you know why Alfred Nobel established the prize? Robert, one of his brothers, died while Alfred was still alive, and one of the newspapers made a mistake and thought it was Alfred. A blistering editorial said that Alfred, who had invented dynamite, was a man who devoted his life to death and destruction. It took Nobel several years to make dynamite safe for transport, and during the first years, there were many accidents. So Alfred decided to do something to enhance his reputation. By establishing the Nobel Prizes, he succeeded.

DA: Others have defended Nobel's decision to not recognize mathematics by noting that biology is not recognized either.

PL: That's true, but medicine is.

DA: Essentially the argument that's offered is that biology is not recognized because it was regarded as one of the tools for medicine. And mathematics was not recognized for essentially the same reason — that it's a tool for physics, chemistry, and other sciences.

One of the things that I like about the Abel Prize a lot is that it really seems to close the "prize gap" between accomplished mathematicians under 40 (the Fields Medal) and those over 40. You've previously said that it's a myth that mathematics is a young person's sport.

PL: I'll stick to that. I can give some examples. For instance, Haar wrote his last paper, on Haar measure, when he was 53, and he died soon thereafter. When Onsager did his work on change of phase, for which he received a Nobel Prize in 1968. He needed a mathematical theorem on the asymptotics of the determinant of Toeplitz matrices. Onsager was told that if anyone can prove it, it would be Szegö; Szegö did. He was 58 at the time.

DA: Of the first four winners of the Abel, Serre, Atiyah, Singer, and you, three have made substantial contributions to applied mathematics.

PL: The index theorem of Atiyah and Singer is of great importance in physics, although that was not their motivation.

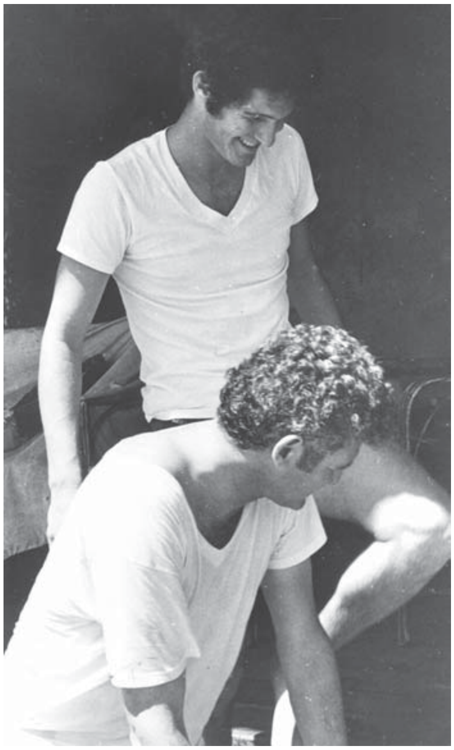
DA: Do you expect future Abel winners to be recognized for work within applications based on the winners so far?

PL: That depends on how the criteria for the Abel prize are specified.

DA: Here's the official statement: "The prize is to recognize contributions to mathematics and its applications of extraordinary depth and influence. Such work may have resolved fundamental problems, created powerful new techniques, introduced unifying principles or opened up new areas. The intent is to award prizes over the course of time in a wide range of areas of mathematics and its applications."

PL: That's a very broad statement. I'm sure that was taken into account when I was chosen.

DA: In 1989 you wrote the "Flowering of Applied Mathematics in America." It was one of the AMS Centennial addresses. You said that "today most mathematicians are keenly aware that mathematics does not trickle down to the applications, but that mathematics and the sciences, mainly but by no means only physics, are equal partners feeding ideas, concepts, problems and solutions to each other." That may be true, Peter, when you look at specialized graduate programs. But it seems to me that most new graduates at all levels are woefully ignorant of applications. Take physics, for example, which used to be required virtually universally of undergraduate majors and hasn't been for twenty years. Today, most undergraduate mathematics majors can take one year of science survey courses, which can be a term of rocks, a term of stars, or a little bit of human biology, and that's it. I think that really gets in the way of developing an appreciation for applications among the students if the majority of faculty themselves do not know any applications. I think that extends through graduate education, too.



With son Johnny.

PL: I'd like to quote a distinguished predecessor, Poincaré, who said: "Nature not only suggests to us problems but also suggests a solution." I think that mathematics education is changing, partly because of the decrease in the number of academic jobs; and because of that mathematicians spend more time as post-docs than they used to, usually at the leading universities.

DA: So those universities can influence the shape of graduate education and undergraduate education.

PL: Yes, the good universities have very good science departments. Now, new areas in biology are becoming important; the biologists themselves are very eager to work with mathematicians. At the last two Joint Meetings in Phoenix and Atlanta, there were some excellent talks on biology.

DA: You may be interested to know that NIH, MAA, NSF, and several other organizations have developed *Math and Bio 2010* with the goal of linking undergraduate mathematics and biology.

PL: At NYU we have a Neurosciences Institute that Courant collaborates with. And we have Charlie Beskin, who works in mathematical biology. If you look at our weekly bulletin, you will find lots of biological talks.

DA: Courant is an unusual institution. In terms of applications, it has always been well ahead of the curve in the United States, thanks in large part to the man for whom the institution is named. Certainly Richard Courant's forced departure from Göttingen by the Nazis and his subsequent arrival at NYU in 1934 was a watershed event in American mathematics, partly because he was a champion of applied mathematics.

You've cited the positive impact of World War II on American mathematics. How do you view the recent decision by the Defense Advanced Research Project Agency (DARPA) — which has long underwritten open-ended "blue sky" research by our best computer scientists in universities—in favor of financing more classified works and narrowly defined projects that promise more immediate results?

PL: I think it's very shortsighted. One of the strengths of funding in America is that financial support for science, and mathematics has come from multiple sources. So if DARPA cuts down, then hopefully NSF will increase. Of course classified research would be incompatible with university research. At the end of the Second World War the American military was very much shaken by their experience. When scientists first brought up the possibility of nuclear weapons, the military refused to support it, but in the end they realized it could make a difference between winning or losing. They were determined never again to be caught flat-footed like that. Sputnik appeared in 1957 — that was 12 years after the war— and that produced another wave of anxiety. In short order the "new math" and the *New Mathematical Library* came into existence. Today the realization that there is a connection between vigorous pursuit of science and national readiness is beginning to fade.

DA: The National Science Foundation really began to develop at that time, too.

PL: The Office of Naval Research was the first agency to systematically support mathematics and science. NSF came after it. It became clear that from theoretical investigations come concrete applications.

With son Jimmy, who now practices medicine in his grandfather's old office.

DA: You're something of a champion of computers and their importance to mathematics. You have said that their role in mathematics is comparable to that of telescopes in astronomy and microscopes in biology.

PL: I don't think I'm alone in extolling the importance of computers in mathematics.

DA: You've been saying that for a pretty long time.

PL: Well, I had the good fortune to get in on the ground floor of computing at Los Alamos in the 50s. I started working there during summers and continued to do so in the summers for the next 10 years. While I was there I was able to work with sophisticated computers.

DA: You had a good time during your Los Alamos years.

PL: Oh, yes, it was very exciting. There were many great people there — von Neumann, Feynman, Bethe, and many more.

DA: And that's where you really came to appreciate the value of computing.

PL: Absolutely; it was vital to the work. Each year's computer was a tremendous improvement over the previous one, so last year's difficult problem was now easy.

DA: Von Neumann entered your life when you were only 15, and his influence on you has been considerable. In your recent *SIAM Review* article about him ("John Von Neumann: The Early Years, The Years at Los Alamos and The Road to Computing"), you wrote: "Nuclear weapons cannot be designed by trial and error; each proposed design has to be tested theoretically. This requires solving the equations of compressible flows, governed by nonlinear equations. Von Neumann came to the conclusion that analytical methods were inadequate for the task, and that the only way to deal with equations of continuum mechanics is to discretize them and solve the resulting system of equations numerically. The tools needed to carry out such calculations effectively are high speed, programmable electronic computers, large capacity storage devices, programming languages, a theory of stable discretization of differential equations, and a variety of algorithms for solving rapidly the discretized equations. It is to these tasks that von Neumann devoted a large part of his energies after the war. He was keenly aware that computational methodogy is crucial not only for designing weapons, but also for an enormous variety of scientific and engineering problems; understanding the weather and climate particularly intrigued him. But he also realized that computing can do more than grind out by brute force the answer to a concrete question."

Von Neumann only lived to be 53. His accomplishments were truly extraordinary. Suppose he had had a normal life span?

PL: In my SIAM article, I give an answer: "Had von Neumann lived his normal span of years, he would have certainly been honored by a Nobel Prize in Economics, created only after his death. And had he lived an abnormal span, he would certainly be honored by a Nobel Prize in Computer Science and another one in Mathematics; these Prizes do not exist yet, but they are bound to be established eventually. So we are talking about a triple, possibly 3 1/2 fold Nobelist, if we take into account his contributions to the foundation of quantum mechanics."

DA: Apart from his powerful intellect, what aspect stands out about him most vividly in your mind?

PL: His interests were so very broad. It was easy to explain things to him because he had such a powerful mind. Most things he figured out himself. In a way it was a curse because he was easily bored.

In a way he extended the boundaries of thinking and intellectual analysis. There's a quote from Wigner. He visited Hungary in the 70s, and they made much of him on television. One of the questions put to him was: "Is it true that in the late '40s and early '50s the policy of the Defense Department was determined by von Neumann?" He replied: "Well, this was not exactly true. But once von Neumann analyzed a problem it was clear what was to be done."

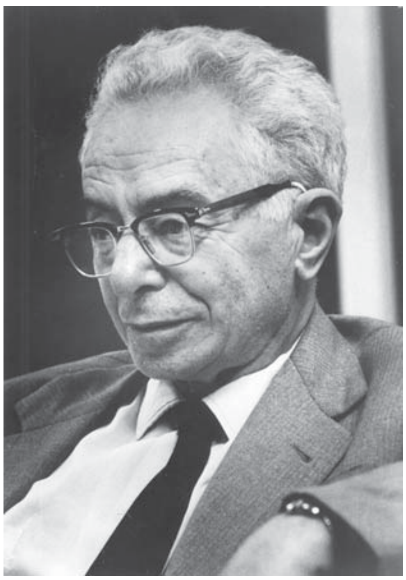
DA: A few years ago you said some pretty strong stuff about the teaching of calculus. You said, among other things, that "we should abolish the calculus committees. The teaching of calculus is completely diverted from the way in which calculus is thought about and used by professionals." And then I love your next one: "If we taught music like we taught calculus we'd just be teaching scales." You also wrote, "I strongly believe that calculus is a natural vehicle for introducing applications and that it is applications that give proper shape to calculus, showing how and to what end calculus is used." The Tulane Conference occurred in 1989 and that basically kicked off the calculus reform movement, and then NSF supported calculus reform throughout the 90s.

PL: Calculus books have improved, but I still worry about their treatment of applications; it is often superficial. I like our book, *Calculus with Applications and Computing,* published in 1976. There are lots of good ideas in it, but they're not polished. A calculus book has to be highly polished. I still dream of finding a good co-author and writing a revised version.

Something that's never asked in a calculus book is how come the laws of physics are in the form of differential equations. Is there a calculus Mafia? The answer is very simple. In nature there is no, or very little, influence at a distance except for gravity. Usually two objects have to be in contact in order to influence each other. The laws of science express the relations between physical (or chemical) quantities at a point of contact. The physical quantities can be expressed in terms of functions and their derivatives.

DA: You're right. That brings me back to a previous concern — I was going to say complaint, but I'll be milder and call it a concern. I still think that most undergraduate calculus classes are taught by people who really know very little about physics, and that's a real impediment.

Lax was only 15 when he first met John von Neumann,. According to Lax, "Most things he figured out himself. In a way it was a curse because he was easily bored."



Dismissed by the Nazis as director of the mathematics institute in Göttingen, Richard Courant, came to the United States and created the mathematics insitute (now the Courant Institute) at New York University. Anneli earned her doctorate under Courant's direction.

PL: You're right.

DA: Some have said, particularly people in computer science, that discrete mathematics is more important than calculus. And that it might be a better foundation than calculus for students. What do you think?

PL: I think that's an exaggeration and I don't agree with it. In particular, discrete mathematics is more difficult than continuous mathematics. If you look at formulas for derivatives of reciprocals and then finite differences for reciprocals, you see how things are more complicated in the discrete case. In fact, I'm just finishing a revision of some very old notes on hyperbolic equations. I have written an additional long chapter on difference approximations for solving hyperbolic equations. The main point in the theory of difference approximations is to prove stability. To prove stability is like getting an *a priori* estimate for the solution of the equation. But to get those estimates for difference approximations is much more sophisticated than to get them for a differential equation. My wife Anneli, however, made the point that a *high school* course along the lines of "Finite Mathematics" would be good.

DA: *Finite Mathematics*, by Kemeny, Shell, and Thompson.

PL: Yes. That was a wonderful book. Something like that on the high school level could be very good.

DA: I think you're right. But a big difficulty for high schools is the pressure to take calculus because having calculus on your record will enhance your chances of getting into the college that you want.

PL: That's fine, if it does enhance your chances. It puts you ahead in studying physics, and chemistry, so there's nothing wrong with that. I'm not saying replace calculus. The thrust of today's educational reform, *No Child Left Behind*, concentrates on the weaker student. That is very important, but it is equally important to not forget about the strong student.

DA: Over the years you have worked on several big problems. Where do the best problems come from?

PL: It helps to be at a center of mathematics like Courant because then you keep your finger on the pulse of mathematics. It's a tremendous advantage and it's really unfair to guys at smaller schools. The Internet helps a little bit, but personal contact is best. So I have had an unfair advantage.

DA: You've previously stated that you really like to find your own problems and that for you those problems have typically been rooted in a natural phenomenon. The more striking the phenomenon the more interested you become in it, and then in trying to explain it.

PL: Yes, yes. Mathematics is certainly very strongly rooted in understanding interesting phenomena.

DA: You have worked in many areas. What's particularly striking are all of the terms and theorems that bear your name: *Lax-Phillips scattering theory*, the *Lax entropy condition*, the *Lax theorem*, the *Lax-Milgram theorem*, the *Lax equivalence principle*, the *Lax-Friedrichs scheme*, the *Lax-Wendroff scheme*, *Lax shocks*, the *Lax relation*, and *Lax pairs*. Your name will live on. Have some of the areas given you more joy or satisfaction than others?

PL: No, I loved all of them.

DA: You loved them all. Like your children.

PL: Yes, yes, like children.

DA: What's the toughest problem you ever worked on and solved?

PL: Two things come to mind. One is a very tricky result — I called it an abstract Phragmen–Lindelöf principle. It's a very difficult result. I had carelessly announced it as a theorem and then I had to prove it. And it takes 12 lemmas.

DA: That's a lot of lemmas.

PL: And the other tricky result is the zero dispersion limit for the KdV equation which I did with a student, Dave Levermore. That was technically very difficult.

DA: You have said that mathematics is like painting.

PL: Yes, yes, I'm very proud of that metaphor. I think it is original. I love painting. And I gave the reason for it. "In math there is a creative tension between describing and understanding and solving the laws governing nature, on the one hand, and making pleasing logical patterns on the other." And in painting it's the same way. There is a creative tension between rendering the shapes, colors, and textures of nature, and making pleasing abstract patterns. I have little talent for it. Finishing a painting was like solving a problem. If I were doing it again, I would work on several paintings at once. Certainly in mathematics I always told my students to work on several problems at the same time. You'll usually be stymied on most of them.

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Don Albers is the MAA's Director of Publications. He was one of the authors of Mathematical People, and More Mathematical People.

Some of Peter Lax's Major Contributions

Shock Waves: All of us are familiar with shock waves coming from airplanes moving at supersonic speeds, but shocks also occur in the interface of oil and water as found in petroleum reservoirs. Shock waves also occur in traffic congestion.

Lax clarified shock wave theory by solving the Riemann problem and then developed practical numerical methods for calculating flows associated with shock waves.

Scattering Theory: In scattering, light or sound that is intercepted by an object, such as a molecule, is sent off in many, perhaps random, directions. For example, the scattering of sunlight by molecules in the atmosphere gives the sky its general glow. Radar is based on scattering of electromagnetic waves.

Lax and Ralph Phillips developed the *Lax-Phillips semigroup*, which led to an improved understanding of scattering. Curiously, this has applications to the theory of automorphic functions.

Solitons: Solitons are solitary waves, first discovered in 1834, when the Scottish engineer, John Scott Russell, while riding his horse along a channel, observed a boat that was being pulled by horses along the channel. When the boat came to a halt, an isolated wave emanated from the bow, and Scott Russell followed it for more than a half mile. The wave did not disperse and its shape remained unchanged.

Solitons were studied by Korteweg and deVries in 1895. The model they derived is now called the KdV equation. Lax provided great insights into the KdV by creating *Lax pairs*. Recent experiments have used solitons for high-speed communication in optical fibers. The digital signal is coded using "ones" and "zeroes," and we let "ones" he represented by solitons. Since solitons are highly stable over long distances, this offers the potential of considerably higher capacity in optical fiber communication networks.

Groups in the Household

By Joseph A. Gallian

"The more math you know, the more math you see…" Jason Fox, *Foxtrot*

Although a typical undergraduate student taking abstract algebra views group theory as something having little connection with everyday affairs, an instructor can counter this impression by calling attention to the fact that groups arise naturally in many ordinary contexts. In this note we describe instances of groups that are commonplace but often overlooked.

Broken symmetries in a car wheel.

An instance of groups that ones sees everyday is automobile wheel designs. These are appealing examples of cyclic and dihedral symmetry groups. Even though wheel patterns appear highly symmetrical and attractive their symmetry groups may be the trivial group. This is usually the case for wheels that have one symmetry pattern around the outer edge and another one in the middle. I have seen examples of wheels with 12-fold, 9-fold, and 8-fold rotation symmetries around the outer edges and 5-fold rotational symmetry in the middle (because of the lug nuts). Since the group of symmetries of the entire wheel is the intersection of the groups of the two patterns, it follows from Lagrange's theorem that in these cases the trivial symmetry is the only symmetry of the entire wheel.

The symmetry group of a bicycle wheel is another case where the symmetry group is not immediately obvious. For example, the wheels on my bicycle have 36 spokes but only 9-fold rotational symmetry since the spokes are staggered four at a time.

