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FOCUS

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Inside

On the cover: A. Square meets Arlene Hex, in Flatland, the Movie. *See page 8.*

FOCUS Deadlines

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

Srinivasa S.R. Varadhan to Receive 2007 Abel Prize

By Harry Waldman

Srinivasa S. R. Varadhan, of New York University's Courant Institute of Mathematical Sciences, has been awarded the 2007 Abel Prize in mathematics by the Norwegian Academy of Science and Letters. Prof. Varadhan will receive the Abel Prize from King Harald V of Norway, in Oslo, on May 22. The honor is accompanied by a prize of approximately $920,000.

In awarding the annual prize, which Norway established in 2002, the Academy cited Prof. Varadhan's exceptional work on probability theory. It singled out Varadhan's development of the theory of large deviations because it "provides a unifying and efficient method for clarifying a rich variety of phenomena arising in complex stochastic systems."

The law of large numbers shows that the average outcome of a long sequence of coin tosses is usually close to the expected value. However, the unexpected does happen. The theory of large deviations concerns the occurrence of such rare events. So, even though in the long term, the probability of a rare event diminishes to zero, the rate at which it does so is important in practical applications. Prof. Varadhan discovered the underlying general principles that govern estimates of large deviations.

Varadhan's pioneering approach to large deviations has applications in fields as diverse as quantum field theory, statistical physics, population dynamics, econometrics and finance, and traffic engineering. Further, the Academy noted that Varadhan's mathematical research has "greatly expanded our ability to use computers to simulate and analyze the occurrence of rare events." Over the last four decades, the theory of large deviations has become a cornerstone of modern probability, both pure and applied.

The Academy also cited Varadhan's work with Daniel Stroock on the development of a martingale method for characterizing diffusion processes, and his work with Maozheng Guo and George Papanicolaou on gradient models, work that Prof. Varadhan eventually extended to handle non-gradient models. Additional information about his work can be found at http://www.abelprisen.no/nedlastning/2007/varadhan_en.pdf.

Math and Science on Local TV News

By Ivars Peterson

Jugglers apply mathematics to invent new tricks. A computerized stethoscope analyzes heart murmurs. Mathematicians work out how much farther players can hit baseballs at high altitudes. The same mathematical formula that describes the shape of stalactites in caves also models icicle growth. High-school math underlies the creation of animated films.

These are among the wide range of mathematical, scientific, and technological topics covered by the syndicated TV series Discoveries and Breakthroughs Inside Science (DBIS). The American Institute of Physics produces these science news programs, with the MAA as a contributing partner. The NSF-funded DBIS project delivers twelve 90-second segments each month for showing on local TV stations across the country. Each segment highlights an advance or finding and demonstrates the important role that science and engineering play in society and in people's daily lives. It typically airs as part of a local newscast.

Along with video segments, the DBIS team offers supplementary material for each episode at its Web site. It also produces two segments per month for Spanish-language television news programs.

The MAA is one of about twenty scientific and engineering societies participating in the DBIS project. Representing the MAA, Joseph Gallian, Carl Pomerance, and Ivars Peterson contribute ideas and review scripts. The MAA has provided some funding for the project since 2006.

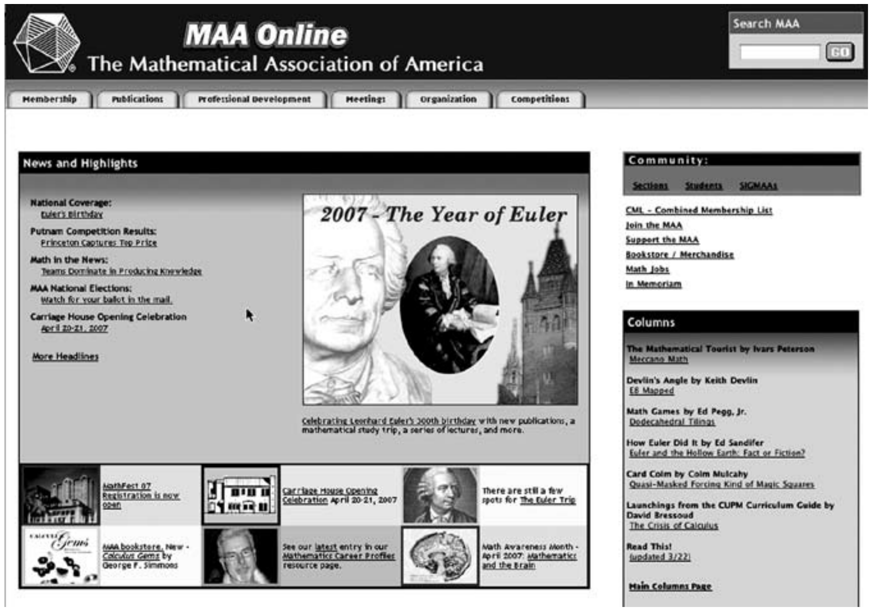
Additional information: http://discoveriesandbreakthroughs.org/dbis/.

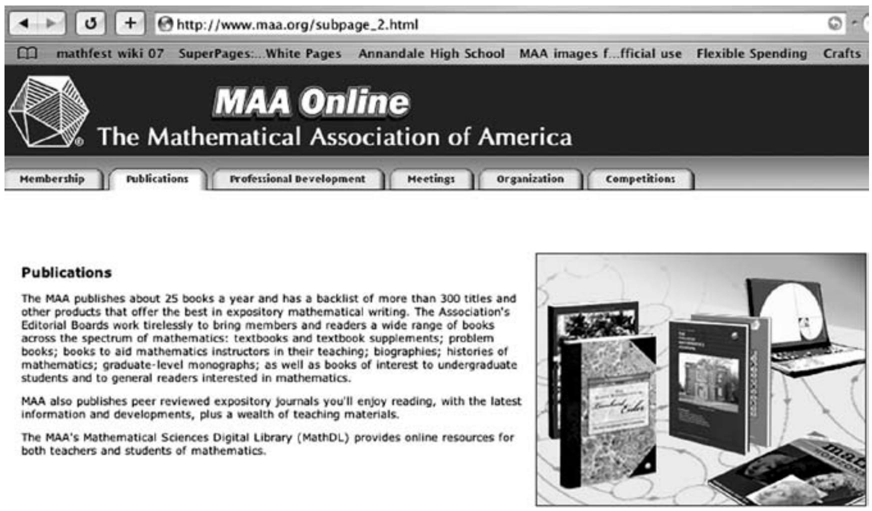
MAA Online Has a New Look

The redesigned version of MAA Online, which debuted in early April, makes more accessible the many features and resources available to MAA members and visitors. Look for regularly updated news reports, highlights, and bulletins, including a daily "Math in the News" column hosted by the Math Gateway, a portal to undergraduate mathematics resources in the National Science Digital Library.

Find links to special programs, including MathFest 2007, the Carriage House Opening Celebration, Math Awareness Month, and online voting for the MAA National Elections. Browse the variety of articles and items available in the journals and other resources of the Mathematical Sciences Digital Library. And read regularly updated columns of Ed Pegg, Jr., Keith Devlin, Ivars Peterson, Ed Sandifer, Colm Mulcahy, and David Bressoud, along with current book reviews.

In addition, MAA members can take advantage of access to digital editions of *The American Mathematical Monthly, Mathematics Magazine*, and *The College Mathematics Journal*. You'll find these and many more useful features once you explore MAA Online.





MAA Journals Available Online for Individual Members

Beginning this spring, individual members of the MAA will be able to access their journals online. The electronic version of each journal will appear in conjunction with the print version that arrives in the mail. Individuals receiving *The American Mathematical Monthly* will be able to view issues dating back to June/July 2006, those receiving *Mathematics Magazine* will be able to view issues dating back to June 2006, and members receiving *The College Mathematics Journal* will have access to issues dating back to May 2006. Members will be able to view only the journal(s) that they currently subscribe to. This new benefit will allow members to read their journals while traveling or in preparation for teaching a class.