Direct products of cyclic groups can be found in your home. In a bedroom the group $Z_2 \oplus Z_2$, which one can also think of as the dihedral group $\mathbf{D}_2$, arises when one rotates a mattress all possible ways. This group consists of R_0, a rotation of 0 degrees; R_{180}, a rotation of 180 degrees about an axis perpendicular to the top; H, a rotation about an axis perpendicular to a side (thereby interchanging the "up" and "down" sides and the head and foot of the mattress); and V, a rotation about an axis perpendicular to the foot (thereby interchanging the left and right sides and "up" and "down" sides but leaving the head side at the head). Since this group is not cyclic there is not a single motion that one can repeat monthly to ensure even wear. However, by monthly alternating the motions R_{180} and V (the easiest two non-trivial motions to perform) all four possible positions of a mattress are realized over the course of four months.

Hallways and stairways often have lights that are operated by two or more switches so that when any one switch is thrown the light changes its status from on to off or vice versa. The group $Z_2 \oplus Z_2$ models the case where there are two of these switches. If the wiring is done so that the lights are on when both switches are up or both switches are down then we can conveniently think of the states of the two switches as being matched with the elements of $Z_2 \oplus Z_2$ with the two switches in the up position corresponding to (0,0) and the two switches in the down position as corresponding to (1,1). Each time a switch is thrown we add 1 to the corresponding component of $Z_2 \oplus Z_2$. It follows that the lights are on when the switches correspond to the elements of the subgroup $\langle(1,1)\rangle$ (the subgroup generated by (1,1)), and are off when the switches correspond to the elements in the coset (1,0) + $\langle(1,1)\rangle$. The case of three switches is modeled by the group $Z_2 \oplus Z_2 \oplus Z_2$

with the subgroup $\langle (1,1,0),(0,1,1) \rangle$ corresponding to the situation where the lights are on.

Items in kitchen cupboards give rise to interesting groups. The symmetry group of a spaghetti box (nonsquare ends) is $Z_2 \oplus Z_2 \oplus Z_2$. The rotation group of a box of crackers (with square ends) is $\mathbf{D}_4$ and the full symmetry group consists of the semidirect product of $\mathbf{D}_4$ and $\mathbf{Z}_2$ (the identity and a reflection). The full group is a semidirect product rather than a direct product since the reflection that interchanges the opposite ends of the box does not commute with the rotations.

Games found around the house occasionally involve groups. The 15-puzzle that has sliding blocks numbered 1 to 15 and a empty space in the lower right hand corner permits rearrangements corresponding to the elements of $\mathbf{A}_{15}$, the alternating group on {1,2,... ,15}. The group of motions of a Rubik's cube has order 43252-003274489856000. The 15-puzzle and the Rubik's cube are good examples of instances where the theory of groups provides insight into the solutions of the puzzles. Without group theory it would be quite difficult to determine exactly which rearrangements of the 15-puzzle are obtainable.

One of the most striking facts about the world we live in is that there are only five kinds of finite groups of rotational symmetry in three dimensions: cyclic, dihedral, $\mathbf{A}_4$, $\mathbf{S}_4$, and $\mathbf{A}_5$. All five are realized by common objects. Indeed, the group of rotations of a volleyball, a cube, and a soccer ball have the rotation groups $\mathbf{A}_4$, $\mathbf{S}_4$, and $\mathbf{A}_5$, respectively. In each case the full symmetry group is the semidirect product of the rotation group and $\mathbf{Z}_2$.

A drinking glass whose symmetry is *not* $\mathbf{R}/2\pi\mathbf{Z}$

Two interesting infinite groups of rotational symmetry are those of a beach ball (sphere) and of a smooth drinking glass. The first is isomorphic to the group of 3x3 matrices of determinant 1 that have the property that the transpose of a matrix is its inverse (the special orthogonal group $\mathbf{SO}_3$) The second group is the group of rotations around a central axis, which can be thought of either as SO_2 or as the factor group $\mathbf{R}/2\pi\mathbf{Z}$, where $\mathbf{R}$ is the group of real numbers under addition and $2\pi\mathbf{Z}$ is the subgroup of integral multiples of 2π.

One can even find an example of a group when wagering on horse races online! There is a wager called the "trifecta box" where a bettor selects three horses that he believes will finish first, second, and third in any order. Of course, this is an instance of $\mathbf{S}_3$. The person who explained this wager to me commented, "Someone figured out that are 9 possibilities." Even though this person is quite intelligent, he accepted this statement as fact.

It is worth pointing out that the connection between groups and commonplace objects is two-way. Sometimes the groups provide interesting information about the objects, as in the case, of the 15-puzzle, and sometimes the objects provide an interesting way to think about the group, as in the case of the rotations of a soccer ball.

Editor's note. This article was the substance of a talk given at the Joint Mathematics Meetings in Atlanta in a special session, organized by the CUPM 2004 Committee, on the topic of introducing contemporary concepts into mathematics courses.

Letters to the Editor

Due to the size of this issue, we have had to save our letters section for the next issue.

Building Bridges for QL Education: National Numeracy Network and SIGMAA QL

By Bernard L. Madison

In response to the increasing need for collegiate education that helps students achieve quantitative literacy (QL) and the complexities of providing that education, two new complementary organizations have emerged. One is the MAA's special interest group SIGMAA QL, and the other is an interdisciplinary membership organization, the *National Numeracy Network* (NNN). These organizations have missions that are integral parts of a growing national effort to make Americans more able to deal with the multitude of quantitative issues that confront them in their daily lives as citizens, consumers, and workers.

Different terms are used around the world with meanings closely related to or interchangeable with QL. "Numeracy" is used in many countries outside the US. Other closely related terms are "quantitative reasoning," "mathematical literacy," "statistical literacy," and "financial literacy."

SIGMAA QL was formed by action of the MAA Board of Governors in January 2004 and aims to provide a structure within the mathematics community to identify the prerequisite mathematical skills for QL and find innovative ways of developing and implementing QL curricula. The 2004 Chair of SIGMAA QL was Judy Moran (Trinity College) and the 2005 Chair is Caren Diefenderfer (Hollins University). Rick Gillman (Valparaiso University) was a driving force in organizing SIGMAA QL.

The National Numeracy Network (NNN) was formally established as a membership organization at a meeting held at Moose Mountain Lodge near Dartmouth College (NH) in June 2004. As stated in its vision statement, NNN aims toward a society in which all citizens possess the power and habit of mind to search out quantitative information, critique it, reflect upon it, and apply it in their public, personal, and professional lives.

NNN is incorporated in the State of Washington, and of the five members of the NNN Board of Directors, two are in mathematics, and one each in physics, geology, and education. Bernard L Madison (University of Arkansas) is NNN President, and Rebecca Hartzler (Seattle Community College) is Secretary-Treasurer. The other directors are Kim Rheinlander (Dartmouth College), Henry L. Vacher (University of South Florida), and Dorothy Wallace (Dartmouth College). The first meeting of NNN will be held at Macalester College in St. Paul (MN) June 18-19, 2005.

Common Goals

Both NNN and SIGMAA QL recognize that education for QL involves disciplines other than mathematics, but that mathematics has a major contribution to make. As stated in its purpose, beyond its work within the mathematics community, SIGMAA QL also intends to assist colleagues in other disciplines to infuse appropriate QL experiences into their courses. NNN is an interdisciplinary organization and is dedicated to promoting education that integrates quantitative skills across all disciplines and at all levels. To this end NNN supports and promotes collaborations among students, educators, academic centers, educational institutions, professional societies, and corporate partners. Both SIGMAA QL and NNN strive to keep issues of quantitative literacy at the forefront of national and international conversations about educational priorities.

NNN Background

For about three years prior to its official organization, NNN had been a loose confederation of QL centers on college campuses and was part of the initiative in QL sponsored by the National Council on Education and the Disciplines (NCED) located at the Woodrow Wilson Foundation. NCED, led by Robert Orrill, was the lead sponsor of the 2001 national forum, *Quantitative Literacy: Why Numeracy Matters for Schools and Colleges*, held at the National Academy of Sciences. MAA was a cooperating sponsor of the forum, which was hosted by the Mathematical Sciences Education Board of the National Research Council.

The NCED QL initiative also resulted in the publishing of *Mathematics and Democracy* (edited by Lynn Arthur Steen) and the proceedings of the national forum, *Quantitative Literacy: Why Numeracy Matters for Schools and Colleges* (edited by Bernard L. Madison and Lynn Arthur Steen). A third book, *Achieving Quantitative Literacy: An Urgent Challenge for Higher Education*, written by Lynn Steen and published by MAA, is based on the proceedings and recommendations from the national forum. All three of these books are available from the MAA Bookstore.

NNN offers memberships for individuals, institutions, and corporations. Membership benefits highlight interdisciplinary communication and cooperation facilitated by NNN publications and meetings.

SIGMAA QL Background

Although mathematics for general education always has been a part of the US college curriculum, expectations in QL as a part of an undergraduate degree have been becoming more prominent in the past few decades. In 1989 the MAA, partly in conjunction with the appearance of the National Council of Teachers of Mathematics (NCTM) *Curriculum and Evaluation Standards for School Mathematics*, appointed a Subcommittee on Quantitative Literacy Requirements (QL Subcommittee) of the Committee on the Undergraduate Program in Mathematics (CUPM). This subcommittee began by considering the question: What quantitative literacy requirements should be established for all students who receive a bachelor's degree?

In 1994, the QL Subcommittee issued a report, "Quantitative Reasoning for College Graduates: A Complement to the

Standards," which highlighted four conclusions:

Colleges and universities should treat quantitative literacy as a thoroughly legitimate and even necessary goal for baccalaureate graduates.

Colleges and universities should expect every college graduate to be able to apply simple mathematical methods to the solution of real-world problems.

Colleges and universities should devise and establish quantitative literacy programs each consisting of foundation experience and a continuation experience, and mathematics departments should provide leadership in the development of such programs.

Colleges and Universities should accept responsibility for overseeing their quantitative literacy programs through regular assessments.

These conclusions emphasize the collegiate responsibility for QL education, but the report did not have much immediate effect on collegiate mathematics, and QL continued to be poorly understood and largely ignored in college mathematics curricula. The QL Subcommittee continued to work after 1994, but the need for a more substantial presence of QL in MAA activities was evident from the work produced by the NCED initiative and the substantial attention to general education issues in the *CUPM Curriculum Guide 2004*. This need led to creation of the SIGMAA QL.

Other Organizations

MAA, NCED, and NNN are not the only organizations that have recognized the growing issue of education for QL. Over the past 20 years the American Statistical Association and NCTM developed curricular descriptions and materials that formed the basis of the NCTM's data analysis and probability strand in the NCTM Standards. These developments were made under the heading of quantitative literacy and are critical components of the existing efforts in QL education.

Len Vacher, NNN Director, has for some time written a column for the *Journal of Geoscience Education* about QL for geoscientists. Project Kaleidoscope, an interdisciplinary science and mathematics project that promotes reform, has organized several sessions and workshops on QL. The Association of American Colleges and Universities (AAC&U) has hosted several major conferences on reform of general education with QL (or quantitative reasoning) as one of the major topics.

The momentum of the QL movement was affirmed and increased with the publication of the Summer 2004 issue of AAC&U's *Peer Review* dedicated to QL. *Peer Review*'s headline mission is to address 'emerging trends and key debates in undergraduate education.' The *Peer Review* QL issue contains two analytical essays by Lynn Steen and Bernard Madison along with descriptions of QL programs at Hollins University, Augsburg College, and James Madison University.

Colleges and QL

One of the driving forces behind the NCED initiatives and the missions of NNN and the SIGMAA QL is the realization that education for QL is a college issue, as made clear in the 1994 MAA report. Lynn Steen makes this point cogently in his *Peer Review* article. Using several examples of percentages and averages, Steen concludes, "… QL is sufficiently sophisticated to warrant inclusion in college study and, more important, that without it students cannot intelligently achieve major goals of college education. Quantitative literacy is not just a set of precollege skills. It is as important, as complex, and as fundamental as the more traditional branches of mathematics. Indeed, QL interacts with the core substance of liberal education every bit as much as the other two R's, reading and writing."

Along with Steen, in his *Peer Review* analysis Bernard Madison emphasizes that education for QL requires interdisciplinary cooperation far beyond what is now the norm in colleges and universities. Madison's analysis focuses on changes in collegiate mathematics that will promote this interdisciplinary cooperation and stronger QL education. Interdisciplinary cooperation is at the very core of the motivation for creating NNN, and the fact that there are strong connections to SIGMAA QL offers opportunities to simultaneously strengthen collegiate mathematics and QL.

Bernard L. Madison is professor of mathematics at the University of Arkansas, member of the SIGMAA QL, and President of NNN.

MAAQL
http://www.maa.org/QL/index.html

National Numeracy Network
http://www.math.dartmouth.edu/~nnn/index.html

SIGMAA QL
http://pc75666.math.cwu.edu/~montgomery/sigmaaql/

National Numeracy Network Meeting
June 18-19, 2005

Immediately following
PREP Workshop: Creating and Strengthening Interdisciplinary Programs in Quantitative Literacy
June 14-17, 2005
http://www.macalester.edu/qm4pp/workshops/prep.html#wl
Macalester College
St. Paul, MN

Archives of American Mathematics Spotlight: The Max Dehn Papers

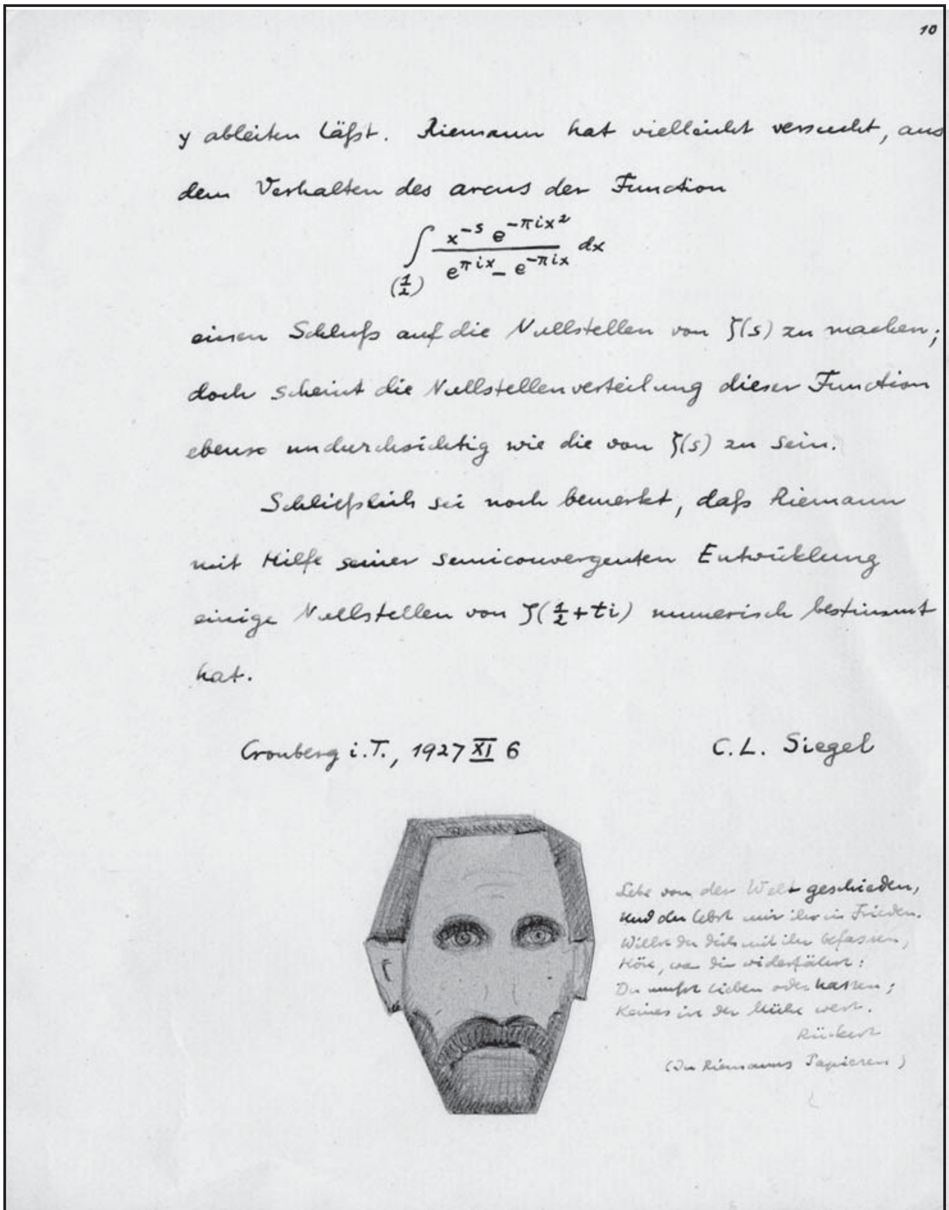
By Kristy Sorensen

The Max Dehn Papers at the Center for American History's Archives of American Mathematics tell the story of an established Jewish mathematician from Germany leaving his homeland under pressure from the Nazis and finishing his career in the United States, moving from one mathematically low-profile position to another. It is not a unique story, but the breadth and detail of the papers collected at the AAM make it an important part of the history of American mathematics.

Dehn (1878-1952) earned his doctorate at Göttingen in 1900 under the direction of David Hilbert. He spent the majority of his career in Germany at Frankfurt University, where he served as the chair of Pure and Applied Mathematics from 1921-1935. In Germany he wrote one of the first systematic expositions of topology and developed important problems on group presentations. His scope of research included geometry, topology, group theory, and the history of mathematics. In 1938 he was forced to leave the university by the Nazis. He first took a position in Scandinavia, and in 1940 came to the United States by an Eastern route through Russia and Japan.

After arriving in the United States, Dehn held several temporary appointments including positions at the University of Idaho in Pocatello, the Illinois Institute of Technology, and St John's College in Annapolis, Maryland, before becoming the first mathematician on the staff of Black Mountain College, an un-accredited creative arts college in North Carolina. Dehn remained in North Carolina until his death in 1952.

The Max Dehn Papers at the AAM include lecture notes by E. Hellinger; and correspondence, notebooks, manuscripts of publications, reprints, and lecture and course notes by Dehn. Correspondents include E. Artin, O. Blumenthal, H. Bohr, S. Breuer, C. Caratheodory, M. Kneser, E. Noether, M.