To access the electronic journals go to the MAA's home page at (http://www.maa.org) and click on the link: "Read recent issues online," which is provided in the lower right hand corner under Journals. This link brings up a login page similar to the other login pages provided for members to order books, pay for membership, and view members-only content. The login procedure is the same. Enter your user id and password to gain entry. Your user id is your MAA member/customer number, which can be found in the top left-hand corner of a recent issue of FOCUS. Your password is your last name unless you have created a new password. Click the submit button and a page listing the journals that you have access to will appear. Members will also be able to access the MAA journals they don't currently subscribe to by going to Ingentaconnect at: http://www.ingentaconnect.com/. Here you may browse their site by article title, read the abstract, and purchase a copy of the article for $20.

Mathematician Trachette L. Jackson Gives MAA's Third Distinguished Lecture: Modeling Cancer Tumor Growth

On March 13, in the MAA's new conference center in Washington, D. C., the young and accomplished mathematician Trachette L. Jackson, of the University of Michigan, tackled the subject "Building Models of Tumor Heterogeneity: Insights into Prostate Cancer and the Cancer Stem Cell Hypothesis."

In giving her talk—the third of five scheduled lectures in the MAA's new Distinguished Lecture Series this year—Jackson came across as engaging, poised, and knowledgeable in mathematics and biology. MAA President Joseph Gallian introduced her to the attendees.

According to Jackson, cancers are composed of clonal subpopulations of cancer cells that may differ among themselves in several ways. They may vary immunologically, by growth rates, the ability to metastasize, the production and expression of markers, and their sensitivity to therapeutic treatment.

This complex heterogeneity has been demonstrated in a wide variety of tumors, including tumors that cause prostate cancer, which is the second leading cause of cancer deaths among U.S. males.

In an effort to better understand the cellular processes that mediate this disease and to give the medical community insights into treating prostate cancer, Jackson outlined mathematical models that describe the pretreatment growth and the post-therapy relapse of human prostate cancer xenografts. These models involve the use of partial differential equations and complex nonlinear systems in cancer biology.

By understanding the interplay among the multiple mechanisms that have been postulated as the causes of hormone-independent relapses of the disease, the goals of more effective treatment and cure of prostate cancer may not be far off.

For Jackson's lecture abstract and additional information about the MAA's Distinguished Lecture Series, see http://www.maa.org/dist-lecture/welcome.html.

Mathematician Makes Pitch for Scholarship in the Teaching and Learning of Undergraduate Mathematics

Should students be using graphing calculators in the classroom? on final exams? What about the classroom use of computer algebra systems? When such issues are debated, said mathematician James T. Fey, of the University of Maryland, College Park, there's far too much reliance on anecdotal "evidence" and a serious dearth of scholarship that sheds light on the issues.

Speaking on April 5 at the MAA's Carriage House Conference Center, Fey made a plea to the mathematics community to lend its support for greater research on the teaching and learning of undergraduate mathematics. Such backing could go a long way, he said, in helping to improve the way teachers teach mathematics and students learn mathematics.

"There is an extensive body of published and ongoing research aimed at understanding and improving mathematics teaching and learning at the elementary and secondary levels," Fey contended. "But comparable work at the undergraduate level has only begun recently."

Fey's talk was a "pitch," as he described it—a call for mathematicians to back the need for ongoing research and scholarship aimed at understanding how undergraduates comprehend and do mathematics in today's technological world. Such an understanding would benefit both those who teach and those who learn the subject. But such research is only at an embryonic stage, Fey claimed, because of a major barrier. At present, the mathematics community does not, in general, consider it appropriate mathematical scholarship.

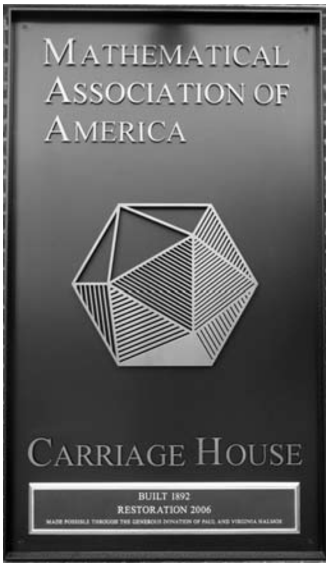
There's more to being an effective teacher than proving theorems and providing clear and compelling exposition, Fey remarked. Studies on how students learn and which teaching methods and styles are effective can also contribute to learning.

Fey provided examples of the sorts of the investigations into aspects of mathematical education that could prove useful, from carefully observing how students actually use new technology to measuring what they have learned. We need to be evaluating benefits and risks, he said. We need to document what works.

"What evidence is there that this or that makes a difference?" he asked. Specialists in mathematics education in partnership with mathematicians could help elucidate such differences.

Fey is widely known in the United States and abroad as a leader in curriculum development, mathematics education reform, and teacher preparation. During his career, Fey has provided leadership to several NSF-funded programs, including the Connected Mathematics Project, a widely acclaimed middle school curriculum; the Core-Plus Mathematics Project, an integrated problem-based high school curriculum; and the Mid-Atlantic Center for Mathematics Teaching and Learning, a collaboration of three universities to create new approaches to doctoral studies in mathematics education.

MAA's Carriage House Conference Center Celebrates Its Grand Opening



MAA President Joe Gallian gives a lecture on breaking driver's license codes at the Math Fair on Saturday April 21st.

On Friday April 20th Laura Taalman presented her lecture on Sudoku.

For three days, beginning April 19, a tent was set up on the MAA's Church Street parking lot. Each day food was served to a full house of attendees who had come to take part in the festivities that formally opened the Association's Mathematics Conference Center.

Attendees included representatives from other associations, government, and federal agencies, including the National Academies, the MAA's Board of Governors, and local colleges and universities. On Thursday, they heard from Tina Straley, MAA Executive Director, and Joe Gallian, MAA President.

On Friday, from 2:00-8:00 p.m., there was a Colloquium honoring the late Paul Halmos, whose generosity allowed the creation of the Conference Center. Mathematicians, including college and university students, heard Carl Pomerance, Laura Taalman, Manjul Bhargava, and Richard Tapia address topics of mathematical interest. (See the schedule of events on the right.)

Finally, on Saturday, from 9:00 a.m. - 2:00 p.m., local area high school teachers and students were in attendance at a Math Fair, where they got to hear Art Benjamin, Melanie Wood, Ron Graham, Brent Morris, and MAA President Joe Gallian.

Schedule of Events

Colloquium Honoring Paul Halmos
Friday, April 20, 2007
2:00 p.m. – 8:00 p.m.

Prime time for primes
Carl Pomerance
Dartmouth College

Sudoku: Questions, Variations, and Research
Laura Taalman
James Madison University

Sums of squares and the "290-Theorem"
Manjul Bhargava
Princeton University

Math at Top Speed: Exploring and Breaking Myths in the Drag Racing Folklore
Richard Tapia
Rice University

Math Fair
Saturday, April 21, 2007
9:00 a.m. – 2:00 p.m.

Mathemagics!
Art Benjamin
Harvey Mudd College

Random Behavior in the Prime Numbers
Melanie Wood
Princeton University

The Mathematics of Juggling
Ron Graham
University of California, San Diego

Magic Tricks, Card Shuffling, and Dynamic Computer Memories
S. Brent Morris
Editor, *Scottish Rite Journal*

Breaking Driver's License Codes
Joe Gallian
University of Minnesota-Duluth

Michael Pearson, MAA Associate Executive Director for Programs and Services, greets Richard Tapia and Sam Rankin.

Manjul Bhargava, one of the invited speakers, at the opening celebration.

The tent goes up in preparation for the grand opening.

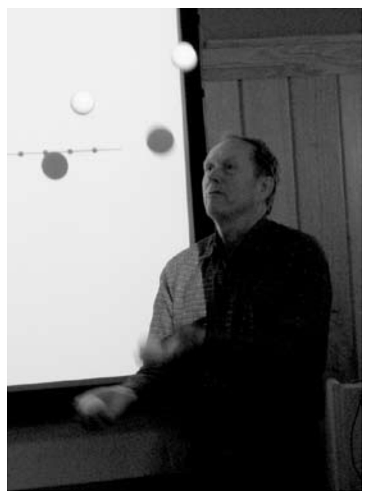
Carl Pomerance, Ron Rosier, Joe Gallian and Tina Straley at Thursday night's Grand Opening Celebration.