10

y ableiten läßt. Riemann hat vielleicht versucht, aus dem Verhalten des arcus der Function

$$\int_{(\frac{1}{2})} \frac{x^{-s} e^{-\pi i x^2}}{e^{\pi i x} - e^{-\pi i x}} dx$$

einen Schluß auf die Nullstellen von $\zeta(s)$ zu machen; doch scheint die Nullstellenverteilung dieser Function ebenso undurchsichtig wie die von $\zeta(s)$ zu sein.

Schließlich sei noch bemerkt, daß Riemann mit Hilfe seiner semiconvergenten Entwicklung einige Nullstellen von $\zeta(\frac{1}{2}+ti)$ numerisch bestimmt hat.

Cronberg i.T., 1927 XI 6 C.L. Siegel

Lebt von der Welt geschieden,
Und der lebt mit ihr in Frieden.
Willst du dich mit ihm befassen,
Hör, was dir widerfährt:
Du mußt lieben oder hassen;
Keines ist der Mühe wert.
Rückert
(In Riemanns Papieren)

C.L. Siegel article with caricature for 1928 Festschrift in honor of Arthur M. Schoenflies, 6 November 1927.

Mathematician C. L. Siegel wrote this article, "Über Riemann's arithmetischer Nachlass" ("On Riemann's arithmetical Nachlass"), as part of a tribute to Arthur Schoenflies, whom Siegel had replaced as professor of mathematics at Frankfurt University six years earlier. His colleague Max Dehn, a former assistant of David Hilbert, organized the compilation of the manuscript. From the Max Dehn Papers, Archives of American Mathematics, Center for American History The University of Texas at Austin.

Pasch, O. Toeplitz, and E. Zermelo. The majority of the materials are written in German, with some English and French.

The finding aid for the Max Dehn Papers is available online at: http://www.lib.utexas.edu/taro/utcah/00192/cah-00192.html.

The Archives of American Mathematics is located at the Research and Collections division of the Center for American History on the University of Texas at Austin campus. Persons interested in conducting research or donating materials or who have general questions about the Archives of American Mathematics should contact Kristy Sorensen, Archivist, k.sorensen@mail.utexas.edu, (512) 495-4539. The Archives web page: http://www.cah.utexas.edu/collectioncomponents/math.html.

American Mathematical Monthly Editor Search

The Mathematical Association of America seeks to identify candidates to succeed Bruce Palka as editor of the *American Mathematical Monthly* when his term expires in December 2006. The Search Committee plans to make a recommendation during the summer of 2005 so that the new editor can be approved by the Board of Governors and begin handling all new manuscript submissions in January, 2006. The new editor would be Editor-Elect during 2006 and would serve as Editor for the five years 2007-2011.

Questions about the position and its workload can be addressed to: G. L. Alexanderson (galexand@math.scu.edu), or Don Albers, Director of Publications at the MAA (dalbers@maa.org). Questions about MAA support for the editor's work can be addressed to Albers. Each applicant should submit a resumé, names of references, and a statement of interest containing his or her ideas about the journal. These can be emailed as attachments in Word or pdf format to the chair of the Search Committee, Gerald L. Alexanderson (galexand@math.scu.edu), or mailed to:

Gerald L. Alexanderson
Department of Mathematics
& Computer Science
Santa Clara University
500 El Camino Real
Santa Clara, CA 95053-0290

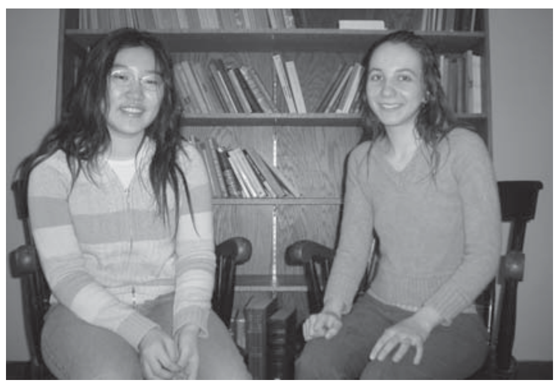
A candidate who would be an outstanding editor may be nominated by someone else. Applications and nominations will be accepted until the position is filled, although preference will be given to applications received by late May.

Women Excel in the 2004 Putnam Competition

By Joseph A. Gallian

In 2004, women made their best showing ever on the Putnam Competition. Sophomore Ana Caraiani of Princeton University became the first woman to be one of the five winners of the competition for a second time. Caraiani and her teammate Suehyun Kwon helped Princeton's team place second among the 411 teams (each with three students) entered in the competition. This marks the first time since 1939 that a team with a majority of women placed among the top five teams. In addition, two women were among Harvard's top three performers: Alison Miller, a freshman, and Inna Zaharevich. Miller, Zaharevich, and Olena Bormashenko of Waterloo finished in the 6–15 category. Women who received honorable mention were Kwon, Yuliya Gorlina of Caltech, Karola Meszaros of MIT, and Shubhangi Saraf of MIT. Eleven more women were ranked in the top 200.

Melanie Wood, who co-coached the 2004 Princeton Putnam problem solving class, attributes the women's success to their high school Olympiad training. Ana, Suehyun, and Alison all agree, citing the great coaching they had for the International Math Olympiad. Ana won a silver and two gold medals as a member of the Romanian IMO team. Suehyun won a gold medal for the South Korean IMO team. Alison was a gold medalist on the US IMO team in 2004. Olena won silver and gold medals as a member of the Canadian IMO team. The intensive training they received in high school for math competitions continues to pay off in the Putnam.



Princeton students Suehyun Kwon and Ana Caraiani.

A record number 3733 students from 515 schools participated in the Putnam. Reid Barton of MIT became the sixth person to win the competition for a fourth time. Along with Barton and Caraiani, sophomore Daniel Kane of MIT was a repeat winner in 2004.

A Century Celebration: Former MAA President G. Baley Price Turns 100

By Steve Carlson

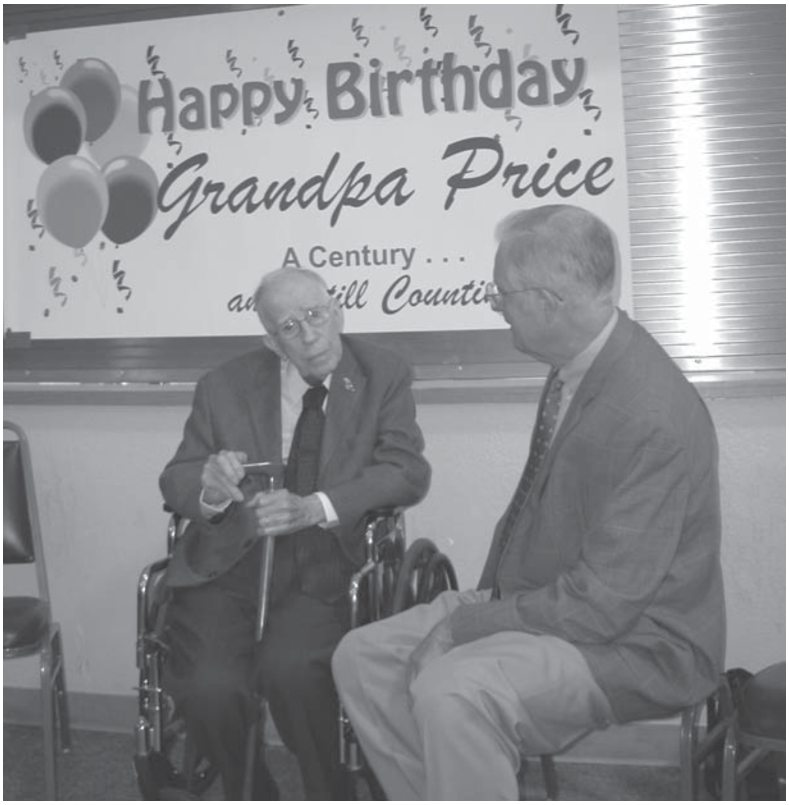
Along the multi-story, upward-spiraling staircase in the Vaughn Building at MAA Headquarters hang photographs of the presidents of the MAA. The tenth picture above the second floor is labeled simply "G. B. Price, President 1957–1958," and it shows a man of humble appearance who was in his early fifties at the time it was taken. It was with great pleasure that on March 14th the MAA — along with his family and many friends and colleagues world-wide — celebrated Griffith Baley Price's 100th birthday. This centennial observance for "Baley," as he is known by many, has been an occasion to celebrate the life of a very special mathematician and teacher.

Baley Price graduated from Mississippi College in 1925, received his Ph.D. at Harvard in 1932 under the direction of G. D. Birkhoff, and joined the faculty of the Department of Mathematics at the University of Kansas in 1937. His professional service contributions began in 1935, serving on the AMS Publicity Committee, followed by several years of work to help launch *Mathematical Reviews*. Among his early contributions to the MAA was a 1938 proposal that led to the establishment of the "Herbert Slaught Memorial Publications" and later, in 1952, the "Earle Raymond Hedrick Lectures." During the 1950s Price proposed and sought NSF funding for the Association's Visiting Lecturers Program, and he influenced — through his involvement with the National Research Council — the creation of both the program of Summer Institutes for teachers and the Committee on the Undergraduate Program. As MAA President he guided the Association's involvement with the "New Math" program of the School Mathematics Study Group (SMSG). His work between 1959 and 1962 on behalf of the Conference Board of the Mathematical Sciences (CBMS) was crucial, including service during the planning stages, as Chairman, and as Executive Secretary.

G. Baley Price with former student Joan Kirkham. She was in his statistics class in 1944. Taken at a March 12, 2005 private celebration at his church.

G. Baley Price with K.U. Professor Jack Porter, current chair of the K.U. Mathematics Department. Taken at the March 18, 2005 reception honoring Price during the Kansas MAA Section meeting held on the K.U. campus.

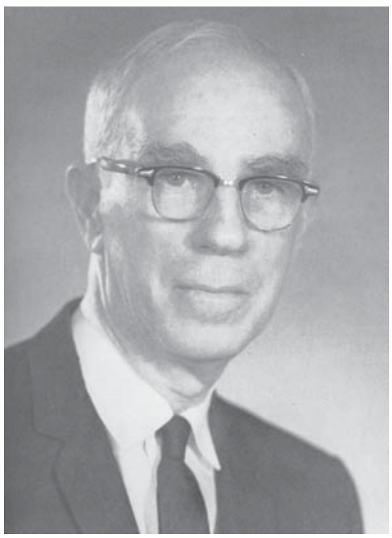
In addition to serving the mathematical community, Price answered the call to serve the nation during World War II, accepting an appointment within the Operations Research Section of the Eighth Air Force in England. His work on behalf of the war effort and the mathematics involved remain today among Baley's favorite discussion topics and were highlighted in a special lecture he presented at the K.U. Dole Institute of Politics in April 2004. He also contributed a section on this topic in Volume 4 of *A Century of Mathematics*.



G. Baley Price with K.U. Professor Charlie Himmelberg, who chaired the Mathematics Department at Kansas from 1978 through 1999. Taken at the March 12, 2005 celebration.

Baley chaired the Mathematics Department at K.U. from 1959 through 1970, the year in which he received the MAA's Award for Distinguished Service and also was named as the first E. B. Stouffer Distinguished Professor of Mathematics at Kansas. Under his leadership the K.U. math department had flourished, and with his unassuming approach and genuine kindliness he easily won the respect of colleagues and students. Baley officially retired in 1975, and that year the K.U. Mathematics Graduate Student Association honored him by naming its annual faculty teaching award the G. Baley Price Award for Excellence in Teaching. In 2004 a trust was funded by K.U. alumnus Balfour McMillen and his wife to honor Price's career achievements at the university with the creation of the G. Baley Price Professorship in Mathematics.

Baley and his wife Cora Lee Beers Price, who retired in 1979 from K.U. where she taught in both the English and classics departments, raised six children — five daughters and one son. Cora Lee died in December of 2004, but will long be remembered on the K.U. campus. Baley recently endowed the Cora Lee Beers Price Professorship in International Cultural Understanding at K.U. to honor her dedication to teaching.


*February 1970 Monthly photo: Photograph of G. Baley Price, 1970. From the article "Award for Distinguished Service to Professor Griffith Baley Price" by W. L. Duren, Jr. (*The American Mathematical Monthly*, Volume 77, No. 2, Feb. 1970, pp. 115-117)*

In addition to private birthday gatherings, Baley's 100th birthday was celebrated at the meeting of the Kansas MAA Section that was held on the K.U. campus March 18th. The special reception honoring his "One Hundred Years of Life and 70 Years of Mathematics" included a slide show of images spanning Baley's career at K.U. Price served as Kansas Section Chair 1940–1941 and as Kansas Section Governor 1952-1955 — just the first three years of a continuous presence in various capacities on the Board of Governors through 1964. He also later returned to the Board as a member of the MAA Finance Committee in the late 1970s and early 1980s, establishing a truly incredible record of Board service.

During one of his birthday events, using notes he typed on his computer, Baley talked briefly about his life. He started with one question: "Can you hear me?" Then he said, "When I talk, I want to be heard!" We have heard your wise words for many years, Professor Price, and look forward to hearing you for many years to come.

The author, who teaches at the Rose-Hulman Institute of Technology but received all three of his degrees from the University of Kansas, is currently a Visiting Mathematician with the MAA.

Looking for Stat(istician)s in All the Wrong Places

By Ann Cannon and Carolyn Cuff

Are you in a mathematics department that has been searching for an academic statistician but having a hard time finding one? Do you anticipate an opening for a statistician in 2006? You aren't alone. Anecdotal evidence suggests that many mathematics departments are having trouble hiring statisticians. The statistics community has taken notice of the situation and is attempting to help.

In the fall of 2004, fifteen statisticians, representing both liberal arts colleges and institutions with graduate departments of statistics, got together to discuss ways to improve the (two-directional) pipeline between these two types of institutions. Graduate institutions are concerned about declining numbers of domestic graduate students. Liberal arts colleges want to attract faculty members with degrees in statistics. This article is one of the results of this conversation.

With respect to the issue of mathematics departments wishing to recruit statisticians, one of the things we noted was that frequently mathematics departments advertise positions in places that are not the ones where academic statisticians tend to look. This article offers suggestions for where to advertise when recruiting academic statisticians. Within each category, we have ordered the listings starting with those mostly likely to be referenced by a graduate statistics student looking for an academic position.

Advertising in print (not free)

1. *AmStat News*, a monthly magazine published by the American Statistical Association and similar to FOCUS. The basic ad listing may not exceed 65 words, not counting equal opportunity information, and the cost for this basic ad is $290 for nonprofit organizations. (Larger ads for greater fees are also available.) Ads must be received (electronically or in hard copy) by the first of the preceding month to ensure appearance in the next issue (for example, September 1 for the October issue). A paid *AmStat News* ad also appears for free during the same month on the ASA job web site at http://www.amstat.org/opportunities/. The contact email address for more information is advertise@amstat.org.

2. *IMS Bulletin,* a bimonthly magazine published by the Institute of Mathematical Statistics. It reaches a much smaller audience than the *AmStat News*, but is still a search source for students in some of the graduate programs in statistics housed within mathematics departments. The deadline for the October issue is September 1 and there will be a similar deadline each year. The cost for a basic ad (up to 100 words) is $100, but they also accept longer ads for a higher fee. For more information about this advertisement option, see http://www.imstat.org/advertising.htm. A position advertisement published in any issue of the *IMS Bulletin* is also posted at the web site without additional cost for the two month period corresponding to that issue.

3. *Newsletter of the Caucus for Women in Statistics*: Job notices must be submitted by December 30, 2005 for inclusion in the Winter 2005 *Newsletter*. The fee for publishing a job notice for a half-page ad or less is $55, if prepaid, and $80 if billed. Longer ads are $75 prepaid and $100 billed. Please send the job notice and a check payable to the Caucus for Women in Statistics to Margaret Minkwitz. For more information, visit http://www.forestsoils.org/wcaucus/.

4. Ranked below the above sources are two mathematics department mainstays: *Employment Information in the Mathematical Sciences* and *The Chronicle of Higher Education*. Of note to potential employers, none of the statisticians at the meeting realized that mathematics departments at liberal arts colleges regularly advertise in the *Chronicle*.

Direct Advertising

Hard copy notices can be sent to the chairs of statistics departments in the United States. The addresses are available from the ASA web site http://www.amstat.org. Job notices sent directly to departments typically get posted in an area available to graduate students.

Electronic Advertising

Graduate students have become quite savvy about searching the web for job opening advertisements from schools which might be of interest. Put your best foot forward and make yourself appealing to a statistician.

1. The Department of Statistics at the University of Florida maintains a job listing web site http://www.stat.ufl.edu/vlib/jobs.html) where any Statistics position can be posted free of charge. The job position description should be sent as a plain text attachment to the email address jobs@stat.ufl.edu with a request to post it to their job listing web site. Questions regarding the web page may be sent to the same email. Many statistics graduate students search this web site every year, looking for positions. Once the job is posted, the electronic advertisement stays on the site for 6 months or when a request is made to have it removed.

2. The American Statistical Association maintains an email alias for chairs of both statistics and mathematics departments that have Ph.D. programs in statistics. Job position advertisements can be emailed electronically to all such graduate programs through this email alias. You will not be able to send the email directly to this list as only people who belong to this group can do that. However, you can send a job position notice to the American Statistical Association's office with a request that the job position be sent out to the chairs via this email alias. For this purpose, you need to send your job position (either as an attachment or entirely contained within your email message) to Carole Sutton, at this email address: Carole@amstat.org, along with the request that she send this job notice out to the "stat academic representatives" list.

Many mathematics departments routinely plan to conduct interviews at the Joint Mathematics Meetings in January. Most statisticians are not particularly interested in (or even aware of) these meetings and hence their graduate students are typically unaware of them. If your position is primarily aimed at hiring a statistician, interviews conducted at these meetings will be frustrating at best.

Statisticians can be extremely happy in mathematics departments. The statistics community has strong support systems for those individuals who serve as the sole statistician at a college (see http://www.isostat.org). The MAA also has a special interest group devoted to the teaching of statistics (see http://www.pasles.com/sigmaastat). Reaching statisticians who may eventually consider a mathematics department as their home is quite possible, but it's important to place the information where it is likely to be seen.

Ann Cannon is associate professor of statistics and mathematics at Cornell College (Mt. Vernon, IA). She is the current moderator of the Isolated Statisticians (a group of self-defined isolated academic statisticians), past chair of the Iowa Chapter of the ASA and is active in the ASA's Section on Statistical Education.

Carolyn Cuff is a professor of mathematics at Westminster College (PA). She is a past-chair of SIGMAA Stat-Ed and is active in the ASA's Section on Statistical Education.

NSF Beat
Course, Curriculum, and Laboratory Improvement (CCLI) Program

By Sharon Cutler Ross

The CCLI program of the Division of Undergraduate Education has been substantially rewritten to reflect the maturation of the program, increased knowledge about the teaching and learning of science, technology, engineering, and mathematics (STEM) subjects, new challenges for STEM education, and changes in the NSF budget. Five components of a cyclic model of knowledge production and improvement of practices have been identified and form the basis for CCLI grant proposals. Briefly, these are research on undergraduate STEM teaching and learning; creation of materials and teaching strategies; faculty development; implementation of educational innovations; and assessment of learning and evaluation of innovations.

The revised CCLI program will accept three types of proposals. Phase 1 projects are exploratory in nature, likely to be focused on one curriculum component, and involve a limited number of students and faculty at one institution. Broader scope projects are possible if within budget limitations. An incentive of additional funding is offered to projects in which two- and four-year institutions collaborate. Depending on suitable applications, between 55 and 70 Phase 1 awards are planned. Grants for one- to three-year projects can be up to $150, 000 (or $200,000 for joint two- and four-year institution proposals).

Phase 2 expansion projects are expected to include at least two of the five components of the cyclic model and to spell out carefully the connections between each part. A Phase 2 project will build on smaller-scale innovations or implementations to refine and test these in several settings. This type of project should aim to develop products or processes to the point where they can be distributed widely or commercialized, if appropriate. Again, depending on the proposals submitted, DUE anticipates funding 15 to 25 Phase 2 awards, each with a total budget of up to $500,000 for 2 to 4 years.

The third category of new CCLI projects is comprehensive projects that combine established results and mature products from several components of the cyclic model. Evaluation activities should be deep and broad based and demonstrate the project's impact on many students and faculty at a wide range of institutions. Dissemination and outreach with national impact are a particularly important element of Phase 3 projects. Funding is available for one to four Phase 3 awards of up to $2,000,000 for 3 to 5 years each.

Important features of successful proposals include: quality, relevance, and impact; student focus; use and contribution to STEM education knowledge; STEM community building; measurable expected outcomes; and a strong evaluation plan.

The former CCLI program was very successful in promoting the development, implementation, dissemination, and evaluation of innovative course and curricular materials and in assisting STEM educators to support these activities with appropriate technology. The kinds of projects supported in the earlier program can be part of these revised categories. The emphasis in the new CCLI program is on greater integration of efforts from all three types of projects to maximize the effectiveness of improving undergraduate STEM education.

How to Design a Mathematics Building

By Brian Birgen

At Wartburg College, we recently underwent an expansion and renovation of our science building. The Becker Hall of Science was built in 1967 and housed the Biology, Chemistry, Physics, Computer Science, and Mathematics departments. Throughout the renovation process the faculty worked with the architects and consultants to help design optimal teaching and research space. However, when preparing for discussions with the architects, we found very little literature specifically addressing designing a mathematics building.

The central study area at the Wartburg College Department of Mathematics

The classroom with a group work arrangement.

Often mathematics gets included in the science building, but the unique demands of a mathematics department are frequently overlooked by consultants. While many of the other sciences require expensive laboratory equipment, the mathematics department is cheap by comparison and gets less attention during the design phase. The purpose of this article is to address the characteristics of a well designed math building for faculty faced with this task in the future.

Study Space

Fundamental to a mathematics department is the existence of places for students to congregate and study. Mathematics thrives on an exchange of ideas, and there must be places available for students to meet and work. Furthermore, the lounge needs to be centrally located to increase the likelihood of random encounters. In this setting faculty are more likely to happen upon students working and offer a word or two of direction or encouragement. Students are more likely to recognize colleagues from class working on assignments and join in.

A well equipped lounge will have chalkboards or whiteboards on which students can do their work. This allows multiple students to work together and also encourages students to separate the process of solving a problem from that of writing up the solution. An open space will help bring more people into the lounge by removing barriers to entry. This also decreases the chance that the lounge will be converted into a classroom or office at some later date.

In addition to a central lounge, having many other spots where small groups can gather for a quick discussion is beneficial. At Rockhurst University, for example, the hallways are lined with benches; students waiting for classes to start have a place to sit and read before class, and teachers have a place to continue a conversation with a student after class. During the design phase, keep in mind that to increase the amount of mathematics done, one must increase the amount of interaction among its practitioners.

Office Space

There are a variety of ways in which mathematicians use their offices, which results in a variety of opinions of how offices should be designed. For some the focus is to bring students into faculty offices, while for others the goal is to get professors out of their offices working together in a common area. Still others want their office to be a place of quiet repose where work can be done. One must try to find a design that can serve all of these needs.

Common to all is the need for offices to be centrally located, ideally around a common study lounge. When offices are close together, there is increased interaction among faculty and more mathematics is done. At institutions with a graduate program, graduate student offices should be mixed together with faculty offices. At the University of Michigan, offices are in clusters of five with faculty in three of the offices and graduate students filling the other two. This facilitates the finding of an advisor, increases the interaction between student and advisor, reminds advisors of the teaching demands on graduate students, and produces other beneficial side effects.

It is also important that future growth be taken into account when planning office space. If the offices are centrally located except for one or two which were added later, there is a danger of departmental fragmentation, isolating the faculty away from the central hub. (This is particularly likely if those faculty members are shy or have the tendency to focus only on their own work.) For this reason it is a good idea to include a small classroom or seminar room among the offices which could be converted into an office in the future.

Ideally the offices should be places which enable both research and teaching. There should be space for individual academic advising and small group interaction, but there also needs to be room for faculty to work on their own research topics. At Kenyon College the offices were designed with a partition in the middle of the room, dividing the space into a research area and a teaching area. This enables faculty to have projects in various stages of completion and to meet with students in a separate area. No matter how it is accomplished there needs to be enough room in the office for advising students without first putting away existing research projects.

Classrooms

The most important factor to consider when designing a classroom is flexibility of the teaching environment. The same classroom should work equally well for a lecture as it does for working in small groups. Teaching techniques are continually being refined and revisited, so this flexibility is crucial. It is best accomplished through appropriate choice of furniture. At Wartburg College the classrooms are equipped with small two-person tables which can be moved to form squares for groups of four or can be placed in rows for a traditional lecture. This gives faculty much more control over the learning environment and the ability to adapt the room to the needs of the students.

Technology should be built into the room, yet unobtrusive. There should be a built-in projector and the ability to easily connect a laptop computer to the system. Technology can add a great deal to the teaching process, both for demonstration and as a computation tool. However, if the process for using the technology is unnecessarily complicated, faculty will be discouraged from trying new things. The computer system in a classroom should be quick and easy to start up and use. USB ports for easy plug-in and internet connectivity to appropriate websites are a must for classroom technology.

Perhaps the greatest source of controversy for mathematicians is the split over chalkboards and markerboards. Most math faculty are used to teaching with chalkboards and the cost of chalk is significantly less than the cost of markers. It is much easier to use color on a markerboard and the amount of dust produced is significantly less. At Wartburg, we decided to create rooms that have both: markerboards at each end and a chalkboard at the front. Due to the flexible seating, faculty can chose which they use by having the students turn their tables to face one wall or another.

There are other issues which one must attend to in order to effectively incorporate technology into the classroom. For example, rather than center the projector on the wall, it can be offset to one side, so there is room to use a chalkboard next to the projector screen. Even better, the projector can be aimed at a markerboard so that the instructor can draw on what is being projected — this is especially good for drawing flow lines on a vector field. This is an area where creativity and vision will continue to find new ideas for the classroom.

Computer Labs

Even with an increased emphasis on wireless technology and laptop computers, there continues to be a need for computer labs. They can serve as a place where students can access specialty software like Mathematica, Maple or Minitab or as a classroom where a professor will lead students through hands-on activities; either way, they are essential. These rooms will not have the same level of flexibility as a classroom — complete rearrangement of the tables is hard with all the computers and cables in the way — but should still be capable of supporting group work as well as lecture as needed. Group work can be facilitated by providing plentiful desk space for each computer and raising the computer monitor so that more students can view it at a time. Additional table space away from the computer is helpful for supporting lectures.

At Wartburg the computer labs are frequently used during only a portion of class time. An instructor might relocate all of the students into the computer lab for the second half of the class period. For this reason each of the computer labs has a classroom next to it, with the doors only a few feet apart. This allows for a quick move from one room to the other, without any students getting "lost" along the way.

The WOW Factor

Finally, a math building needs some identifying characteristic so that anyone entering will immediately know that this is not the English department. There are many examples of details that can be added to make for a special space that mathematicians can call home. Most mathematicians are familiar with the sculptures of Helaman Ferguson which display the inherent beauty of mathematics. At Meredith College the floor of the atrium has a Penrose tiling which was designed by two students and a faculty member. At Central College the floor has a large sine wave down the hallway. Carleton College boasts an outdoor chalkboard where professors can relocate class outside on especially nice days. There should be some way to identify your building where the mathematicians can be found.

In summary, when designing a math building the focus should be on enabling its inhabitants to interact more readily with each other. Learning space should be flexible and technology should fit in naturally. And finally, a math building should showcase the beauty and uniqueness of mathematics for the entire world to behold.

Brian Birgen teaches at Wartburg College. *He thanks Russell Goodman, Ruth Gornet, Jill Guerra, Jennifer Hontz, Thomas Hull, Sarah Merz, Gail Ratcliff, Carol Schumacher and others for their contributions.*

In Memoriam

Kenneth P. Bogart, Professor of Mathematics at Dartmouth College, died in a biking accident. He was 62. He was a member of the MAA for 40 years.The following is excerpted from the Dartmouth College Department of Mathematics website.

Bogart graduated from Marietta College in Ohio in 1965, and earned his Ph.D. in mathematics from the California Institute of Technology in 1968. He started his career at Dartmouth in 1968, where he remained for 37 years. Bogart chaired the mathematics department from 1989 to 1995. At the time of his death, Bogart was in California on a sabbatical and working to complete revisions on his books, *Introductory Combinatorics* and *Discrete Mathematics in Computer Science*, while continuing his research on graph theory and partially ordered sets. During his career, Bogart published nine books and over 60 articles. His many years of service to Dartmouth were marked by a dedication to teaching, which included participation in Math Across the Curriculum and his own grant for Teaching Introductory Combinatorics by Guided Discovery.

Bogart's career was characterized by a love of mathematics and scholarship, and a passion for teaching and mentoring at all. His passion for research was evident. Almost half of his more than two dozen collaborators were his Ph.D. students and some of these collaborations continued well after the students had established their independent research careers.

Bogart's deep commitment to and involvement with undergraduates spanned many decades. Throughout the 1990s, he had a broad involvement in the Women in Science Program (WISP). Throughout the later part of his career, Bogart became increasing interested in how students learn mathematics.

A memorial service for Bogart will be held on Sunday, May 22 at 1pm. on the Dartmouth campus.

For more information, visit the web site of the Dartmouth Mathematics Department at http://www.math.dartmouth.edu/news/kpbogart.phtml.

H. Martyn Cundy died on February 25, 2005, at the age of 91. His book *Mathematical Models*, written with A.P. Rollett, was very influential in the young lives of many mathematicians. He taught for many years in Malawi. After returning to England, he settled in Kendal, Cumbria, where he taught in the Open University for several years. He was active mathematically to the end, writing several papers on geometric topics.

Saunders MacLane former president of the MAA from 1951-52, died on April 14. He was 95. An extended obituary will appear in the August-September issue of FOCUS.

Travel Grants for ICM 2006, Barcelona, Spain

The American Mathematical Society has applied to the National Science Foundation for funds to permit partial travel support for U.S. mathematicians attending the 2006 International Congress of Mathematicians (ICM 06) August 22-30, 2006, in Barcelona, Spain. In anticipation of the availability of funds, the Society is preparing to administer the selection process, which would be similar to previous programs funded in 1990, 1994, 1998, and 2002.

Applications for support will be printed in the September issue of Notices, and forms will be available on the AMS website (at http://www.ams.org/careers-edu/icmapp.html) beginning August 1, 2005. All completed application forms must be mailed to the AMS by October 31, 2005. This travel grants program, if funded, will be administered by the Membership and Programs Department, AMS, 201 Charles Street, Providence, RI 02904-2294. You can contact the AMS at ICM06@ams.org, 800-321-4267, ext. 4058 or 401-455-4058.

This program is open to U.S. mathematicians (those who are currently affiliated with a U.S. institution). Early career mathematicians (those within six years of their doctorate), women, and members of U.S. groups underrepresented in mathematics are especially encouraged to apply. ICM 06 Invited Speakers from U.S. institutions should submit applications, if funding is desired.

Applications will be evaluated by a panel of mathematical scientists under the terms of a proposal submitted to the National Science Foundation (NSF) by the Society.

Should the proposal to the NSF be funded, the following conditions will apply: mathematicians accepting grants for partial support of the travel to ICM 06 may not supplement them with any other NSF funds. Currently, it is the intention of the NSF's Division of Mathematical Sciences to provide no additional funds on its other regular research grants for travel to ICM in 2006. However, an individual mathematician who does not receive a travel grant may use regular NSF grant funds, subject to the usual restrictions and prior approval requirements.

All information currently available about the ICM 06 program, organization, and registration procedure is located on the ICM 06 website, http://www.icm2006.org.

Welcome to the Euclid Challenge Home Page

HOME
PAGE 1
PAGE 2
PAGE 3
PAGE 4
PAGE 5
PAGE 6
PAGE 7
PAGE 8
PAGE 9
PAGE 10
PAGE 11
PAGE 12
PAGE 13
EMAIL

EUCLID CHALLENGE

SUCCESSFUL RESPONSE

by Milton A. Mintz
http://www.euclidchallenge.org

Euclid Challenge - Comparison			
	Archimedes	**Hippias Quadratrix**	**Milton A. Mintz**
EUCLID TOOLS Unmarked Straightedge and compass	NO	NO	YES
UNIFORM RATE 1. Confirmation of accurate results: Two test angles applicable to all angles.	N/A	NO	YES
2. Same Uniform Rate used by both hands.	N/A	NO	YES

- Best viewed by Internet Explorer 4.0 or greater.
- To print a copy of any page, "right-click" on the right side of the page, and choose "Print". - This will prevent the navigation buttons from printing.

For Comments or Questions about Euclid Challenge, please contact:
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Phone: 408.356.5356

What I Learned from... Working in a Professional Learning Community

By Laura Pyzdrowski

I recently found myself in the situation of being involved in two major professional projects at the same time. Fortunately, the goals of the projects were similar enough that it proved to be a synergistic experience.

I have been participating in project MERIT (Mathematics Education Reform Initiative for Teachers) for almost five years. This is funded by a $6,241,995 grant from the National Science Foundation (NSF, 9911928); its goal is to improve mathematics teaching in middle schools in West Virginia by enhancing the pedagogical content knowledge of teachers. One method that leaders in MERIT use to foster and sustain such growth is through the enabling of Collaborative Professional Learning Communities (CPLCs).

In the spring of 2002, I was accepted to participate in the MAA's Professional Enhancement Program (PREP) workshop on *Teaching Future High School and Middle School Teachers*. The program consisted of two summer workshops presented by Ed Dubinsky and Kathy Heid. It was designed to enhance participants' effectiveness in preparing undergraduate students to teach mathematics in high school and/or middle school. One requirement of each PREP participant was to conduct a project during the intervening year. So, as a teacher educator, it was natural for me to intertwine my work in both projects. I chose a project that would reflect the focus of my learning community, which was student communication about mathematics through writing.

Why a Learning Community?

Eaker and DuFour (1998) argue that developing the ability of school personnel to function as a professional learning community is the most promising strategy for sustained, substantive school improvement. Roberts and Pruitt (2003) agree: "As educators collaboratively engage in conversation and deliberate about teaching and learning, they gain new knowledge and discover original ways to resolve instructional issues." (p. 20) Given the existence of such support for the establishment of learning communities, it is not surprising that their use was embraced in project MERIT. The early CPLCs were regionally based and included members who taught mathematics in middle school, high school and college. Although at this time the project is encouraging the establishment of school based CPLCs, the fact that the first communities included participants who were from different grade bands was not a hindrance for success. We were able to share a common vision as well as develop an action plan in order to impact student learning. In fact, successful cross-disciplinary faculty learning groups in higher education are reported by Cox (2002).

What Makes a Learning Community?

Involvement in a learning community affords a way for self-improvement while keeping student learning central. Linda Foreman of the Teachers Development Group in Oregon served as a consultant who helped us learn how protocols and action plans can contribute to the success of learning communities. As we developed our CPLC, we discovered the need for communication norms and accountability. We also learned the value of a safe environment, a shared vision, and shared leadership. When the annual action plan was realized, it was a shared victory.

Each participant in MERIT was assigned to a specific learning community, first by geographic region and then by a random assignment into smaller groups. Our learning community was successful. We had all been through almost two years of professional development together and held a common vision of the project goals and student needs. So, when we met to reflect upon an action plan, most of us knew that communicating about mathematics was a problem for most of our students. We were ready to engage in the project. A handful of us filled out the action plan and logged our contributions and responsibilities for the meetings as we progressed. The duty of facilitator was rotated, as was the duty of documenting into the official log book. I think that this rotation and documentation helped us to be accountable and to remember that we were sharing leadership.

The concept of communication norms had been introduced in other MERIT professional development sessions. When we participated in sessions about using timed protocols for reflective discussion, many were skeptical. We soon realized, however, that often we did not do a good job of listening carefully, sharing only relevant information, and developing a shared meaning. Following a timed protocol is a way to make sure that each participant has an opportunity to contribute. I also think that it is a nice way for each of us to reflect upon what it means to be a collaborator. It prompts participants to ask themselves whether they tend to dominate conversations, not value input from others, or be off task. Once we became really comfortable as a group and had a sense of safety in sharing our ideas, the protocol became less crucial.

It was important for our group to establish a one-year plan which included both, activities that we would do, both in and outside of the classroom, to obtain our long term goal and activities that would provide the evidence that we were making progress. The long term goal was to improve our students' ability to communicate mathematically and to support arguments. We selected mathematical activities that required written as well as algorithmic responses. Each of us brought varying levels of student work to our sessions on which to reflect. Such activities as *Checkerboard Squares* and *A Shaking Party* from the *It's All Write* materials were used. The materials included anchor papers and rubrics which were used to help students understand expectations when writing about mathematics as well as the process used when assessing their work. It was interesting to see how common the mistakes were at all grade bands; but, it was rewarding to be a part of a group that was sharing ideas and strategies that could work at different grade levels.