MAA Executive Director Tina Straley welcomed visitors to the opening day of lectures in the Carriage House.

Doug Ensley, editor of Digital Classroom Resources, attended the opening celebration for the Carriage House.

Melanie Wood presented her lecture at Saturday's Math Fair.

Art Benjamin with a group of high school students at Saturday's Math Fair.



Ron Graham juggles during his lecture.

A packed house of high school teachers and students for the lectures.

Carl Cowen, MAA Past President, talks with a guest at the opening night celebration.

Princeton Captures Its First Putnam Team Title

By Joe Gallian

After placing second nine times without ever winning the team portion of the Putnam competition, Princeton finished first in the 67th competition held in December 2006. Team members Aaron Pixton and Andrei Negut were in the top 15, while Ana Caraiani was in the top 75 to give Princeton the smallest sum of ranks. Harvard placed second with one team member in the top five, one in the top 15 and one in the top 75. Despite having three individuals among the top five and nine in the top 15, MIT wound up in third place. The 67th competition marks the sixteenth time that the winning team did not have one of its members among the top 5. The Princeton mathematics department receives $25,000 for finishing first, Harvard receives $20,000 for second and MIT receives $15,000 for third. Because the team members must be designated in advance, it is not particularly unusual for a team to dominate the top positions but not win the team competition. In fact, MIT had three individuals in the top five in 2005 and finished fourth in the team competition.

Daniel Kane of MIT became the seventh person to win the Putnam (top five) four times. Remarkably, three of these seven competed against each other in 2003. What makes this especially noteworthy is that although only students from colleges and universities in the United States and Canada are eligible, in recent years many elite institutions have recruited gold medal winners in the International Mathematical Olympiad (IMO) from around the world to their undergraduate programs. Indeed, all top five scorers in the 2006 competition are IMO gold medal winners and 12 of the top 26 scorers participated in the IMO for teams other than the United States or Canada, making the Putnam a truly international competition at the high end. In earlier decades there were far fewer competitors and they were almost exclusively from the United States and Canada. (The fact that only seven people have been Putnam Fellows four times is tempered somewhat by the fact that some legendary problem solvers such as Noam Elkies and Lenny Ng took the exam only three times.) Only two of the top five were born in the United States, Kane and Po-Lu Roh of Caltech. Oddly enough, both were born in the same town: Madison, Wisconsin.

Besides Kane, Tiankai Liu of Harvard was a repeat winner. The top five individual winners receive the coveted designation "Putnam Fellow" and, less importantly $2,500. Alison Miller of Harvard won the $1,000 Elizabeth Lowell Putnam Prize for outstanding performance by a woman for the second time. Through 2006, there have been 261 Putnam Fellows.

The 2006 competition attracted 402 teams and 3640 individual participants. Both of these totals are second highest ever behind the 2004 competition. The top five scores ranged from 101 to 92 (there are 12 problems worth 10 points each). As has frequently been the case since 1999, the median score was 0. In fact, the 2006 competition had a record 2279 scores of 0 (62.6%). The mean score was 6.2. A score of 14 was good enough to be in the top 500. Among the top 198 scorers only three received any points on the last problem of the morning session with one person getting 10 points and two getting 1 point. Of course, that does not necessarily mean that that problem was the most difficult because many people have little or no time left by the time they reach problem 6.

The 2006 competition brings the total number of Putnam contestants (counting multiplicity) since its inception in 1938 to 107,452.

A lengthy history of the Putnam Competition is available at http://www.d.umn.edu/~jgallian/putnam.pdf.

Flatland the Movie

By Fernando Q. Gouvêa

Flatland is coming to the screen! Edwin A. Abbott's well-known parable about "many dimensions" has been a staple of mathematics classes for a long time. Reading the book has helped many of us gain a better understanding of how dimensionality works, and perhaps even offered us a glimmer of what a four-dimensional space might be like. Now we'll be able to see it on screen.

Flatland the Movie will be released this summer. It is a short animated film produced by (what else?) Flat World Productions. The mathematical advisors to the project are Thomas Banchoff, Sarah Greenwald, Jon Farley, and John Benson, who are credited with having provided "mathematical advice/input, helped promote the film, or created supplemental materials"; each of them will produce some commentary that will be available on the DVD. Among the voices to be heard in the movie are those of Martin Sheen and Kristen Bell.

A short trailer and much more information about the project can be found online at http://www.flatlandthemovie.com. There will be a showing of the video at the San Jose MathFest, on Friday, August 3 at 4 p.m. Tom Banchoff will introduce the movie and lead a discussion afterward.

Do You Want to be a Quant?

By Scot Adams

Many people interested in mathematics are curious about how mathematics is used in finance, and perhaps some even have an eye toward a career in quantitative finance. Others are already pursuing a career in finance and the capital markets, and have an interest in learning more of the underlying mathematics. All around the world Financial Mathematics and Financial Engineering programs are appearing, filling a growing educational need. The umbrella organization for these programs is the International Association of Financial Engineers, online at http://www.iafe.org/home.php.

The proliferation of financial mathematics programs was the subject of a recent *Wall Street Journal* article ("Wall Street Warms To Finance Degree with Focus on Math", 14 November 2006), by Ronald Alsop. It's also the cover story of the 23 January 2007 issue of *Business Week*. The subject matter was a main focus of a one-quarter program entitled "Quantitative Modeling in Finance and Econometrics" held in Spring 2004 at the Institute for Mathematics and Its Applications (see http://www.ima.umn.edu/complex/#spring.

The basic mathematics that underlies the subject is probability theory, with strong connections to PDE and numerical analysis. On the finance side, the main topics of importance are the pricing of derivatives, the evaluation of risk, and the management of portfolios. In today's world, many aspects of capital markets management are becoming more quantitatively and computationally sophisticated, but it all began with derivatives.

A derivative is a financial instrument whose value is derived from some other instrument, called "the underlying." A simple example: Suppose I own a single share of stock that is selling for $1 today. Suppose I offer you a contract, called a "forward," that commits me to sell you this share for $1.03 one year from today; no money changes hands now. Suppose you have access to a bank that offers 6% effective interest annually. Finally, suppose you have a friend who, like me, owns a share of the stock, and who has no plans to sell it in the next year. Suppose your friend is willing to loan it to you for a year, but then wants a share returned at that time, along with a fee of two cents.

Then you can make guaranteed money: You sign the forward with me, borrow your friend's stock, sell it for $1, and put that $1 in the bank. A year later, you have $1.06. Honoring your forward with me only costs you $1.03, and you're left with a stock share and three cents. You give your friend back that share and two of the three cents. You're left with a penny over which your heirs can squabble.

Here's the point: I mispriced my forward at $1.03. Its correct valuation should have been $1.04, and my mistake gave you an opportunity to earn a penny. Finding the correct value of the forward is dependent on knowing other prices, and so it "derives" its value from other market variables, like the price of the underlying stock. It is therefore referred to as a "derivative" (quite different from derivative in the sense of calculus!). This contrasts with the underlying stock, whose value comes from the hard work and toil of the good people running the company that issued it.

While there are difficulties that can come up in the pricing of forwards, they are not nearly as complicated as some other derivatives, and many clever tools exist to light the way in the pricing of these more sophisticated financial products.

In the example above of the mispriced forward, there was guaranteed risk-free money to be had — assuming all parties honor their commitments. Often things are not as simple as that. Sometimes one is in a situation where one has to accept a certain amount of risk; not to put too fine a point on it, risk even appears in the assumption that individuals and companies will not default on their obligations.