Benefits for the Pre-Service Students

Because I participated in the CPLC, I was able to take back the work of local seventh and eighth grade students into my classroom. As some of the pre-service teachers did the problems, they were convinced that no seventh or eighth grade student would be able to solve them. They were surprised to see how good some of the work of the local students was.

I extended the work of the CPLC action plan to accommodate my intervening year project for the PREP program. I used interviews with the intention of finding out if the use of writing assignments helped my students gain content knowledge. Three students were interviewed, one each to represent those in a group with the highest final grade, median final grade and lowest final grade. All three students indicated that the various types of writing assignments in the course, including laboratories, the *It's All Write* materials, and a paper about the NCTM Standards, helped them to learn mathematics. I was surprised to learn that all three of the students found vocabulary to be a challenge when completing the writing assignments. I teach a little differently now and do not assume that just because my students must have had at least college algebra to enter the course, they all are comfortable with the language of middle and high school mathematics.

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Laura Pyzdrowski is a member of the Institute for Math Learning in the Mathematics Department at West Virginia University. You may contact her at lpyzdrow@math.wvu.edu.

Student Learning Goal: To Communicate Mathematically to Support Arguments.

Short Term Benchmarks (incremental indicators of progress and timeline)	**Action Plan** (what we will do to "get there," i.e., ways we will change/refine our teaching practices to impact student learning)	**Documentation** (evidence that will help us know that we are "getting there" and that will support our reflection along the way)
Students become aware of what a quality paper looks like with problem solving prompts (4-point prompt) and anchor papers from the book, *It's All Write*.	Use "Checkerboard Squares" from the book, *It's All Write*, or a similar standards-based lesson. Students write and then do self and/or peer evaluation compared to a model (anchor papers). A quality paper is shown after rough draft. Student compares his/hers to it and self evaluates. Has the option of rewriting before handing in the paper.	Student Work and how it was self and/or peer assessed. Editing of self and peers. Changes made in rough draft to final copy.
Students produce and evaluate a quality paper with prompts but without models.	Students will be encouraged to use the 4-point prompt on appropriate writing assignments in daily work.	Student work on daily assignments from October to February revealing the effectiveness of using the 4-point prompt. Comparison to determine improvement.
	Use the book, "A Shaking Party" from *It's All Write* or a similar standards-based lesson. Students write and self and/or peer evaluate with no models (anchor papers). May include a rewrite (optional).	Student work and how it was self and/or peer evaluated. Compare student progress from the paper on "Checkerboard Squares" or the alternative lesson used.
	At RESA meeting, view the tape, *Good Morning, Miss Tolliver*. Discuss oral communications.	Teacher Log with Date/Task/Reflection concerning student work.

Short Takes

Compiled by Fernando Q. Gouvêa

Dean's Star Keeps Rising

The Mathematical Sciences Research Institute (MSRI) has a Human Resources Advisory Committee (HRAC) that represents underrepresented US minority and female mathematical scientists. The Board of Trustees of MSRI unanimously elected Nathaniel Dean to be a member of the HRAC for a three year term beginning July 1, 2005. In addition, the Board voted unanimously to appoint him as the HRAC chair for a two year term. Dean is an MAA Governor-at-Large representing minority interests.

SASTRA Ramanujan Prize

The Shanmugha Arts, Science, Technology, Research Academy (SASTRA) University in Tamil Nadu, South India, has announced the creation of a prize named for Ramanujan. The annual $10,000 prize is to be awarded to a young mathematician (under age 32) who has made significant contributions to those areas of mathematics influenced by Srinivasa Ramanujan. The age limit of 32 is, of course, inspired by Ramanujan's age when he died. For more information, visit http://www.math.ufl.edu/sastra-prize/

"Math Made Me Quit"

According to a report in *Education Week*, many high school dropouts cite mathematics as the specific reason they had left school. Researchers from the United Negro College Fund visited West Virginia and asked 62 high school dropouts, mostly African-American and Hispanic, why they had left school. "With surprising consistency," says the article "a majority of the participants, most of whom were African-American or Hispanic, gave the same answer: 'Math'." The evidence is anecdotal, but it highlights the importance of making sure mathematics teaching works well, particularly in a time of high expectations of students. See http://www.edweek.org/ew/articles/2005/03/23/28math.h24.html for the full article.

Gender Gap Closing in England

According to a report in the *Wall Street Journal* (March 30, 2005), changes in mathematical pedagogy have helped close the "achievement gap" between boys and girls. The article mentions the introduction of a national curriculum in 1988 and teacher training on how to improve girls' participation in class as the main reasons for the change. By the 1990s, girls and boys were passing the O-level mathematics exam at the same rate.

Test Prep Guides Recalled in New York City

On March 25, the *New York Times* reported that the city's education officials had recalled a set of test preparation guides intended for students in grades 3–7. The guides apparently included many errors, from spelling and arithmetic mistakes to badly drawn diagrams. Officials blamed a faulty quality control process, but the local teachers union pointed out that such mistakes could be avoided if the city worked with teachers. A union leader pointed out the irony the city did not hesitate to criticize teachers "for failing to meet its picayune mandates. But then it produces a test prep manual riddled with errors and misspellings."

Francis Bacon Award Announced

A new $20,000 award for research in "the history of science, the history of technology, or historically-engaged philosophy of science" has just been announced. The Francis Bacon Prize, to be offered every two years, is sponsored by the California Institute of Technology, the Francis Bacon Foundation, and the Huntington Library. Nominations for the award are due by December 1, 2005. See http://pr.caltech.edu/periodicals/336/articles/Volume%203/10-02-03/historyaward.html for more information.

Introducing Non-Mathematicians to Emmy Noether

John Derbyshire continues to do his part to tell outsiders about mathematics and mathematicians. He regularly talks about mathematical topics in his columns at *National Review Online*. His April 21 column, entitled "Noether's Novelty: The greatest female mathematician of the 20th century, and maybe ever," is a short account of Noether's life and work. Derbyshire explains that he decided to write the article partly because of the 70th anniversary of Noether's death and partly in the light of all the discussion of women in the sciences generated by Larry Summers now-infamous remarks. Derbyshire names Noether "The Lady of the Rings" for her crucial work on ring theory. The article can be found at http://www.nationalreview.com/derbyshire/derbyshire200504210758.asp.

Richard H. Herman is Named Chancellor at Urbana-Champaign

Richard Herman, a mathematician with a Ph.D. from the University of Maryland, has been named the new Chancellor of the University of Illinois at Urbana-Champaign. Herman had been provost and vice chancellor for academic affairs at UIUC since 1998, and became interimchancellor in the summer of 2004. Herman worked mostly on Operator Theory (40 mathematical publications are listed on the UIUC web site) and was on the mathematics faculty at UCLA, Penn State University, the University of Maryland, and at the University of Illinois before moving on to positions at NSF, JPBM. He became Dean of the College of Computer, Mathematical and Physical Sciences at the University of Maryland (College Park) in 1990, and has held various administrative posts since. Seehttp://www.admin.uiuc.edu/newchancellor/ for more information.

Sources:
Nathaniel Dean: Jackie Giles. SASTRA: email communication. Math and dropping out: NASSMC Briefing Service, *Education Week*. English gender gap: *The Wall Street Journal*, 30 March 2005 (p. A01). NYC Guides: NASSMC Francis Bacon Award: Shirley Gray, HSS web site. Derbyshire on Noether: email, http://www.nationalreview.com. Richard Herman: email communication, UIUC web site, Briefing Service; *The New York Times*, 25 March 2005 (p. B03).

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MAA Establishes a Prize to Honor David P. Robbins

By Joe Buhler, Ron Graham, and Ann Watkins

David P. Robbins had a long, varied, and productive career in mathematics. His many friends describe him as magnanimous, hard-working, unpretentious, brilliant, and possessed of a rare ability to explain his insights clearly. David died of cancer in September 2003 at the age of 61. To honor his memory, the family of David Robbins has given the Mathematical Association of America funds sufficient to support a prize honoring the author or authors of a paper reporting on novel research in algebra, combinatorics, or discrete mathematics. Papers will be judged on quality of research, clarity of exposition, and accessibility to undergraduates. The prize of $5000 will be awarded every third year. A parallel prize will be awarded by the American Mathematical Society, honoring the author or authors of a paper that is broadly accessible and provides a clear exposition of work with a significant experimental component.

David P. Robbins received a Ph.D. from MIT, and then taught for a total of 10 years at the Fieldston School in New York City, Phillips Exeter Academy, Hamilton College in Clinton, New York, and Washington and Lee University in Virginia (1978-81). While at Phillips Exeter, he collaborated with Richard Brown, a colleague there, on a high school math text called *Advanced Mathematics, an Introductory Course* published in 1975 by Houghton Mifflin. The editorial adviser on the textbook was Andrew Gleason, who was David's adviser when he was an undergraduate math major at Harvard.

He then had a 24-year career on the research staff at the Institute for Defense Analyses — Center for Communications Research (IDA-CCR) in Princeton. He exhibited extraordinary creativity and brilliance in his classified work, while also finding time to make major contributions in combinatorics, notably to the proof of the MacDonald Conjecture and to the discovery of conjectural relationships between plane partitions and alternating sign matrices. For more information, see his 1991 paper in the *Mathematical Intelligencer*, "The story of 1, 2, 7, 42, 429, 7436, ..." or "How the Alternating Sign Matrix Conjecture Was Solved" by David Bressoud and James Propp in the June/July 1999 *Notices of the American Mathematical Society*.

David lived in Princeton, where he settled in about 1981, and served for a number of years as a member and then president of the Princeton school board.

Working on (and, especially, collaborating on) mathematics gave him enormous pleasure and fulfillment, and he had some 82 different coauthors. As reported in "Dying Mathematician Spends Last Days on Area of Polygon" in *The Wall Street Journal* on July 29, 2003: "He reacted to the news [of the cancer diagnosis] by considering his options: He could stick to his normal work routine at a government research institute. He could search desperately for a cure for his disease, even though his doctors told him the cancer is inoperable. He could go home and wait to die. Or he could finally get around to a math problem that has been bugging him for decades." He chose the last option and his last mathematical efforts with his "pals" led to a generalization of Heron's formula, answering a question that had intrigued David since childhood.

The prizes established in David's memory will, we hope, keep his name alive in the mathematics community, and also help support the kind of writing he would enjoy.

Photograph of David Robbins courtesy of Ken Robbins.

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The Preparation of Mathematics Teachers: A British View Part I

By Peter N. Ruane

'University scraps maths degrees'

'Hull University is to scrap its maths degree courses because of "falling interest" in the subject'
[Recent BBC website headline]

Yes, a major British university has announced that, due to a shortage of suitably qualified applicants, it has decided to close down its long-standing mathematics degree courses. Several other universities in the UK are also considering this option and, for the very same reason, many of our newer universities have never run mathematics degree courses in the first place.

One may therefore conclude that mathematics education in the UK is in crisis, but the shortage of mathematicians has been a matter of increasing concern ever since the launch of Sputnik in the late 1950s. Yet, over this period of time, there has been an ongoing process of curriculum reform, accompanied by the emergence of modern teaching aids and innovative self-study materials (including what seems like a 'new' calculus book every month!).

In spite of such developments, the majority of students continue to regard subjects like maths and physics as being too difficult. Instead, they opt for courses in business studies, the arts, social sciences or many of the newer 'disciplines' related to the leisure industries. Universities in the UK also suffer from the restrictive nature of the government funding system of higher education, which makes it impossible to maintain courses with low recruitment. Then there is the changing pattern of career opportunities arising from the demise of the British manufacturing industry.

Obviously, this decline is really a downward spiral. A shortage of mathematicians means fewer, and more poorly qualified, teachers, which, in turn, leads to ineffective teaching etc. In response to the present crisis, one national body recently came up with the ingenious proposal that mathematics should no longer be a subject of compulsory study for all secondary school pupils. It was thought that, by reducing demand, there could be no defined shortage!

Unfortunately, we who have committed ourselves to lives of relative penury in the service of mathematical education have little influence over matters such as the future of our national industries or levels of government funding. On the other hand, we are in a position to rectify some of the causes for the unpopularity of our beloved subject. Take, for instance, the matter of teacher training and consider the personal mathematical knowledge of those who teach or intend to teach it. Consider also a few elementary questions of the following sort:

What is the justification for including topics like tessellation and symmetry in school mathematics curriculum?

Can you explain why $(-2) \times (-3) = 6$? In how many different ways can this be demonstrated?

By visual or practical means, show that $\frac{2}{3} + \frac{4}{5} = \frac{2}{3} \times \frac{5}{4}$.

In the expression $\frac{dy}{dx}$, what, if any, are the meanings of dy and dx?

$0 \div 7 = ? \quad 7 \div 0 = ?$

What practical activities can you devise to enable children to understand that $\frac{1}{3} = 0.333 \quad ?$

Can the long division algorithm be taught with understanding? Should it be taught at all?

A child writes

$7 \times 16 = 7 \times 6 = 42 = 70 + 42 = 112.$

What is your response?

You know that $7^3 = 7 \times 7 \times 7$, but what is $7^{0.375}$?

In my experience, too many teachers are totally flummoxed by basic questions such as those above, and this is true whether or not they happen to be mathematics graduates. What seems to have transpired is that, since their own school days, they have maintained their ignorance of important, elementary concepts and techniques, despite their subsequent progression through higher education and professional training. This, then, is the beginning of that deadly downward spiral and it raises certain fundamental questions:

1. Why does teachers' subject knowledge lack sufficient relevance to the demands of school mathematics?
2. How does this affect the way that the subject is taught in school?
3. What can be done to improve matters?

The ensuing discussion arises from the context of my own experience in teacher training in the UK and I believe that much of what is said is also applicable in the USA and elsewhere.

Teachers' Subject Knowledge

Mathematics graduates, embarking upon a teaching career, will be versed in many topics that bear little relationship to the mathematics that they will be called upon to teach. Even on completion of their one year Post Graduate Certificate of Education course, newly qualified teachers may have insufficient awareness of the nature of school mathematics — and the way it should be taught. In reality, their previously acquired knowledge in the realm of advanced topics like partial differential equations, stochastic processes or algebraic geometry is of little help when it comes to meeting the needs of classes of mathematically alienated fourteen year olds.

Another way into teaching is via the three year B.Ed degree, which includes the opportunity to specialize in a range of subjects, including mathematics. Students from these courses may eventually teach at secondary level (ages 11 to 18) but, more often than not, they will be primary school teachers (ages 5 to 11).

Although B.Ed courses do provide greater emphasis to the pedagogical aspects of mathematics, the chosen specialist mathematics modules are often very much like those on a conventional mathematics degree course and successful completion of these does not usually result in the correction of personal mathematical blind spots of the sort illustrated by the introductory questions above. Also, the expected mathematical qualifications for admission to B.Ed. courses are generally lower than those required for admission to a B.Sc. in mathematics.

The correlation between the level of a teacher's mathematical qualifications and his/her effectiveness in the classroom is not strong enough. In fact, there are some acceptable teachers of mathematics who have received no training in the subject other than the basic school leaving qualification (GCSE). What seems to characterize the 'good' teacher is the ability to recognize the difficult concepts and techniques and to anticipate when pupils are likely to come to grief. In other words, some teachers become more effective classroom practitioners because they can see mathematics from the child's point of view and look for the interconnections between seemingly different areas of mathematics (e.g., connecting geometrical ideas with numerical concepts).

In secondary schools, the shortage of trained mathematicians results in the situation in which teachers, trained to teach other subjects, will be called upon to take mathematics classes. And, whatever their qualifications or experience, most teachers are required to teach a wide range of classes, from low-achieving pupils to the more academically able. Usually, however, it is the most highly qualified mathematics teachers who teach the brightest pupils, whilst the lesser qualified usually have to cope with the low-attainers.

Then there is the pressure on schools arising from the present obsession in the UK with 'testing'. Schools have to prepare children for national tests at the ages of 7, 11, 14 and 16. The government then publishes league tables showing how each school has performed in these tests (Mathematics and English being the main subjects). Given the crowded nature of the mathematics curriculum, teaching is inevitably compressed and geared towards the examinable topics. Investigative, practical, and remedial work is therefore marginalized.

How should mathematics be taught?

It isn't just because mathematics is regarded a difficult subject that is a deterrent to further study. A person's perception of the subject is also affected by memories of mathematics lessons in which they may have felt totally uninvolved. In cases where this is true, it wouldn't be surprising to find lack of motivation when it comes to coping with some of the more difficult concepts and techniques.

Consequently, styles of teaching should be in accordance with the nature of mathematics as an activity rather than mathematics as an extraneous body of knowledge, by which we may attempt to pour into the heads of children (it would flow out the other end of course). A questioning, investigative attitude has to be developed via an interactive style of teaching. Lessons should provide opportunity for pupils to explain their thinking. Common difficulties should be discussed and some sessions could be devoted entirely to this purpose. In other words, the learner must be fully involved in the lesson process.

On an optimistic note, the National Numeracy Framework, used by most primary schools in the UK, does emphasize the importance of interactive teaching and it stresses the importance of incorporating children's ideas through small group and class discussion. But many 'traditionalist' teachers feel somewhat insecure about this because they are still imbued with the idea of mathematics as being that old immutable body of facts and skills.

It is often said that the way we teach is in accordance with our own learning, possibly adopting teaching styles of our former mentors. In which case, maths' graduates may be in for something of a shock when they begin teaching. Have they ever benefited from interactive teaching? Did that module on functional analysis provide scope for exploratory group activities and discussion of common misconceptions?

Postgraduate teaching qualifications should, of course, facilitate the transition from esoteric world of university mathematics to the organic realities of school maths lessons, but such courses are too brief to facilitate this. But, as mentioned, the B.Ed route, with its greater emphasis on pedagogical themes, does a better job of easing the transition.

What can be done?

Mathematical qualifications, acquired at university level, are obtained by a compilation of vocationally generic modules, which are taken by math majors, physicists, engineers, and intending teachers, etc. Those who do embark on a career in mathematics teaching are then faced with the task of trying to interpret school mathematics from the perspective of their knowledge of advanced mathematical topics. For teachers, this is the wrong way round. It would make life much easier if their mathematical education had its roots in the wide range of mathematical ideas that they will inevitably be called upon to teach. This philosophy is illustrated by the following brief account of my own experience of its implementation.

When re-writing the mathematics component of a primary B.Ed degree some years ago, my colleagues and I were directly faced with the problem of a likely shortage of students with appropriate mathematical qualifications. This would have led to under-recruitment for the mathematics modules, thereby threatening the viability of mathematics as a major component of the degree.

However, preceding the choice of an in-depth subject specialization, all students had to complete modules relating to the teaching of the primary mathematics curriculum. There were several modules on the teaching of numbers, some on shape and space and a variety of others. Because our approach required students to readdress their own mathematical knowledge and because the sessions were practical and informal, they became very popular and created great interest in maths as a major subject.

So that we could keep the students once we had recruited them to study it in greater depth, what we did was to turn things upside down by making sure that all 'advanced' mathematics modules began with the mathematics from primary or secondary school. This was done very much in the spirit of Klein's books, 'Elementary Mathematics from and Advanced Standpoint'. We also ensured continuity between the teaching style that we expected them to adopt in the classroom and that which we employed in our lectures.

The modules we developed were mathematically challenging and will be described in detail in part II.

Peter Ruane (ruane.p@blueyonder.co.uk) *is retired from university teaching, where his interests lay predominantly within the field of mathematics education*

The NSF Budget: Not Far Away From Us

By David Lutzer, for the MAA Science Policy Committee

A character in *Fiddler on the Roof* invokes a special blessing for the Czar, chanting "May God bless and keep the Czar… far away from us." Some Americans might be tempted to invoke that same blessing for our entire federal government, but mathematicians today cannot afford such an attitude. We have a professional interest in government budget decisions. It is far from clear that things will work themselves out if we stand above the fray.

Think of NSF. Probably the first thing that comes to a mathematician's mind is "research grants." That's understandable, but it's too narrow. NSF also supports national-level mathematical institutes, VIGRE grants to strengthen doctoral programs, a library digitization project, programs to create international collaborations, and a multitude of postdoctoral and pre-doctoral fellowships. NSF's Research Experiences for Undergraduates program has made it possible for post-1990 undergraduates to get out of the classroom and into the research world many years earlier than before. NSF undergraduate support has created opportunities for an increasing number of women and other mathematical minorities to study mathematics. NSF has helped the mathematical community improve the mathematical education of pre-college teachers. NSF has also funded national curricular projects in pre-calculus, calculus, and linear algebra.

Any newspaper will tell you that these are difficult budget times in Washington. While the proposed Fiscal Year 2006 budget would almost restore the total NSF budget to its 2004 level, mathematics does not fare well. Recall that NSF support for mathematics comes primarily from two NSF-subunits: the Division of Mathematical Sciences (DMS) and the Division of Undergraduate Education (DUE). In the proposal, the DMS budget would be $200 million, the same as in 2004 and 2005. The DUE budget would see its third consecutive decline, dropping from $173 million in 2003 to $135 million in the 2006. The mathematical sciences have been identified as a priority area within NSF during this five year period, but, given recent budgets, one might justifiably describe us as an "unfunded priority."

How can you find out about mathematics funding issues at the national level? The policy page of the AAAS web site at http://www.aaas.org/port_policy.shtml offers frequently updated summaries of overall federal R&D spending and proposals. The AMS Government Relations web site at http://www.ams.org/government is a source for mathematics-specific issues, and so is the MAA Science Policy web site at http://www.maa.org/sciencepolicy/index.html.

What can you do to help? One option is to write to your congressional representatives and senators. An even better option is to schedule a meeting with one of your representatives and senators. Politics is still local, so the most effective approach is to describe benefits that you, your students, or your college or university have received. Some broad themes you could cover are in a "talking points" document at the Science Policy web site. An even more interesting way to support the NSF budget is to say "Thank you" whenever you, your students, or your department receive NSF support. Don't thank the granting agency — instead thank your representatives and senators for making the support possible. You can find their email addresses at http://www.house.gov or at http://www.senate.gov.

Federal science policy is deeply involved in the future of mathematics and science education in this country. Our professional societies have long argued that predictable, steady investment in mathematics and science education is a key to a nation's economic development, and a proof of that conjecture is now being discovered. Unfortunately for the U.S., that proof is being found in China, India, and Europe. Federal science policy is no longer "far away from us," and you can help.

Joel Cohen Interviewed Online at NAS Site

The National Academy of Sciences' *InterViews* web site (at http://www.nationalacademies.org/interviews) contains interviews with various NAS members in different fields. The recently added interview with Joel Cohen starts with a note pointing out that "At 14 Joel E. Cohen knew he wanted to be a mathematical biologist. Not only was it an interesting choice of career for such a young man, the field didn't even exist yet." Though Cohen's field is given on the interview page as "mathematics," he is listed under biology on the main *InterViews* page. The confusion captures well the blend of interests and topics that Cohen discusses. To listen to the interview (in *RealPlayer* format), go to http://www.nationalacademies.org/interviews/people/cohen.html.

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They Chose Mathematics

By Gilbert Strang, Walter Meyer, and Ken Takata

Why do our majors choose mathematics? That question seems interesting, and the answers could certainly be important (if we knew them). Was their choice due to a good teacher in the past, an attractive career in the future, or the fun of doing mathematics in the present? This article is a brief report on surveys that attempt to collect some information about this — surveys that you can try also. Our work began as a do-it-yourself effort sponsored by the US National Committee on Mathematics and initially involved five institutions: MIT, Macalester, William and Mary, Penn State, and Mount Holyoke. This article reports on the results at Adelphi University. A typical short survey is included at the end of this article. It can, of course, be modified.

These surveys can be extremely easy to do (just email questions directly to the math majors or poll them in their classrooms). The response rate is often remarkably high, and the students seem pleased to be asked. Their answers are not necessarily what you would expect.

We think the answers should influence our course offerings and degree requirements. In comparison with engineering curricula, mathematics can offer more freedom. There is already much variation in mathematics curricula. We believe that it is important to listen to our students and make curricular choices informed by their opinions.

Our requirements do not commit the students to a mathematical career. Students use what they learn in so many different ways.

While this article focuses on what we learned at Adelphi, there are some common patterns among all institutions. For example, we do need to recognize how few majors (at all six institutions) have graduate school in mathematics in mind. Plans for the future vary enormously. If we provide encouragement, the pleasure of engaging in serious thinking, and the opportunity to progress toward a range of careers, students will come.

The Adelphi Results

At Adelphi, instead of contacting the students by email, we distributed questionnaires in class, hoping to reach every major who was either a junior or a senior. Since most of our majors plan to become high school math teachers, we customized our survey to deal with that fact. (This longer questionnaire is available from the authors.) We received completed surveys from 40 of our 42 junior and senior majors.

The most important reason for majoring in mathematics was that the student liked the subject in high school. For 35 students, liking the subject was 'highly influential' in the ultimate choice of major. Of these, 22 had thought about the possibility of majoring in mathematics in high school or earlier. Next in importance was whether the student thought he or she could get good grades in college math courses. This in turn was followed by the idea that a mathematics degree could lead to an attractive job. The advice of teachers, parents, and friends played a role, but it is not easy to evaluate those influences. Experiences at college seem to have played only a minor role in the choice of major.

Fifteen years ago Adelphi had about one third as many majors as we have today. It appears that students' perception of career prospects has improved. In fact,

A Sample Questionnaire

These questions could have been more sophisticated. We could have used a professionally developed questionnaire, but sophistication wasn't our goal. We could also have surveyed students who didn't choose mathematics, but that would have been a much bigger project. If you want to know more about your students, we encourage you to start simply. Use direct — and partly open-ended — questions for your own students. We can send you these questions, or the longer teacher-oriented Adelphi survey, electronically.

1) When did you first know that you wanted to major in mathematics?
(age 12, before college, freshman year, sophomore, junior, senior)

2) Which TWO of these were most important in your decision to major in math?

a. You just like mathematics

b. You like the freedom to take courses in other fields

c. You see mathematics as good preparation for your (different) career

d. Particular mathematics courses or books (which?)

e. Particular person (teacher, adviser, parent, friend)

f. Other (specify)

3) Do you plan to go to graduate school, in mathematics or another subject? Beyond 'yes' or 'no', do you have a specific career in mind? Did your eventual career enter heavily into your choice of major?

4) FOR SENIORS: Are you applying to graduate schools in mathematics?

5) What should mathematics departments do to encourage students to major in mathematics? (This is an open-ended question about colleges everywhere.)

there has been a recent upsurge in demand for new high school teachers of mathematics in the local area (a wave of retirements is in progress). As it happens, 35 of our 40 responding majors intend to become teachers. Only ten would have majored in mathematics if a teaching career were not a possibility.

The model for choice of major at Adelphi is this. Students get interested in high school. They follow through provided they can see a career at the end of their studies. We would like to know what 'choice of major' model seems most reasonable at other colleges. It was also interesting to see that switching from major to major and finally settling into mathematics didn't often occur at Adelphi.

Finally, we were surprised to discover that if our math majors had needed to pick a different major, their choices would have been very diverse. The most popular choices would have been business (13 students) and other sciences (7). Interestingly, the major that is most commonly linked with mathematics in the popular mind, computer science, was chosen by only 2 students as their second choice. Other choices included Spanish, English as a Second Language, psychology, dance, architecture, social work, accounting, law, engineering, communications, physical therapy, and art.

In future surveys we at Adelphi would like to find out more about our students' high school experiences, and whether they prepare students for the logical thinking needed for upper division college mathematics.

Gilbert Strang teaches linear algebra and applied mathematics at MIT. The review material and videos of his lectures on OpenCourseWare (http://ocw.mit.edu) *are very widely used. His email address is* gs@math.mit.edu *and his Web page (linked to the current courses) is* http://math.mit.edu/~gs. *Walter Meyer is Professor of Mathematics at Adelphi; his email is* meyer@adelphi.edu. *Ken Takata is Assistant Professor at Adelphi, where he teaches a variety of courses in the Department of Mathematics and Computer Science. His research interests concern computational complexity and combinatorics. His e-mail is* takata@adelphi.edu.

GRANT FUNDING ENDED

The Calculus Consortium for Higher Education (CCHE) is a small non-profit public charity which was an outgrowth of an NSF funded project in innovative coursework in undergraduate education (the "Calculus Consortium based at Harvard"). The mission of CCHE was to improve the teaching of mathematics in secondary schools, two-year colleges, colleges and universities. It supported workshops, meetings, conferences or research projects in innovative coursework, making 41 grants totaling $455,280 over a period of 7 years. The scope of these projects was broad, ranging from small grants for rural school districts to national grants to the MAA to support curricular recommendations and to the AMS to support teaching workshops for graduate students. We hope these projects have made a difference. CCHE will be dissolving by the end of this year and is no longer accepting proposals. We want to thank all of the members of the mathematics community who sent in grant requests; we are sorry we couldn't fund them all.

New 2005 MAA Section Governors

Allegheny Mountain Section	John Bukowski Juniata College
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Spatial Visualization: Is There a Gender Difference?

By Terri Bennett

While research in this area has been ongoing for at least the past fifty years, it took the comments by Harvard president Larry Summers to make stories about women, their brains, and their ability in math and science appear on the front pages of nearly every newspaper in the country as well as on the March 7, 2005 cover of *Time*. Many people believe that mathematics is the "critical filter" for careers in scientific fields, and gender differences in spatial visualization skills have been used as one possible explanation for sex differences in mathematical performance. In this article, we will address the following questions: What are spatial skills? Have researchers observed a gender difference in spatial ability, and are there performance factors that affect these results? And finally, does spatial ability predict mathematical achievement?

Psychologists define three main classes of cognitive ability: verbal, quantitative, and spatial. Researchers do not always agree on a single definition of spatial ability or how it should be measured. One widely referenced meta-analysis of research studies on gender differences in spatial ability by Linn and Peterson [9] states that "spatial ability generally refers to skill in representing, transforming, generating, and recalling symbolic, nonlinguistic information." This definition encompasses simple tasks such as being able to generate an image of a triangle in your mind and also harder skills such as being able to imagine what an irregular figure looks like when it is rotated in space.

In a classic textbook in cognitive psychology [6], Diane Halpern lists five main categories of spatial tasks: spatial perception, spatial visualization, spatiotemporal ability, maintenance and generation of a spatial image, and mental rotation skills. These categories and the definitions that follow come primarily from her work.

Spatial perception, sometimes classified as a spatial orientation skill, is the ability to determine spatial relations despite distracting information. An example of a test that measures this skill is the water level test, in which subjects are shown a picture of tilted glass and are asked to draw a horizontal line at a level where the glass is half-full of water.

Spatial visualization can be defined as the ability to do complex, analytic, multi-step processing of spatial information. The hidden figures test, in which subjects are asked to identify single shapes that are parts of a whole, more complex picture, is one way that psychologists measure this ability. This type of skill is also used by children when they do the "hidden pictures" game in *Highlights* magazine.

Spatiotemporal ability, also sometimes referred to as target-directed motor skills, involves responding to moving visual displays. A computerized test might show a moving ball that will become obscured by a solid vertical area. Subjects are asked to press a key at the moment that they believe that the ball will become visible on the other side. Both accuracy and reaction times are measured.

Maintenance and generation of a spatial image involves being able to generate a visual image in memory, maintain that image, and answer a question about it. An example of this skill given by Halpern is the following: Imagine a lower-case letter B in your mind. Is the round part of the letter to the left or to the right of the vertical line?

Mental rotation skills include the ability to rotate two or three-dimensional figures quickly and accurately in your imagination. Some of the cognitive tests that measure this ability require subjects to be able to visualize transformations from one type of object to another, and thus some researchers would categorize this as a spatial visualization skill, as defined previously. We ask our students to do these kinds of tasks in two-dimensions in elementary teacher preparation classes that use manipulatives to teach fractions and geometry. We do two-dimensional to three-dimensional transformations in calculus when we teach students to visualize the steepness of a surface by looking at a contour map. Our students do three-dimensional to two-dimensional transformations when we ask them to visualize cross-sectional slices of surfaces for finding volumes or for generating sets of level curves.

While the transformational tasks just mentioned may use mental rotation, the more classic mental rotation tests ask subjects to look at a picture and decide which of the choices given could match the original shape when rotated. This can be done in both two and three dimensions, but the task becomes much harder in the latter case. The most famous test of this skill is called the Mental Rotations Test (MRT), which was first developed by Vandenburg and Kuse in 1978 [13]. The MRT contains 20 questions, each of which is similar to the one shown in Figure 1. In each question, the subject is asked to identify 2 out of 4 correct answers during a testing period of only three minutes. Thus speed as well as accuracy is being tested.

In 1980, Benbow and Stanley published a highly publicized and controversial study in *Science* magazine [1]. This research study examined the SAT scores for highly talented junior high school students with the intent of showing that sex differences in mathematical ability are not caused by differential course taking, as had been hypothesized previously by other researchers. One of their concluding statements was that "sex differences in achievement in and attitude toward mathematics result from superior male mathematical ability, which may in turn be related to greater male ability in spatial tasks." Since that time, much research has been done — and is still being done — to investigate whether a gender difference exists, and if so, why.

While the results of independent researchers have supported both "yes" and

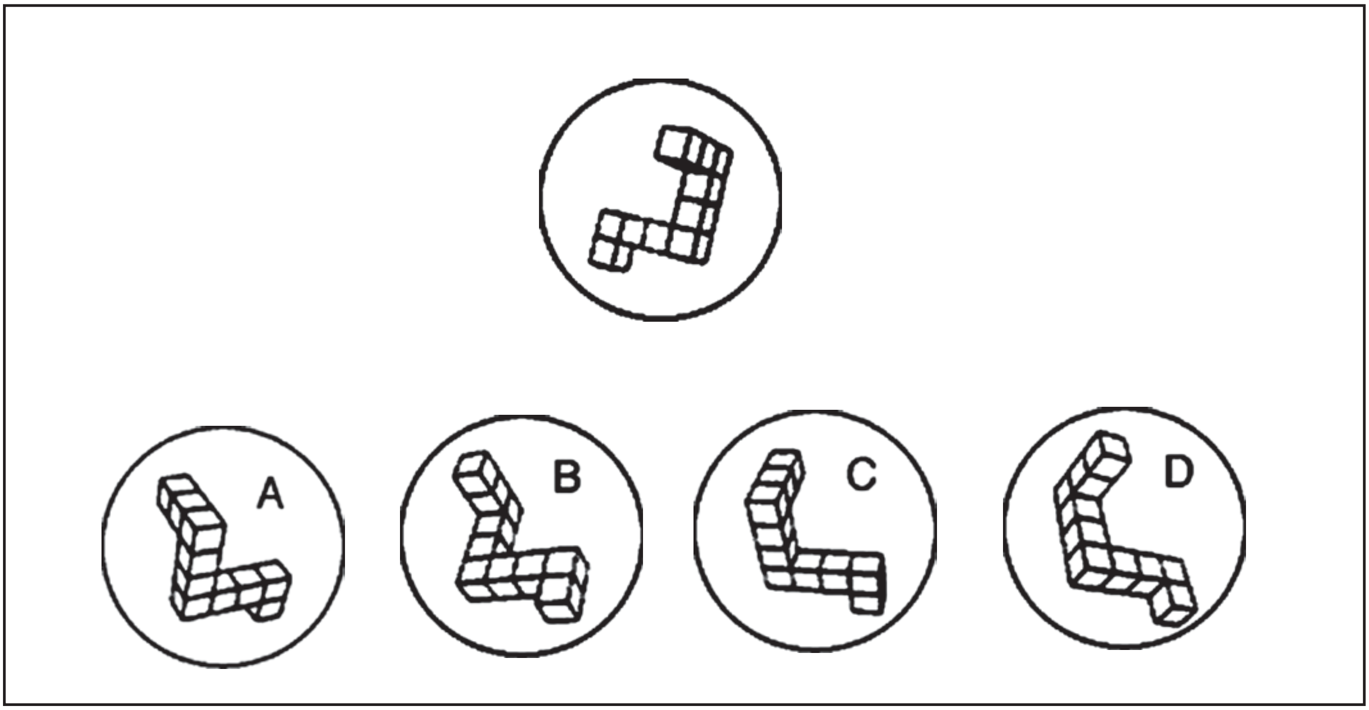

Figure 1

Look at the object on the top. Two of the four drawings below it show the same object. Identify those two drawings. Reprinted with permission from Eliot J., & Smith, I.M. (1983). *An international directory of spatial tests.* Windsor, England: NFER-Nelson.