Measuring the risk of individual assets held by a company is a difficult mathematical task, but one also has to be aware that risks are not additive; they sometimes cancel each other, but sometimes don't. Suppose you've invested in 100 risky ventures, each of which has a 10% chance of costing you $1,000, but a 90% chance of earning you $1,000. You feel pretty safe, right? Your feeling of safety might be undermined, however, if you find out that a rise in the price of oil could cause all of the ventures to go bad, and, for each one, 9% of the bad 10% is driven by oil. That is, the risks are not independent, and you're facing a 9% chance that you'll owe 100 x $1,000. Now suppose you can find 100 risky ventures with the same probabilities (10% and 90%) and same returns (lose $1,000 or earn $1,000), but which are all independent of one another. Then you should trade in your current 100 for this new 100. The business of managing portfolios via understanding risk and return is another key topic in the area of Financial Mathematics.

The simplicity of the ideas expressed above gives way, in modern finance, to very sophisticated mathematics. For example, a whole new approach was necessary to be able to apply calculus to processes with random elements, such as stock markets and quantum physics. Kiyoshi Itô, the mathematician most responsible for the foundation of stochastic calculus, was just awarded the first ever Gauss medal, a new award that will go every four years "for outstanding mathematical contributions that have found significant applications outside mathematics."

This application of advanced mathematics to finance has had a profound impact on the global economy. Almost any issue of business magazines such as *Business Week* or *The Economist* will have discussions of new financial products, such as credit derivatives and mortgage-backed securities, which depend on this mathematics. Investment banks and commercial banks now employ thousands of people with advanced degrees (PhDs in mathematics and physics, Masters in Financial Engineering and Financial Mathematics) who are working on these products. This represents one of the fastest growing segments of the industry. Tens of thousands of computer scientists are employed programming these calculations. The exciting and rapidly growing new industry of hedge fund management also utilizes many of these ideas and employs many of the same type of graduates. In 1997, Robert Merton and Myron Scholes, two of the pioneers in mathematical finance, received the Nobel Prize in Economics in recognition of the major role this work has had on the world of finance.

With tighter regulation (Sarbanes-Oxley and the Basel accords) and a growing awareness of quantitative risk management, the job prospects of "quants" have been soaring. Those who have the mathematical skills to do this kind of analysis are in greater and greater demand. Moreover, in finance, the data environment is the envy of professional statisticians everywhere!

Scot Adams is the Director of the new Master of Financial Mathematics program at the University of Minnesota, Twin Cities campus. He received his PhD in Mathematics from the University of Chicago in 1987 under the supervision of Robert J. Zimmer, who played a major role in beginning Chicago's financial mathematics program.

Singing the Mandelbrot Set

Well, sooner or later someone was going to write a song about the Mandelbrot set… Jonathan Coulton did it. You can see his lyrics at http://www.jonathancoulton.com/lyrics/mandelbrot-set. Of course, once there was a song a music video was sure to follow. You can see that at (where else?) YouTube: http://www.youtube.com/watch?v=IIlwFpz9s_I&mode=related&search=. Alas, the description of the Mandelbrot set seems a little off…

An Open Problem — Mathematics at the AAAS Annual Meeting

By Brie Finegold

Mathematicians often collaborate with other scientists but are rarely cast into the limelight by the media. Of course, no one becomes a mathematician expecting fame and glory. Still there are remarkably few forums that can draw the public's attention to the benefits and content of mathematical research. One such forum is the AAAS Annual Meeting, which I attended this last February.

The titles of talks at the meeting were conspicuously devoid of technical jargon. Scientists attended symposia that may have been tangential to their research area but which harbored thought-provoking parallels or perhaps as yet unseen opportunities for applications of their work. And reporters from the *New York Times, Science News*, and *Discover*, to name a few, interacted freely with presenting mathematicians and other scientists.

The basic problems in many fields have similarities that can be expressed mathematically. Princeton biologist Iain Couzin, for example, explained that locusts' movements can be studied using some of the same models as those used by physicists to study particles. Minnesota computer scientist Guillermo Sapiro fills in missing parts of images by modeling the flow of color into a damaged area with the same types of differential equations used in fluid mechanics. Hany Farid, a Dartmouth computer scientist, has created software that analyzes the authenticity of photos by searching for inconsistencies in light sources, while Pixar's researchers try to create more and more authentic lighting in their computer animations. Tony DeRosa, who uses mathematics at Pixar to control animated characters, compared the characters to marionettes, which are fundamentally mechanical. And in modeling the spread of disease, although a specific disease may be the source of data or the focus of the work, the model may be applicable to other diseases or even to trends and ideas that "spread" over time and space and affect living things.

The basic challenges faced by mathematicians today are also shared by other scientists. One of our strengths is the ability to put politics aside in order to focus on the problem at hand. But as Los Alamos researcher Mac Hyman discussed his difficulties in bringing over foreign researchers to collaborate, I realized that we are not immune from politics. As Florida State Professor De Witt Sumners discussed the low participation of mathematicians in the AAAS, it brought to mind my own lack of understanding of other sciences, a sort of tacit disinterest that has been cultivated by my training. As Sumners pointed out, universities should encourage math students to receive training that would prepare them for interdisciplinary projects.

At the AWIS-sponsored panel discussion on gender reporting, science writer Annalee Newitz asked "How can we prepare for a future that is radically different from the past?" She was referring to the prospect of an increase in the numbers of women scientists and academics. This question is relevant to anyone who is modeling natural phenomena. As in mathematics, the questions that are easiest to ask are often hardest to answer. By participating in more events like this one, we can momentarily shift our point of view and influence the views of others. Perhaps we will be able address some of the questions that we share, bring them into the public arena, and render them more tractable.

Brie Finegold is a graduate student at University of California, Santa Barbara, where she studies topology. She is also a freelance science writer and a 2006 AAAS Mass Media Fellow.

Short Takes

By Fernando Q. Gouvêa

Does Technology Help?

An article in the April 4 issue of *Education Week* reports that a "major federal study of reading and mathematics software" has found no measurable difference in learning outcomes for students who used various kinds of technology in their classrooms. The study, led by Mark Dynarski of Mathematica Policy Research, had teachers use several standard commercial software packages. The mathematics packages were used for 6th grade pre-algebra and 9th grade algebra. The report does not give information on how well individual packages worked; it limits itself to the overall impact of the packages when compared to classrooms whose teachers used other methods. See http://www.edweek.org/ew/articles/2007/04/04/32software_web.h26.html for the *Education Week* article. The study itself is online at http://ies.ed.gov/ncee/pubs/20074005/. The study is one of many being conducted by the Institute for Education Sciences, which is an agency of the United States Department of Education. See http://ies.ed.gov/whatsnew/ for a list of the latest research results published by IES.

CRAFTY on College Algebra

The MAA's subcommittee on Curriculum Renewal Across the First Two Years (CRAFTY) has produced guidelines for the "College Algebra" course. The guidelines, which represent the recommendations of the subcommittee, were approved in January by the MAA Committee on the Undergraduate Program in Mathematics (CUPM). The guidelines envision a course that "can serve as a terminal course as well as a pre-requisite to courses such as pre-calculus, statistics, business calculus, finite mathematics, and mathematics for elementary education majors." The guidelines can be found on the MAA web site at http://www.maa.org/cupm/.

Euler in the News

The April 9 issue of the *Washington Post* included an article on Euler by David Brown. Entitled "The Countless Achievements of a Math Master," the article opens with a quote from William Faulkner: "You should approach Joyce's *Ulysses* as the illiterate Baptist preacher approaches the Old Testament: with faith." Brown then applies the lesson to Euler's mathematics: "Let's approach Leonhard Euler and his work the same way. It will make things a whole lot easier. If one is not a mathematician (and except for a few of you out there, who is?), it's going to be impossible to actually understand why Euler was such a great man. Other people will have to tell us, and we should probably believe them." The article goes on to tell a little bit about Euler's life and work, quoting, *inter alia*, Bill Dunham and Ron Calinger.