"no" answers to the question of whether gender differences exist, there seems to be agreement that the answer is "yes" for *some* categories of spatial skills. The size of the sex difference varies by test, and for many tests the gender gap is not statistically significant. The largest between sex differences have been found on tests measuring spatiotemporal ability and mental rotation skills. In fact, the results from tests of mental rotation skills such as the MRT exhibit the largest gender gap on record for any cognitive ability [6]. However, much of the research concludes that the largest differences occur at the extremes, with little variation in the performance of men and women of medium spatial ability. In [10], Richardson concludes that sex differences diminish with educational experience, as the sex differences were much smaller when college seniors and post-graduates were tested, as compared to the gender gap in the scores of college freshmen. A very readable article about brain differences in men and women written for *Scientific American* in 1992 [7] explains that although men are better in certain spatial abilities such as navigating their way through a route, they use a different set of skills than women, who are better at recognizing and remembering the landmarks along the route. The conclusion is that it is not necessarily a question of being better, or more intelligent, but of different ways of using the brain.

Other research studies have focused on identifying performance factors that affect the results of spatial tests. The strategy of guessing has been hypothesized to be a factor in sex differences in testing situations. In a study of 13 to 17-year olds [8], researchers found that females were more likely than males to use the "I don't know" alternative on the National Assessment of Educational Progress in Science test. In another study [5], Goldstein and others concentrated solely on the MRT and found that sex differences were no longer statistically significant when the test was administered under different conditions. Their first study used ratio scoring (counting the number correct out of the number attempted) to show that they could completely eliminate the gender gap using this type of scoring. They hypothesized that the men were guessing more than women and/or the women were working more slowly. In a second experiment, the test was given both timed and untimed. While the males had significantly more items correct when timed, the difference was marginal when the test was untimed. Other studies have focused on the use of video games for improving spatial abilities. In [11], a group of 10 and 11-year olds boys and girls were trained on action video games that required the manipulation of shapes, and both the boys and girls improved on tests of spatial ability. It is of interest to note that both genders improved their scores at this age, since many studies indicate that gender differences in spatial tests begin sometime around puberty. Tartre [12] cites a Harvard study in which a test of spatial skills with questions involving mental rotation was given to adult subjects, and as usual the men outperformed the women. After playing video games for five hours, the subjects were retested, and the women now scored as well as the men.

Even if gender differences in some spatial categories do exist, is there a relationship between spatial ability and mathematical performance? Once again, we have mixed findings. In one study of four groups of subjects [2], the researchers concluded that spatial ability as measured by the MRT was an important factor in the SAT math scores for all groups except for low-ability high school seniors. Once again, the largest between sex differences were found at the extremes, this time in the group of precocious youths of average age 13.

In her meta-analysis [4], Friedman agreed with these results, but found that in general, the correlation between spatial ability and mathematical ability is not high. In fact, she found that the correlations with success in mathematics from lowest to highest were two-dimensional visual skills, then verbal logic skills, then three-dimensional visualization skills, and finally reading comprehension. She also found that the correlation between spatial ability and mathematics performance is higher for females than males. And, as had been found in previous studies, she found that the gender difference is more pronounced in college-bound or gifted samples.

In [3], Fennema and Tartre grouped students according to their verbal and spatial visualization skills. The male group that was classified as low-spatial and high-verbal had the highest math achievement scores, whereas the similar female group was lowest. This, as well as Friedman's findings, may suggest that spatial ability might be more of a factor for females than for males in mathematical performance. But it certainly contradicts the hypothesis that men are better in math because of their spatial ability.

So what can we conclude from all of this research? It seems clear that there is a gender difference on some tests that measure spatial visualization skills, but the causes of the differences are not as apparent. Some research indicates that spatial ability can be learned through training and experience. Moreover, spatial ability does not always predict mathematical achievement.

The more significant implications seem to be pedagogical. If men and women employ a different set of skills for learning mathematics and solving problems, then it seems clear that the way in which we test and present material can have an affect on the performance of our students. If we hope to attract a diverse set of minds to our field, then we have to always be aware that not all of our students (men or women) will learn in the same way that we do.

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Terri Bennett is at the Department of Mathematics of Southern Connecticut State University in New Haven, CT. This article is related to a talk she gave at the January Joint Mathematics Meetings

FOCUS

The next issue of FOCUS will appear in early September. But don't panic! You'll still be able to find news, columns, book reviews, and other features in FOCUS Online. Go to: http://www.maa.org, and place your mouse over the FOCUS Online listing to see what's available.

What Will They Do This Summer?

By sarah-marie belcastro and Mira Bernstein

Every summer, hundreds of mathematically talented high-school students attend enrichment and acceleration programs in the United States. (Many readers of FOCUS were at one time among this population!) There are a variety of programs available. Some are residential, others are not; some are purely about mathematics, others combine mathematics with science; some draw students from across the country, and others from a specific geographic area. Sadly, the majority of high-school students and teachers are not aware of these programs, and so a large pool of mathematical talent is out there, ripe for development but inaccessible. For example, the authors currently work every summer with mathematically gifted high-school students, but when we were in high school, we had no idea that such programs existed.

In this article, we are concentrating on the national-level programs in the country — those which attract the brightest students from across the continent and even some from overseas. A fuller, though by no means exhaustive, list of summer math programs can be found at http://www.ams.org/employment/mathcamps.html (please contact the AMS if you know of programs which are not listed there). There are definitely opportunities out there for every high-school student interested in mathematics, ranging from summer institutes at local universities to state Governor's Schools to the programs described below.

Each of the following programs has a different personality and a different emphasis, so students should check them all out before deciding where to apply. Of course, students are welcome to apply to multiple programs, and we encourage them to do so! All of the programs encourage participatory learning.

The Ross Program at Ohio State University

http://www.math.ohio-state.edu/ross, is the eldest of the summer programs, having begun in 1957. The first-year curriculum focuses on number theory, and advanced courses vary from year to year.

The Hampshire College Summer Studies in Mathematics

http://www.hcssim.org, in Amherst, Massachusetts has been in operation since 1971. This program accepts 34–51 students each summer. The curriculum varies each year, but covers a broad spectrum of mathematics.

Program in Mathematics for Young Scientists

http://www.promys.org

Texas Mathworks Honors Summer Math Camp

http://mathworks.txstate.edu/student/HSMC/description.htm

Both programs are descendants of the Ross Program and have similar philosophies and curricula. However, each has added a twist: PROMYS has been held at Boston University since 1989 and accepts approximately 60 high-school students. Since 1991, it has also held a parallel program for ten high-school teachers. Texas Mathworks Honors Summer Math Camp has been held at Texas State University, San Marcos since 1989, and involves an Honors Seminar in addition to the number theory curriculum.

Canada/USA Mathcamp

http://www.mathcamp.org, is younger, having begun in 1993, and hosts over 100 students each year. The location varies from year to year; in 2005, Mathcamp will be held on the campus of Reed College in Portland, OR. Multiple levels of classes are offered on a wide variety of topics.

Stanford University Mathematics Camp, http://math.stanford.edu/sumac/, began in 1995. It has two programs, the first centered on algebra and number theory, and the second on combinatorial, differential, and algebraic topology.

So, here is our plea to MAA members: Contact a local high-school mathematics teacher. Tell him or her that summer mathematics programs exist for talented students, and direct her or him to the websites of your local/regional programs and the national programs. If every reader does this, no mathematically talented high-school student will miss the opportunity to participate in a summer enrichment program!

sarah-marie belcastro (Xavier University) is Co-Director of HCSSiM. Mira Bernstein (Wellesley College) Executive Director of Mathcamp.

Take a closer look at
Governors State University

Mathematics Faculty

Governors State University invites applications for a full-time, tenure track faculty position in applied mathematics at the assistant/associate professor level beginning August 2005. Our desired candidate will have the ability and desire to work across disciplines. It is expected that the faculty member will collaborate with the Division of Science (which also includes computer science, chemistry, and biology) and education faculty. The successful candidate will teach courses at the upper-division level in a new BA in Mathematics (which includes a Secondary Teacher Education sequence); serve as coordinator for both programs; provide leadership in developing and implementing the curricula; advise undergraduate students and supervise their research projects, and pursue scholarly activity in mathematics or mathematics education. The current faculty in Mathematics consists of a team of experienced university lecturers who deliver the general education mathematics curriculum. **Qualifications:** A Ph.D. in Mathematics and a strong commitment to both teaching and research. To apply, send a letter of application, curriculum vitae, a brief statement of research results and interests, transcripts, and three professional letters of reference to: **Dr. Gary Lyon, Chair, Mathematics Faculty Search Committee, College of Arts and Sciences, Governors State University, 1 University Parkway, University Park, IL 60466.**

If you would like more information about the university, please visit our web site at: **www.govst.edu/hr**

AA/EOE

MAA Contributed Paper Sessions
San Antonio Joint Mathematics Meeting, January 12-15, 2006

Call for MAA Contributed Papers

The MAA Committee on Contributed Paper Sessions solicits contributed papers pertinent to the sessions listed below. Contributed paper session organizers generally limit presentations to ten or fifteen minutes. Each session room contains an overhead projector and screen; blackboards will not be available. Speakers needing additional audiovisual equipment should contact, as soon as possible, but prior to September 28, 2005, the session organizer whose name is followed by an asterisk (*). Organizers have been advised that the majority of speakers in a session must require the use of additional audiovisual equipment in order to justify the expenditure. Please note that the dates and times scheduled for these sessions remain tentative.

MAA CP A1 Philosophy of Mathematics
Thursday morning
Roger Simons*, Rhode Island College, rsimons@ric.edu
Satish C. Bhatnagar, University of Nevada
This session, sponsored by the SIGMAA for the Philosophy of Mathematics, invites papers on any topic in the philosophy of mathematics except logic and set theory. Possible topics include the nature of mathematics, the nature of mathematical objects, the nature of mathematical knowledge, the relation between mathematics and the physical world, the role of esthetics in the development of mathematics.

MAA CP B1 Mathlets for Teaching and Learning Mathematics
Thursday and Friday mornings
David Strong*, Pepperdine University
david.strong@pepperdine.edu
Thomas Leathrum, Jacksonville State University; and Joe Yanik, Emporia State University
This session seeks to provide a forum in which presenters may demonstrate mathlets and related materials that they have created or further developed. Mathlets are small computer-based (but ideally platform-independent) interactive tools for teaching math, frequently developed as World Wide Web materials such as scripts or Java applets, but there may be many other innovative variations. Mathlets allow students to experiment with and visualize a variety of mathematical concepts, and they can be easily shared by mathematics instructors around the world.

MAA CP C1 Post-Secondary Mathematics Assessment – Needs and Challenges
Thursday morning
Gloria Dion*, Educational Testing Service, gdion@ets.org
Daryl Ezzo, Educational Testing Service; Luis Saldivia, Educational Testing Service
We invite the submission of papers related to the mathematics assessment of college students. Topics of interest for this session include admissions testing, placement or proficiency testing, course assessments, outcomes testing, and exit exams. We are especially interested in innovative programs and experiences with integrating technology into assessment; performance or portfolio assessments; the uses and impact of national tests; assessing students with disabilities; placement testing for incoming students whose high school experience is in a standards-based curriculum; outcomes testing at critical junctures, e.g., following developmental courses; diagnostic and formative assessments; and other new directions in assessment or research related to the mathematics assessment of college students.

MAA CP D1 Professional Development Programs for K-12 Teachers
Thursday morning
Zsuzsanna Szaniszlo*, Valparaiso University
zsuzsanna.szaniszlo@valpo.edu
Laurie Burton, Western Oregon University; Judith Covington, LSU Shreveport; Patricia Hale, California State Polytechnic University, Pomona
The mathematical community has long recognized the importance of teacher education. PMET (Preparing Mathematicians to Educate Teachers) is a prime example of projects that aim to help college mathematics faculty to train teachers. The next step in this endeavor is to include mathematicians in the professional development of in-service K-12 teachers. All over the country many small and large scale projects exist aimed at providing a mutually beneficial opportunity in which mathematicians work with K-12 mathematics teachers. The directors of these projects will share their experiences developing and implementing the projects, including both mathematical and organizational issues. The session invites talks that showcase successful in-service training programs for K-12 mathematics teachers that utilize college and university mathematics faculty. The talks should reflect on every aspect of the program and include a description of the experiences of mathematicians. Programs that are easily replicable will be given priority. The submissions should include the grade levels of the participating teachers.

MAA CP E1 Number-Theoretic Applications
Thursday afternoon
Thomas Koshy*, Framingham State College
tkoshy@frc.mass.edu
Thomas Moore, Bridgewater State College.
The advent of modern technology has brought a new dimension to the beauty and the power of number theory. Once considered the purest of pure mathematics, it is increasingly used in the rapid development of technology in a number of areas.

The various fascinating applications have confirmed that human ingenuity and creativity are boundless. Relevant and thought-provoking applications establish a strong and meaningful bridge between number theory and a number of other areas. Historical anecdotes, woven throughout a number theory course, give a meaningful, historical perspective about the development of the subject. They add a human face and touch to the development of the subject, and should provide a meaningful context for prospective and in-service teachers in mathematics. Attendees of the session should be able to take them to their own classes and in turn excite their own students, and share their enthusiasm with others. This contributed paper session focuses on interesting applications of and historical anecdotes in number theory, and the relevance of computers in the study of number theory. It is primarily aimed for number theory enthusiasts who enjoy teaching number theory for mathematics majors, and in-service and pre-service teachers.

MAA CP F1 Teaching Mathematics Courses Online MAA
Thursday afternoon
Kate McGivney*, Shippensburg University, kgmcgi@ship.edu
Cheryl Olsen, Shippensburg University
In recent years there has been an increasing trend for undergraduate institutions to offer mathematics courses online. This session will focus both on presenting successful strategies for teaching such courses as well as describing shortcomings in delivering mathematics online. Consideration will be given to courses where at least 50% of the content is communicated via the web. Proposals that address issues including, but not limited to, designing effective means of communication between students and the instructor, managing group projects and assignments, incorporating various technologies into the course, and implementing successful assessment strategies are welcome. Papers that address how to design an online course that meet the same course goals as a traditionally taught course are of particular interest. Finally, data based on student experiences from learning in an online environment are welcome.

MAA CP G1 Teaching and Assessing Modeling and Problem Solving
Thursday afternoon
Mike Huber*, United States Military Academy
michael.huber@usma.edu
Alex Heidenberg, United States Military Academy
Developing problem-solving skills in the modeling sense is a central component in refocusing courses to emphasize process, conceptual understanding, and student growth. Universities and colleges are now writing institutional goals that address the capabilities of their graduates. How do we measure success in teaching our students to be effective problem-solvers? This session invites presentations about courses that focus on the process of problem-solving as a vehicle to learning mathematics at the pre-calculus/introductory calculus levels, with special emphasis on modeling. Of particular value will be presentations which offer assessment techniques in problem-solving courses. These presentations can include course philosophy, mid-term examinations, attitude surveys, past projects, and other successful methods of assessment where students have become competent and confident problem-solvers. Each presentation should address the specific goals in developing problem-solvers as well as the assessment techniques used to measure attainment of those goals.

MAA CP H1 Getting Students to Discuss and to Write About Mathematics
Thursday and Friday afternoons
Martha Ellen (Murphy) Waggoner*, Simpson College
waggoner@simpson.edu
Charlotte Knotts-Zides, Wofford College; Harrison (Chuck) W. Straley, Wheaton College
This session invites papers about assignments and projects that require students to communicate mathematics through in-class oral presentations that they make or in-class discussions that they must lead and motivate, and through written assignments and/or papers. These assignments can include analysis and applications of mathematics, presentations of and analysis of proofs, presentations about famous mathematicians and the mathematics that they studied, and assignments/projects that utilize creative writing. Each presenter is encouraged to discuss how the use of the assignment/project helped students to improve their understanding of mathematics and their ability to communicate mathematics. Of particular interest is the effect of such projects/assignments/presentations throughout the course on the students' understanding of mathematics, their communication of mathematics, and their attitude toward mathematics.

MAA CP I1 Using History of Mathematics in Your Mathematics Courses
Friday morning
Dick Jardine*, Keene State College, rjardine@keene.edu
Amy Shell-Gellasch
This contributed paper session solicits talks that describe ways to use or embed the history of mathematics in the collegiate mathematics curriculum. Talks should discuss ways to use history to enhance the teaching of mathematical subjects as opposed to ways to teach history of mathematics courses.

MAA CP J1 Innovative Teaching/Learning Ideas Using Technology in the Teaching of Courses before College Algebra
Friday morning
Ed Laughbaum*, The Ohio State University
elaughba@math.ohio-state,edu
Mohammad H. Ahmadi, University of Wisconsin-Whitewater
In this session, we are looking for creative ideas that demonstrate how faculty are using handheld graphing or computer technology to enhance teaching and learning in remedial/developmental algebra courses. Examples might involve graphing calculator apps, the use of function as a central theme, teaching techniques that promote understanding, portable e-lessons, electronic class polling as formative assessment, etc.

MAA CP K1 Research and Other Mathematical Experiences for Students Outside the Classroom
Friday morning
Kay Somers*, Moravian College, mekbs01@moravian.edu
Susan Morey, Texas State University; Sivaram K. Narayan, Cen-

tral Michigan University; Jody Sorensen, Grand Valley State University

Mathematics "happens" both inside and outside the classroom and, in fact, many mathematics majors are drawn to the subject through a special event sponsored by a Student Chapter or Math Club or through special research projects and programs. This session seeks presentations by academic, industrial, business, and/or student mathematicians so that the audience will be encouraged to organize and run special events for their students. Descriptions of activities could include, but are not limited to, special lectures, workshops for students, Math Days/ Fairs, student conferences, recreational mathematics activities, problem solving activities and contests, general community-building activities, and student consulting projects. We especially encourage information about student research projects and programs, including program logistics and project ideas. Information on how such activities are organized and carried out, what activities especially grab students' interests, how students are contacted and encouraged to participate, and how the events are funded will be especially helpful. This session is organized by the MAA Committee on Undergraduate Student Activities and Chapters and by the CUPM Subcommittee on Undergraduate Research.