National Curve Bank Announces This Year's Renie

On March 31, the anniversary of René Descartes' birthday, the Advisory Board of the National Curve Bank Project proudly announced the fifth annual Renie Award for best deposit of 2006. The award went to Tevian Dray of Oregon State University, who contributed a page on "Vector Fields" that uses Java and JavaView to visualize the geometry. The citation said: "In his interactive vector models Dr. Tevian Dray of Oregon State University recognizes the stellar contributions of Hamilton, Maxwell and Gibbs. Thus, he represents mathematics from Ireland, Scotland and the United States." Dray's deposit may be found at http://curvebank.calstatela.edu/vectors/vectors.htm.

The National Curve Bank describes itself as "a resource for students of mathematics. We strive to provide features — for example, animation and interaction — that a printed page cannot offer. We also include geometrical, algebraic, and historical aspects of curves, the kinds of attributes that make the mathematics special and enrich classroom learning." The Curve Bank encourages all of us to "submit your best web animation as a 'deposit' in the National Curve Bank." The annual Renie award recognizes the best deposit for each year.

More Euler in the News

John Derbyshire, author of *Prime Obsession*, which won this year's Euler Prize for expository writing in mathematics, has done a lot to make non-mathematicians aware of Euler's tercentenary. Writing in the *National Review Online*, he noted that in Charles Murray's book *Human Accomplishment*, Murray ranks Euler highest among mathematicians. Murray's rankings are based on measuring the amount of space dedicated to each person in standard reference works.

Derbyshire also wrote an article on Euler for the April issue of *The Wilson Quarterly*. The six-page essay gives a good quick survey of Euler's life and work, describing him as "a mathematician of towering genius who lived nobly, calmly, cheerfully, and well."

Cryptology Undergraduate Paper Competitions

The journal *Cryptologia* has announced two undergraduate paper competitions: the Undergraduate Paper Competition in Cryptology and the Greg Mellen Memorial Cryptology Scholarship Prize. The topic of the papers may be any area in cryptology, ranging from technical papers to literary and historical work. Each competition offers a $300 cash prize; the winning papers will be published in *Cryptologia*. More information can be found at their web site: http://www.tandf.co.uk/journals/titles/01611194.asp.

Noting that a past winner, Heidi Williams, was featured in the October 2002 issue of *Glamour* in a piece titled "Top 10 College Women 2002: 10 Women Most Likely to Succeed at Anything," the editors of *Cryptologia* commented: "who says mathematics isn't glamorous? Not us!"

The SUMS Conference at James Madison University

By Elizabeth Brown and Laura Taalman

The Shenandoah Undergraduate Mathematics and Statistics (SUMS) Conference is a yearly undergraduate research conference held at James Madison University in Harrisonburg, Virginia. The heart of the SUMS conference consists of contributed undergraduate talks on original mathematical research. Additional events include research and expository poster sessions, invited faculty speakers, opportunities for networking and social interaction, and practical panel sessions on REU programs, graduate school, and careers in industry. There is also a high school outreach component to SUMS.

Ed Burger lectures at the SUMS Conference.

The conference is a one-day event held in early fall. The organizers' intent is that the conference provide an optimal venue for sharing the results of summer research projects, while inspiring other students early enough in the academic year that they can pursue research during the school year or following summer. The day starts and ends with dynamic invited addresses that are both accessible and mathematically robust. Arthur Benjamin, Edward Burger, Tim Chartier, and Greg Warrington have all been SUMS speakers; their talks were enjoyed by conference attendees of all types.

Undergraduate talks occupy a central position, with parallel sessions through the middle of the day. Contributed posters are on display throughout, and are judged during an extended lunch hour when students can be on hand to describe their work and answer questions. After the afternoon's parallel research talks come panels about undergraduate research programs, mathematics careers, and graduate school. Tea time provides an opportunity for informal networking, followed by awards and recognition of the student contributors, and the closing address. In 2005, SUMS hosted 233 conference participants from 27 colleges and universities and 6 high schools, with 16 student talks and 11 student posters. In 2006, SUMS grew to an attendance of 252 people from 30 undergraduate institutions and 5 high schools, with 23 student talks and 27 student posters.

Fostering an upbeat, welcoming tone has been important to the success of the conference. We find it helpful to remember that an undergraduate conference can be an interactive social event as well as an academic one. At SUMS, we schedule a number of open networking times (coffee, tea) for participants to get to know one another. This year we set up a puzzle table where people could stop throughout the day and solve various mathematical and geometric puzzles. This was a very popular location for students, faculty, and even the children of participants. Both years, we distributed Sudoku and mathematical puzzle packets free to participants. These were received with enthusiasm. Attendees are invited to an informal speakers' dinner the evening before the conference. This past year we were able to coordinate a special reception at the JMU New Image Gallery, which was hosting an exhibit of contemporary mathematical photography and new media.

James Madison University is located about two hours west of Washington, D.C. It is one of the larger schools in the rural Shenandoah Valley area, so it made sense for us to develop an event at which students from nearby colleges and JMU could be exposed to mathematical research at the undergraduate level. We have also been successful in attracting students from nearby states, and as far away as Ohio and Kentucky. Much of our conference funding is spent assisting student speakers with travel and hotel stipends. Other funding enables us to attract well-known, entertaining invited speakers that have a particular knack for energizing undergraduate audiences.

In addition to providing an academic resource for the Shenandoah Valley, the SUMS conference adds to the academic culture of the JMU Department of mathematics and statistics. It has helped to bridge the divide between the department's ongoing NSF-funded REU program, which takes place over the summer, and JMU students who are on campus during the academic year. This is changing the way our students think about mathematical research. One of our students, Sara Toosarvandani, put it this way: "SUMS really made me want to present a talk/poster for the next year. I went to SUMS two years in a row now and felt my Saturday was well spent both times!"

JMU student participation in the poster

sessions increased from 5 posters in 2005 to 19 posters in 2006. Many of our students have decided to pursue thesis projects or apply to REU or other extra-curricular mathematics programs after attending SUMS and seeing firsthand that their peers can and do engage in original mathematical research projects. It even seems that more of our students are now interested in pursuing graduate school in mathematics. In addition, many of our students work side-by-side with faculty members in organizing the conference itself. By doing so, these students get to know the faculty better and become more involved members of our department, along with developing a sense of ownership about the conference.

The SUMS conference also reaches out to area high school students and faculty. We advertise the conference to high schools within driving distance and to Governor's Schools across the state. We provide funding when necessary to help defray travel costs for high school participants. Just as undergraduates can have a great experience at a faculty research conference such as MathFest or the Joint Mathematics Meetings, we believe that high school students can learn much from attending an undergraduate research conference. The poster competition has a high school category. While the number of entries in this category so far has been limited, quality has been high, and we expect the numbers to grow as we establish relationships with interested high schools. A workshop for the American Mathematics Competitions runs concurrently at JMU with the afternoon portion of the SUMS conference, providing an added draw for high school teachers and students.

Starting an undergraduate research conference and, more importantly, keeping it going from year to year, are momentous tasks, but they are also extremely rewarding. A well-thought out conference on any scale is worthwhile, so we encourage interested organizers to give it a try. For those considering starting a similar conference at your school, we offer the following sage advice: Delegate. Start preparations early. Get an army of students who are willing to help. Delegate some more.

The puzzle table offered challenging entertainment.

The SUMS conference is one of a growing number of undergraduate research conferences funded through the MAA/NSF Regional Undergraduate Mathematics Conferences (RUMC) grant program. SUMS also receives significant funding from JMU itself, at the club, department, college, and university levels. Other support comes from the Blue Ridge chapter of the Association for Women in Science, Pi Mu Epsilon, and the NSF-funded REU program at JMU. In addition, various book publishers have made generous contributions of books or other swag to the SUMS conference. At each conference we have been able to award each and every student speaker with a quality high-level math text, many of which are worth over $100. We get the books well in advance of the conference, and can match each student speaker with an appropriate text for their field of research. This past year so many books were donated to SUMS that we were also able to award small books for each poster presentation.

Interested in Hosting an Undergraduate Conference?

The MAA Regional Undergraduate Mathematics Conference program provides funds to help. Visit http://www.maa.org/rumc for details.

The 2007 SUMS conference will be held on Saturday, October 13. We encourage you to attend! For more information, please see our website at http://www.math.jmu.edu/SUMS.

Elizabeth Brown has been at James Madison University since 2003, following a postdoctoral appointment at Dartmouth College and graduate work at Boston University. Her mathematical research is in set theory. Her other academic interests include the teacher training of mathematics graduate students for college and university careers, the philosophy of mathematics and science, and mathematics in fine and performance art. This summer, she will serve as a mentor in an internally funded REU program for JMU students. Before discovering the joys of mathematics, she studied epistemology in the context of analytic philosophy for a first Master's. She is a 2002-3 Project NExT fellow. She has the dubious honor of being a winner of the 2007 JMU Mathematics and Statistics Department Pi Day contest (held on March 14 at 1:59), in which students donate money to a charitable cause in order to be able to throw pies at the top three faculty earners.

Laura Taalman came to JMU in 2000, directly after completing her graduate work at Duke University. In addition to her work in singular algebraic geometry, she has written an award-winning calculus text and an award-winning expository article that had nothing to do with calculus, along with articles on the teaching of university mathematics, the mathematics of games, and knot theory. As a partner in Brainfreeze Puzzles, she is the author of several published puzzles and a forthcoming book, Color Sudoku. *She is active in the department's NSF-funded REU program, with a third mentorship planned for this summer, and in the sectional leadership of the MD/DC/VA section of the MAA. Laura is the winner of the 2006 Alder award and, with Eugenie Hunsicker, of the 2002 MAA Trevor Evans award for mathematical exposition. She is a 2000-1 Project NExT fellow. She was also a winner in this year's Pi Day contest.*

An Interview with Doron Zeilberger

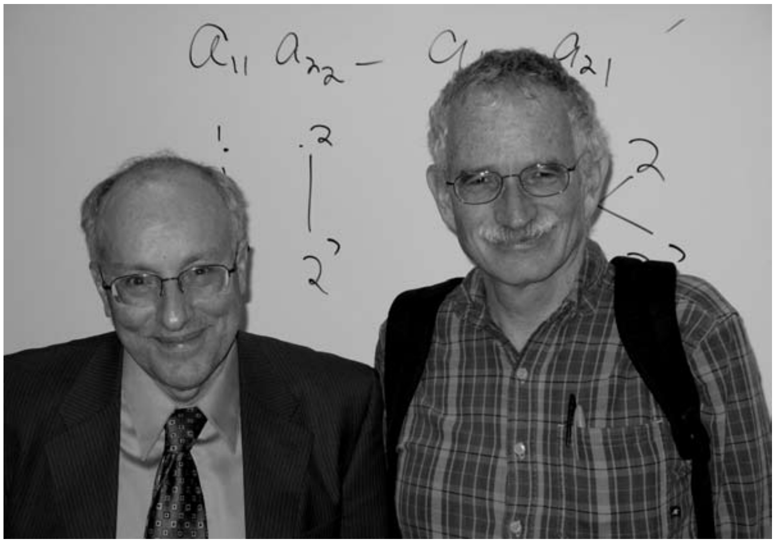
By Joe Gallian and Michael Pearson

To celebrate the opening of the Carriage House Conference Center at MAA headquarters, made possible by a gift from Paul and Virgina Halmos, the MAA received a grant from the National Security Agency to support a Distinguished Lecture series intended to appeal to a general audience.

The second lecture in the series was given by Doron Zeilberger on February 20, 2007. Zeilberger is the Board of Governors Professor of Mathematics at Rutgers University. He is widely known for the development of "WZ" (Wilf-Zeilberger) Theory and Zeilberger's algorithm which are used extensively in modern computer algebra software. Zeilberger was the first to prove the elusive result in combinatorial theory known as the alternating sign matrix conjecture. Among his honors are: the American Mathematical Society Steele Prize for seminal contributions to research (co-recipient with Herb Wilf); the Institute of Combinatorics and Its Applications Euler Medal for "Outstanding Contributions to Combinatorics"; the Laura H. Carnell Professorship at Temple University; and the MAA Lester R. Ford award for a paper in *The American Mathematical Monthly*.

The citation for the Euler Medal describes Zeilberger as "a champion of using computers and algorithms to do mathematics quickly and efficiently." In his opinion "programming is even more fun than proving, and, more importantly it gives as much, if not more, insight and understanding."

While at the MAA for his lecture, Professor Zeilberger talked with Joe Gallian about his research and teaching. Following are excerpts from the interview.



Joe Gallian and Doron Zeilberger

JG: How do you describe your research area?

DZ: I work mainly in combinatorics and the theory of special functions, but in the last 10–15 years I have considered myself mainly an experimental mathematician, and combinatorics and the theory of special functions are just sources for examples and case studies of a methodology with the aim of training the computer to discover conjectures and then try to prove them all by itself, without any human intervention.

JG: Are there now a number of people who are doing experimental mathematics?

DZ: Experimental mathematics is a rapidly growing field, both explicitly and implicitly. Explicitly, there is a very good journal by that name, an Institute in Simon Fraser University, and at the recent annual meeting at New Orleans there was a special session dedicated to it. This is a good start, but still at its infancy. However, implicitly, more and more mathematicians, even pure ones, use the computer daily to formulate and test conjectures, in a mode that George Andrews calls "pencil with power-steering." However, more often than not, the computer's often crucial contribution is not mentioned, or grossly understated. Human beings are such ingrates.

Also, Jon Borwein and David Bailey wrote a very nice monograph on Experimental Mathematics that I highly recommend. But their emphasis is more on the traditional experimental mathematics that has been pursued by all the great, and less-great, mathematicians through the centuries, using pencil-and-paper. Of course, with computers you can do so much more, and you can be very systematic, and the great power of today's computers, guided wisely, can take you a very long way. However, their emphasis is still on using computers to find interesting conjectures and phenomena, but not to prove them. The proof itself (when feasible) is still done largely by human beings, although sometimes with the assistance of computers.

As for computer-generated proofs, there is a whole community of Automatic Theorem Proving, which is very successful. Their methodology is logic-based, and they try to teach the computer formal reasoning, using axioms and "laws of deduction." My approach is more akin to what the great algebraic geometer Shreeram Abhyankar calls "high-school algebra" and physicist Richard Feynman calls "Babylonian mathematics": using algorithmic frameworks, that I call "ansatzes." But since the algorithms are symbolic rather than numeric, one can hope to prove genuinely new general theorems, valid for infinitely many cases. In this kind of research, we try to teach the computer to first make a conjecture, all by itself, and then automatically prove its own conjectures, also all by itself! Of course, the only way we can do it, at present, is by focusing on narrowly-defined areas.

JG: Are you getting some resistance from the traditional math community with your approach?

DZ: Definitely. Many people are not very comfortable with this approach. First, they claim that you can't trust computers (as if humans were so trustworthy!), and they also feel that it's not fun to have a computer do your work, or that it is "cheating." For me, teaching the computer how to discover and prove new theorems is even more fun than discovering and proving them myself. As for the cheating part, this is science not sport, and besides we can always change the rules of the game.

JG: The Wilf-Zeilberger algorithmic proof theory is contained in all major computer algebra systems. What does it do?

DZ: It's a collection of algorithms that can discover, and then prove, binomial coefficient identities, and identities involving sums or integrals of special functions. As you know, the binomial coefficient "*n* choose *k*" counts the number of *k*-element subsets of an *n*-element set. Since many objects in combinatorics boil down to unions and cartesian products of such choosings, it turns out that many enumeration problems can be expressed as such binomial coefficient sums, and often we get surprising identities. Before W-Z theory, every such identity required its own ad hoc proof, and any such new identity, or even a new proof of an old identity, was publishable. But thanks to Wilf-Zeilberger theory, any such identity can now be proved automatically. No one today would submit a paper stating and proving the "theorem" that "ten plus five equals three times five." Analogously, an identity like

$$\sum_{k=0}^{n}(-1)^{k}\left(\frac{2n}{n+k}\right)^{3}=\frac{(3n)!}{n!^{3}}$$

first proved by Dixon in 1904, is now completely routinely and automatically provable thanks to the Wilf-Zeilberger algorithmic proof theory.