MAA CP L1 Courses Below Calculus: A Continuing Focus

Friday and Saturday mornings

Mary Robinson*, University of New Mexico-Valencia Campus
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Florence S. Gordon, New York Institute of Technology; Laurette Foster, Prairie View A&M University; Arlene Kleinstein, Farmingdale State University of New York; Norma Agras, Miami Dade Community College; Linda Martin, Albuquerque T-VI

The MAA, AMATYC, and NCTM have been working together on a national initiative to refocus the courses below calculus to better serve the majority of students taking these courses. The goal of the initiative has been and continues to be to encourage courses that place much greater emphasis on conceptual understanding and realistic applications of the mathematics compared to traditional courses that too often are designed to develop algebraic skills needed for calculus. In support of the emphasis placed on this topic by the MAA, AMATYC, and NCTM within their committees and executive boards, this session will address the courses below calculus, with particular emphasis on offerings in college algebra and pre-calculus. We seek presentations that present new visions for such courses, discuss implementation issues (such as faculty training, placement tests, introduction of alternative tracks for different groups of students, etc. related to offering such courses), present results of studies on student performance and tracking data in both traditional and new versions of these courses and in follow-up courses, and discuss the needs of other disciplines from courses at this level. This session is co-sponsored by the CRAFTY, the Committee on Two Year Colleges, and the Committee on Service Courses.

MAA CP M1 Mathematics of Sports and Games

Friday afternoon

Sean Forman*, Saint Joseph's University, sforman@sju.edu
Doug Drinen, Sewanee: University of the South

When applied to the sporting arena, mathematics can provide both compelling classroom examples and interesting research problems. Baseball has long been mined for interesting statistics examples ranging from regression and probability to the game theoretic aspects of in-game strategy (for example, Albert and Bennett's *Curve Ball* presents introductory statistics through baseball statistics.) Recent books on Jai Alai, football, and a few other sports have likewise studied those sports through a mathematical lens. The economics of sports is now covered by its own journal and the statistics publication *Chance* routinely discusses statistical examples in sports. Games have likewise taken on additional interest with the explosion of the professional poker circuit and interest in simulation and combinatorics relating to poker and other games of chance. The objectives of this session include the presentation of interesting classroom examples utilizing examples from sports and games and the discussion of research topics relating to sports and games.

MAA CP N1 Mathematical Connections in the Arts

Friday afternoon

Douglas E. Norton*, Villanova University
douglas.norton@villanova.edu
Reza Sarhangi, Towson University; Nathaniel A. Friedman, State University of New York, Albany.

This session seeks interdisciplinary abstracts relating mathematics and one or more of the arts, considered in the broadest sense: architecture, dance, music, literature, theater, film, the visual arts, and others. Number, pattern, line, shape, and symmetry have long been mathematical tools at the disposal of the arts. Increasingly, the various expressions of artistic form have lent themselves to aesthetic presentations of mathematical topics and results. Mathematical concepts inform artistic presentation, while artistic presentation illuminates mathematics. In both directions, new technologies provide new possibilities. Altogether, the new approaches and new tools provide new opportunities for teaching and for outreach to the general public about the unexpected place of mathematics in relation to the arts, culture, and society. Session objectives include: (i) Explore old and new connections between math and the arts, from ancient Islamic tiles to contemporary folk arts, from perspective in paintings to Möbius sculptures; and (ii) Demonstrate the use of new technologies and new looks at old technologies to illustrate connections between mathematics and the arts.

MAA CP O1 Research on the Teaching and Learning of Undergraduate Mathematics

Friday afternoon

Bill Martin*, North Dakota State University
william.martin@ndsu.edu
Barbara Edwards, Oregon State University; Mike Oehrtman, Arizona State University

Research papers that address issues concerning the teaching and learning of undergraduate mathematics are invited. Appropriate for this session are theoretical or empirical investigations conducted within clearly defined theoretical frameworks, using either qualitative or quantitative methodologies. Of highest priority are proposals that report on completed studies that further existing work in the field.

MAA CP P1 On Achieving Quantitative Literacy

Friday afternoon

Aaron Montgomery*, Central Washington University montgoaa@cwu.edu

Stuart Boersma, Central Washington University; Semra Kilic-Bahi, Colby Sawyer College

The issue of Quantitative Literacy (QL) has become one of the challenging topics in the education community as many schools are developing programs to improve their students' ability to use quantitative information in their lives. Many are faced with the difficulty of establishing the role of QL in the undergraduate mathematics curriculum as well as agreeing on necessary QL skills for students. The organizers of this session invite papers that will contribute to the ongoing discussion of quantitative literacy, quantitative reasoning, and/or numeracy. Papers contributed to this session should attempt to address topics such as: working definitions of QL; assessable QL standards; the development of a QL program; the development of QL related courses and course material including modules, or units within a course; the assessment of the QL skills of students; and the assessment of a QL program.

MAA CP Q1 Mathematics of Chemistry

Saturday morning

George Rublein*, College of William and Mary gtrubl@math.wm.edu

Mathematics makes its appearance early on in college-level chemistry courses. Physical chemistry, which is heavily laced with mathematical models, has a reputation as the most difficult course in the undergraduate chemistry curriculum. The treatment of mathematics in chemistry textbooks often bears little resemblance to the approaches that students see in mathematics courses. This session solicits contributions that show examples of models drawn from chemistry that might comfortably appear in the calculus, differential equations of linear algebra courses in which chemistry students are commonly enrolled. Chemical thermodynamics, stoichiometry, and chemical kinetics are good sources for such models.

MAA CP R1 Mathematics Experiences in Business, Industry, and Government

Saturday morning

Phil Gustafson*, Mesa State College, pgustafs@mesastate.edu

Michael Monticino, University of North Texas

This contributed paper session will provide a forum for mathematicians with experience in Business, Industry, and Government (BIG) to present papers or discuss projects involving the application of mathematics to BIG problems. BIG mathematicians as well as faculty and students in academia who are interested in learning more about BIG practitioners, projects, and issues, will find this session of interest. This session is sponsored by the MAA Business, Industry, and Government Special Interest Group (BIG SIGMAA).

MAA CP S1 Countering "I Can't Do Math": Strategies for Teaching Under-Prepared, Math-Anxious Students

Saturday and Sunday mornings

Bonnie Gold*, Monmouth University, bgold@monmouth.edu

Suzanne Dorée, Augsburg College; Richard Jardine, Keene State College

How can we create a comfortable learning environment for under-prepared or math-anxious students and, in particular, how can we constructively assess student learning? What classroom practices are especially effective with such students and how does research on student learning inform those practices? How might the recommendations of the *2004 CUPM Curriculum Guide* influence our approach in teaching developmental or introductory courses to better reach these students? This session invites papers on all aspects of "what works" in teaching under-prepared, math-anxious students.

MAA CP T1 Teaching Operations Research in the Undergraduate Classroom

Saturday morning

Christopher J. Lacke*, Rowan University, lacke@rowan.edu

Paul E. Fishback, Grand Valley State University

This session solicits papers highlighting innovative instructional strategies and assessment methods in the introductory undergraduate operations research sequence. Suggested topics include, but are not limited to, course projects, case studies, technology demonstrations, cooperative learning activities, and writing assignments. Papers may focus on original teaching materials or the creative use of previously existing ones, but all papers should provide specific learning objectives addressed by the use of such materials. Each submission must focus on operations research topics at the undergraduate level, including those in the introductory undergraduate operations research sequence or undergraduate courses in stochastic processes, queuing theory, network optimization, etc. In addition to the abstract sent to the AMS, the organizers request that they be sent a course syllabus relating to the submission.

MAA CP U1 MY FAVORITE DEMO—Innovative Strategies for Mathematics Instructors

Saturday morning and afternoon

David R. Hill*, Temple University, hill@math.temple.edu

Lila F. Roberts, Georgia College & State University

Mathematics instructors use a myriad of innovative techniques for teaching mathematical concepts. Technology readily available in colleges and universities has provided a means to boost creativity and flexibility in lesson design. Tools an instructor utilizes may include specialized computer applications, animations and other multimedia tools, java applets, physical devices, games, etc. This contributed paper session will focus on novel demos that mathematics instructors have successfully used in their classrooms and facilitate learning. Mathematical content areas will include pre-calculus, calculus, elementary probability, and selected post-calculus topics. This session invites (1) demos that introduce a topic, (2) demos that illustrate how concepts are applicable, (3) demos that tell a story or describe the development of a procedure, and (4) demos that lead to an activity that involves the class. Presenters of demos are encouraged to give the demonstration, if time and equipment allow, and to discuss how to use it in a classroom setting. Proposals should describe how the demo fits into a course, the use of technology or technology requirements, if any, and the effect of the demo on student attitudes toward mathematics. Presenters should strive to include information regarding the effectiveness of the demo and assessment techniques employed.

MAA CP V1 Mathematics and Popular Culture
Saturday afternoon
Sarah J. Greenwald*, Appalachian State University
greenwaldsj@appstate.edu
Christopher Goff, University of the Pacific
One way that mathematics and popular culture interact is through Hollywood. Computer animators for blockbuster filmmakers like Pixar use mathematical algorithms in their work. In addition, television series such as *Numb3rs*, and movies like *A Beautiful Mind, Mean Girls,* and *Proof* (expected in 2005) offer varied portrayals of people with mathematical talent. These references to mathematics in popular culture can reveal, reflect, and even shape how society views mathematics. In the classroom, using popular culture can be a powerful technique for engaging diverse audiences. Capitalizing on student enjoyment of popular culture can alleviate math anxiety, energize shy and quiet students, and provide a creative introduction to an in-depth study of the related mathematics. This session invites presentations on all aspects related to mathematics and popular culture, including music, movies, television, artwork, and other media. Presentations could focus on how mathematics is changing Hollywood and movies, or how popular culture can be used to understand the way society views mathematicians and their mathematics. Conversely, presentations could focus on how appearances of and references to mathematics in popular culture have been used creatively and effectively in mathematics courses to reduce math anxiety and motivate students to explore significant mathematics.

MAA CP W1 My Three Favorite Original Calculus Problems
Saturday afternoon
J.D. Phillips*, Wabash College, phillipj@wabash.edu
Tim Pennings, Hope College
This session is for those who, while teaching single and multivariable calculus over the years, have thought of a couple of clever or novel problems with solid pedagogical value that they would like to share with others. In particular, we are looking for original problems suitable for homework assignments or challenging test questions. (We are not looking for extended modeling projects and open-ended problems since good collections of these already exist.) We hope to organize these into a booklet for publication which could be used as a resource for calculus courses. Submissions may include from two to four problems. Participants should bring copies of their problems to the session for distribution. Each problem should begin on a new page.

In addition to the abstract sent to the AMS, the organizers have requested that they be sent: (i) A statement of the problem, (ii) A brief explanation of why it is interesting and pedagogically valuable, and (iii) A complete solution leading to an answer in closed form.

MAA CP X1 First Steps for Implementing the Recommendations of the Guidelines for Assessment and Instruction in Statistics Education (GAISE) College Report
Saturday afternoon
Ginger Holmes Rowell*, Middle Tennessee State University
rowell@mtsu.edu
Thomas L. Moore, Grinnell College
The Guidelines for Assessment and Instruction in Statistics Education (GAISE) Project, funded by the American Statistical Association (ASA), has written a report which focuses on the introductory college statistics courses. In addition to providing a historical overview of these courses and offering a list of goals for statistically literate students, this report updates the 1992 recommendations by George Cobb for teaching these courses. The report contains the following six recommendations: (1) Emphasize statistical literacy and develop statistical thinking, (2) Use real data, (3) Stress conceptual understanding rather than mere knowledge of procedures, (4) Foster active learning, (5) Use technology to develop conceptual understanding and analyze data, and (6) Use assessments to improve and evaluate learning. In a 2004 summary of the report, Robin Lock stated that putting these recommendations into practice may be an evolutionary process. For example, an instructor may take a first small step by finding or developing a case study of statistical interest. Instructors are invited to submit proposals describing successful first steps at implementing one or more of these recommendations. Innovative approaches for successful implementation are encouraged. Presenters in this session will be considered for the SIGMAA on Statistics Education's Best Contributed Paper Award.

MAA CP Y1 Hand-Held Technology in Content and Methods Courses for Prospective Teachers with a Special Interest Strand Devoted to Teaching and Learning Geometry
Saturday afternoon
Charles Vonder Embse*, Central Michigan University
vonde1cb@cmich.edu
Deborah A. Crocker, Appalachian State University; Gregory D. Foley, The Liberal Arts and Science Academy of Austin at Lyndon B. Johnson High School; Stephen F. West, SUNY Geneseo.
Technology has significantly changed the way we teach and learn mathematics at both the school and collegiate levels. Various types of hand-held technology are increasingly used in nearly all mathematics and mathematics education courses for prospective teachers of mathematics in both elementary and secondary level programs. In particular, interactive, dynamic geometry software for hand-held graphing calculators has changed the basic way that mathematics is taught from a didactic, rigidly structured approach to an exploratory and investigative journey of discovery. State and national curriculum standards specify that geometry be an integral part of school

mathematics programs from kindergarten through grade 12. As a result, geometry units and courses are a critical part of the mathematical development for preservice teachers. This session seeks papers on promising practices and research involving the use of hand-held technology with prospective teachers of mathematics in Grades K–12. A strand of the session will be devoted to papers on hand-held technology in geometry courses for preservice teachers. Papers may concern hand-held technology use in mathematics content courses or mathematics methods courses.

MAA CP Y3 Models That Work: Building Diversity in Advanced Mathematics
Sunday morning
Abbe H. Herzig*, University at Albany, SUNY (aherzig@albany.edu
Patricia Hale, California State Polytechnic University, Pomona.
The goal of this contributed paper session is to present to the mathematics community models of programs that have been successful at supporting diverse groups of people (women of all races and African Americans, Latinos and Chicanos, and Native Americans) in their pursuit of advanced mathematics study and careers. We believe that it is important to examine this question holistically, across the span of the educational pathway, since issues of diversity need to be addressed at every educational and professional juncture. Consequently, we seek proposals for presentations that will describe successful programs for post-doctoral (faculty), graduate, undergraduate, or pre-college students. We interpret "success" broadly, and are looking for ideas that should be shared with others in the mathematics community as models for promoting diversity across the educational spectrum. These might be academic or extracurricular programs, which have targeted any group of people traditionally underrepresented in the mathematical sciences. Historical perspectives are also welcome. This session is jointly sponsored by the MAA Committee on the Participation of Women and the MAA Committee on the Participation of Minorities.

MAA CP Y5 CTUM Session on Strategies to Encourage Persistence in Mathematics
Sunday morning
David C. Carothers*, James Madison University carothdc@jmu.edu
Ahmed I. Zayed, DePaul University; Keith E. Mellinger, University of Mary Washington
Enrollments in advanced mathematics courses have declined in recent years, as shown by CBMS surveys. This has happened at a time when more than ever students majoring in many different disciplines would benefit from more mathematics. The CUPM Curriculum Guide also recognizes that mathematics departments should seek to enroll more students from the physical and life sciences, computer science, engineering, business and many other disciplines in advanced mathematics courses, while at the same time recruiting mathematics and statistics majors. This session will explore strategies to encourage students to persist in mathematics beyond introductory or required courses. Speakers are invited to present teaching and other strategies that have been successful in increasing the number of students who continue on to additional advanced courses after beginning calculus, statistics, or other introductory courses.

MAA CP Y7 Introductory Actuarial Science Programs
Sunday morning
Robert E. Buck*, Slippery Rock University, robert.buck@sru.edu
Multiple changes in the SOA/CAS exam structure over the past several years have impacted heavily on schools with actuarial science programs, particularly those institutions with small introductory programs. With another exam restructuring in 2005, as well as increased interest in the field, it would be useful to share responses to the situation. This session invites papers outlining how departments have adjusted their programs to respond to these changes, as well as papers detailing the type of programs offered. Of principal interest are papers discussing Introductory Undergraduate Actuarial Science Programs, but papers describing Advanced Undergraduate Actuarial Science Programs will also be considered. This session will be of special interest both to departments with existing actuarial programs and those considering such programs.

MAA CP Z1 General Session
Thursday, Friday, Saturday, Sunday mornings and afternoons
Stephen Davis*, Davidson College, stdavis@davidson.edu
Eric Marland, Appalachian State University
Papers may be presented on any mathematical topic. Papers that fit into one of the other sessions should be sent to that organizer, not to this session.

SUBMISSION Procedures for MAA Contributed Papers

Send your abstract directly to the AMS (abstracts should not be sent to the organizer(s)). Participants may speak in at most two MAA contributed paper sessions. If your paper cannot be accommodated in the session it was submitted, it will be automatically considered for the general session. Speakers in the general session will be limited to one talk because of time constraints. Abstract must reach the AMS by Tuesday, September 28, 2005.

The AMS will publish abstracts for the talks in the MAA sessions. Abstracts must be submitted electronically to the AMS. No knowledge of LaTeX is necessary, however, LaTeX and AMSLaTeX are the only typesetting systems that can be used if mathematics is included. The abstracts submissions page is at http://www.ams.org/cgi-bin/abstracts/abstract.pl. Simply fill in each field as instructed. The MEETING NUMBER is 1014.

Submitters will be able to view their abstracts before final submission. Upon completion of your submission, your unique abstract number will immediately be sent to you. All questions concerning the submission of abstracts should be addressed to abs coord@ams.org.

Employment Opportunities

WASHINGTON, DC

TRINITY COLLEGE
Clare Boothe Luce Assistant Professor of Computer Science and Mathematics
Trinity, a comprehensive university in Washington, DC is one of the thirteen institutions named in Clare Boothe Luce's bequest to receive funds in perpetuity to support women in Math, Science and Engineering through scholarships and professorships. Trinity College emphasizes the education of women in undergraduate programs. The University invites applications from outstanding women committed to undergraduate education for a tenure-track position at the assistant professor level in Computer Science and Mathematics beginning fall 2005. The candidate search is restricted by the Luce bequest to the Henry Luce Foundation to women who have U.S. permanent residency.

The position offers an excellent starting salary and access to the research support provided by the Clare Boothe Luce Professorship in the form of a generous discretionary fund. The position carries a 9-hour teaching load each semester divided between the mathematics program and the relatively new and growing computer science program. Doctorate in Computer Science or Mathematics required. Review of applications will begin immediately and continue until the position is filled. Send cover letter, resume, transcripts, a statement of teaching philosophy in a liberal arts setting, and three letters of recommendation to: Carole King, Trinity College, 125 Michigan Ave, NE, Washington, DC 20017; email: humanresources@trinitydc.edu; or fax to 202-884-9123. Trinity College is an EEO employer.

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