JG: You seem to have an evangelical-like faith that computers will make obsolete the way mathematics has been done for over 2000 years. Is that a fair assessment of your view?

DZ: Yes, but people who know me well know that they should not take me too seriously (laughing). In the Talmud it says that if you have a talit (garment) and one guy says that it's all his and the other guy says that it's all his, then they each get half. But if somebody only claims a half and the other guy claims a whole, then the guy who claims a half will only get a quarter and the other guy gets three quarters. So if you want a half, you have to claim a whole. So you have to overstate your case. Then again, sometimes overstating can backfire and turn people off.

JG: Tell me about your frequent co-author Shalosh B. Ekhad.

DZ: It is a charming individual. Of course it is made of silicon, and it is not really *one* body, but it is definitely *one* soul (software). The body has just been reincarnated many times. As we know, computers are very powerful, but their life expectancy is much shorter than that of humans, since computers get better and faster so quickly, you have to get a new one every three years, but you can always upload all the software from one Shalosh to the next, thereby guaranteeing the immortality of its soul.

JG: Where did you get that particular name?

DZ: The original Shalosh B. Ekhad was actually a Hebrew translation of the first PC that I owned, called AT&T 3B1. At the time it was a very innovative machine, the first UNIX PC, that was manufactured by AT&T in the 80s. The Hebrew translation of 3B1 is Shalosh B. Ekhad.

JG: Tell me about your book *A* = *B*.

DZ: It was written by Marko Petkovsek, Herb Wilf, and myself, and is an elementary introduction to the so-called Wilf-Zeilberger algorithmic proof theory mentioned above . It also has a long chapter on the very important Petkovsek algorithm for deciding whether a sequence is closed-form.

JG: It was quite a coup to get Donald Knuth to write the preface. How did that come about?

DZ: First, and foremost, Knuth is a good friend of Herb Wilf. Also, Knuth loves binomial coefficient identities. He dedicated quite a few pages to them in his classic *Art of Computer Programming*, which is the "bible" of computer science, and later, in much more detail, in his beautiful book with Ron Graham and Oren Patashnik, *Concrete Mathematics: A Foundation for Computer Science*. He still loves them. In the latest issue of *The American Mathematical Monthly* (February 2007) there is a problem proposed by him that could be easily done using the WZ method. I was a little taken aback. If somebody submitted a problem to prove that $11x13 = 12^2-1$, they wouldn't accept it, since there are nowadays (and have been for the last 5000 years) algorithms that can routinely prove this. Similarly, for Knuth's *Monthly* problem there are (and have been for the last 15 years) algorithms that can routinely find a proof. But then again, Knuth is Knuth, and if he proposed as a problem to prove that 1 + 1 = 3 – 1, it might be accepted. Of course, Knuth is very much aware of WZ, and he probably had some hidden agenda in proposing this problem. Maybe he meant some cute combinatorial argument.

JG: I notice that the preface of your book *A* = *B* begins with Knuth's famous quote "Science is what we understand well enough to explain to a computer. Art is everything else we do." Was *A* = *B* the first place that quote appeared in print?

DZ: Yes, I think so.

JG: I was very surprised that a commercial publisher would agree to permit the book to be downloaded free over the internet.

DZ: Herb Wilf is a great advocate of free publishing and AK Peters is not a typical publisher. Klaus Peters, and his wife Alice, are very good people, who care more about mathematics than making a quick buck. Commercially it seems to have been a wash, some people who would have bought it, didn't, and vice versa.

JG: I notice that you prefer *Maple* over other software. Why is that?

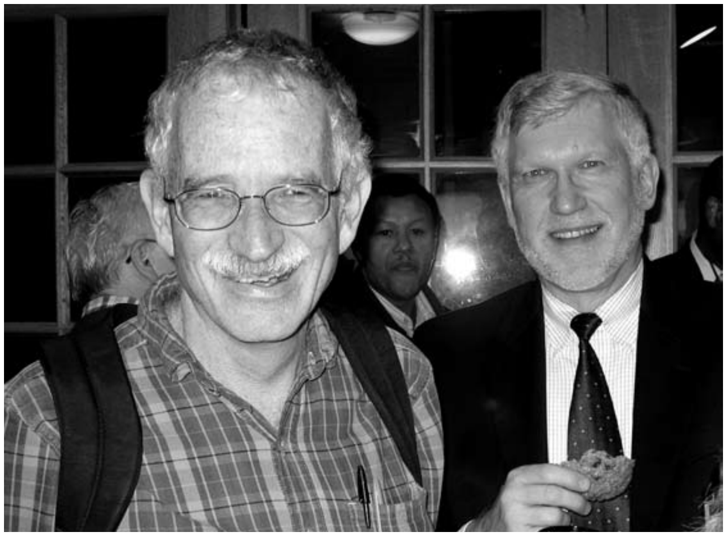
DZ: Originally, *Maple* was much cheaper and more accessible than its competitors. *Mathematica* was much more commercial. Unfortunately, now *Maple* is very commercial too, and *Mathematica*'s prices have gone down, and many people prefer the latter for its elegant syntax and beautiful graphics. So I use *Maple* for "old times sake" and mainly because I am used to it.

JG: Describe your Experimental Mathematics course.

DZ: I really enjoy teaching it. It is a graduate class (with one or two advanced undergraduate students) that is held in a "smart" classroom where everyone is connected to a terminal. It is a hands-on course where the main point is to teach students how to program in *Maple*, in order to explore new mathematics. The actual topic changes every year, so that I won't get bored, and sometimes I even learn a new subject myself, since the best way of learning a new subject is by teaching it. Of course, in this class we also learn how to program everything, and an even better way to learn a new subject is by teaching it to a computer, i.e. programming. So both my students and I learn the substance of the course very well, and at the same time my students learn how to program in *Maple*.

JG: You have Erdös number 2, Einstein number 3, Wiles number 3, and Knuth number 2 but you say on your website that you are most proud of your Garfield number 2. Why is that?

DZ: Richard Garfield is one of the most talented and creative combinatorialists alive, but he used his talents in a non-standard way. He is also a very nice guy, and I am fortunate to have known him, although only briefly. During the mid-90s, he was a teenage idol thanks to his innovative and lucrative *Magic: The Gathering* card game. He designed the game while he was Herb Wilf's PhD student at Penn in the late 80s and early



Doron Zeilberger and Ivars Peterson.

90s. He did good research, but not as much as he could have, because he was so busy developing and testing his card game. After his PhD, he got a one-year job in some small college in Washington State, with a salary of about 22K. When the year was almost up, and it was not clear what his prospect for the future in academia would be, his card game caught on, and the rest is history.

JG: There must be a story behind the "Who you gonna call" T-shirt.

DZ: This is a T-shirt that I am wearing in my picture on my website. It features a certain binomial-coefficient identity, with the caption "Who you gonna call." The back of that T-shirt has the few lines of *Macsyma* code needed to prove it, and the caption "the binomial-coefficient-identity-busters." My kids told me that it is an allusion to the film *Ghost Busters*. This cute design was made by Herb Wilf's son, David, who is a lawyer by profession, and Herb gave me one of them.

JG: Something that I found surprising is that the narratives for your grant proposals are posted at your website. That certainly helps people learn about your work.

DZ: I think that it's a waste to write something just for five or six people and for no one else to be able to see it. I think that everything should be public; I don't like secrecy. I also hate the tradition of anonymous refereeing. I think that there should be open refereeing. Also people should post their PhD theses, especially the introduction, that often gives a very good overview of a field.

JG: Another thing that surprises me is that you slip a bit of humor in your grant proposals. One is "There is a delicate balance and trade-off between the general and the specific, the abstract and the concrete, the strategical and the tactical, the sacred and the profane." Another is the line "My particular shtick is experimental mathematics." A third is "The computer is a powerful tool, go forth and use it!" Your proposals are less formal than I would expect.

DZ: That's my style. I don't like to be too serious. But I think that it has cost me some funding. In my last grant proposal, I was hoping to get co-funded by the computer science division of the NSF. I had no problem getting funding from the mathematics division, but of course mathematics doesn't have much funds, so I was hoping to get some additional funding from computer science. So I also sent my grant proposal to the computer science division. That was a disaster. One of the panelists gave me a lecture, saying this might make a good essay, but it's not what one would expect in a grant proposal, and they refused to give me funding.

JG: You are known for your opinions on your web page, some of which are a bit over-the-top, especially those on April 1.

What changes — if any — are you hoping to encourage in the mathematics community by posting your opinions online?

DZ: I'm not trying to change people's views, at least not consciously. I just like to express my opinions. It's only the Internet, which is a free-for-all, and one doesn't have to be too uptight. So I don't really worry about whether or not my pieces always make sense. Hopefully they do most, or least some, of the time.

JG: You have been known to celebrate both Valentine's Day and April Fools Day in the classes you teach. What is the most memorable thing you have done to mathematically celebrate a holiday?

DZ: In my calculus class, I assign a homework "project" due February 14, to graph the parametric equation for a cardioid. Some people came with very strange shapes, but some people realized what was going on and just drew a regular heart shape. But they made a pointy one, which is wrong, because a cardioid is more rounded. It was nice to get 150 valentines (some rounded, some not), and I could brag to my wife how much my students love me. In my computer algebra class, I gave my students some extremely complicated differential equations that they had to use *Maple* to solve. The solution happened to be a cardioid. Then they had to draw it (using the *Maple* plot program), and cut it out.

JG: You have been known to spontaneously hand out money to students for solving problems or pointing out a correction in class. What is the largest prize you have ever awarded, and what was it for?

DZ: For calculation errors the most I've given out is $1. But for conceptual errors in graduate classes, I think I once gave $10. I also offer prizes for really challenging problems.

JG: Do you have any concluding words?

DZ: Yes, I believe that teaching is at least as important as research, and I put lots of effort into my teaching and take great pride when I do a good job. Many research mathematicians dislike teaching and view it as an unavoidable chore, but they are wrong. First, teaching is great fun, and secondly, it is very important, since this is the future!

So already today teaching is at least as important as research. But in years to come, when more and more original mathematical research will be conducted by computers, the importance of the human research mathematician will diminish, and the importance of teaching, at all levels, will increase tremendously. Also for a long time to come, we still need humans to program the computer, but what is programming? It is teaching computers, and I am sure that being a good programmer and being a good teacher (for humans) are strongly correlated. One of the reasons that I believe that I am a good teacher is that I do so much programming, and am used to spelling out each and every step. In short, the future of mathematics is in good teaching, both to machines and to humans.

Joe Gallian is President of the MAA. Michael Pearson is the MAA Director of Programs and Services.

In Memoriam

Paul Joseph Cohen died in Stanford on March 23. Born in 1934, Cohen got his graduate training at the University of Chicago and eventually became a professor at Stanford University. Though he made contributions to analysis and the theory of partial differential equations, he was best known for his development of "forcing," now a fundamental tool of set theory, and using the new technique to prove that the Continuum Hypothesis and the Axiom of Choice are independent from the axioms of set theory. This groundbreaking work won him the Fields Medal in 1966, and he received many other honors and prizes. FOCUS will have a longer article about Cohen in its August/September issue.

Frank Burk died on March 17. Born in 1942, Burk received a Ph.D. from the University of California, Riverside, in 1969. He taught at California State University, Chico, from 1968 to 2004. Burk was the author of two books, both on the theory of integration. The second, entitled *A Garden of Integrals*, will be published by the MAA in May.

James Eells died on February 14 at the age of 80. Eels graduated from Bowdoin College and then from Harvard University. His doctoral work was completed in 1954, under Hassler Whitney. After holding several prestigious positions in the U.S., he moved to the United Kingdom and became Professor of Analysis at the University of Warwick. He was later named the first head of the mathematics group at the International Center of Theoretical Physics in Trieste, Italy. His research dealt with harmonic maps, geometric evolutions, and stochastic analysis.

We are deeply grateful for the generosity of the following individual, who has made a bequest to the Mathematical Association of America.

Every bequest is a powerful expression of loyalty, their lifetime involvement, and their faith in the future of the MAA. We remember each of them fondly and with deep personal and professional respect.

Francis D. Parker
Member for 55 years

The PascGalois Summer Undergraduate Research Retreats

By Michael Bardzell and Eirini Poimenidou

In the summers of 2005 and 2006, undergraduate students from around the country were invited to apply for a one-week intensive undergraduate research retreat at New College of Florida to investigate questions related to the PascGalois Project. This NSF-supported project aims to stimulate undergraduate research by providing accessible problems that are linked to a range of undergraduate mathematics and computer science courses, such as abstract algebra, number theory, dynamical systems, and computer graphics. The project focuses on cellular automata, a type of discrete dynamical system, generated over group alphabets. Properties of these systems can be studied in terms of number theoretic and/or group related properties. Because of the visual nature of cellular automata, the variety of mathematical disciplines touched upon, and the computational nature of many questions, it is a promising area of research for a wide variety of undergraduates. Students from rising sophomores to seniors, including both mathematics and secondary education majors, attended the retreats. A few of these students had prior experience with the PascGalois project, but most did not.

For both retreats, a small group of students (13 in 2005 and 12 in 2006) were accepted to attend. Participants received a $300 stipend, free room and board, and travel reimbursement. Students attended lectures and were then given time for individual exploration and group work using software designed specifically for the project. Student presentations were given at the end of the week. Social events and outings to explore the local attractions in Sarasota were also built into the itinerary. One of the 2006 participants, Casey Kuhn from Pittsburg State University in Kansas, stated "the PascGalois Retreat was an amazing experience for me. I learned more in one week than I could have ever imagined… and I definitely made some life long friends!"

PascGalois retreat participants in 2006.

The PascGalois project is based at Salisbury University in Maryland. The supporting NSF grant was written to include a sub-contract for New College of Florida to host these retreats, partially as an experiment to test the viability of a one-week research experience. There are numerous wonderful REU experiences available for students each summer. However, REUs require large time commitments that may not be attractive or even possible for many students. It was our hope that these one-week retreats would prove a nice alternative for students interested in a research experience, but not willing to commit to an entire summer for an REU. Our main concern was whether or not a productive start to student research could occur in one week.

In the end, we were quite pleased with both retreats. A visiting faculty member for the 2005 retreat, Tyler Evans from Humboldt State University in California, noted, "I was amazed at how, by week's end, each of the student participants was engaged in genuine mathematical research. The night before the final presentations, the group sharing my dormitory suite wrote and ran code until the wee hours of the morning, and I was right there among them as the excitement was too good to miss."

One of the 2006 student participants, Ryan Johnson from the University of Mary Washington in Virginia, said that "the retreat was one of the best experiences in math that I have ever been a part of, as it opened my eyes to the world of mathematical research. It was invaluable experience and has given me a great start on my sojourn through the world of mathematics." Johnson is currently writing a paper about fixed points based on the research he started at the retreat. Two other participants, Katelin Childers and Erin Craig from New College, presented their research on binomial identities in the student poster session at the 2007 Joint Mathematics Meetings in New Orleans. We hope that other new types of research experiences continue to become available to undergraduates. Mathematics students across the country will benefit from a variety of research options, both in content and format.

More information about the PascGalois Project and the summer retreats can be found at http://www.pascgalois.org. Support for this project was provided by NSF award #DUE-0339477.

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Teaching Time Savers: Homework Without Grading

By John Prather

Experienced teachers are aware of the inherent tension in grading homework. On the one hand, students need feedback on the lessons, and the instructor needs to know how they are doing. Moreover, some students will not do homework that is not collected. On the other, homework is time-consuming to grade. More than that, many students will not even look at the comments that the teacher has written. And even if they do, by relying on the instructor's grading students are not learning to assess whether what they have done is correct.

A solution to this tension occurred to me at a Project NExT workshop in which end-of-class one-minute essays were discussed. Adapting this idea to homework, I now require students to include a short cover page on every assignment in which they must briefly reflect on the material.

On the cover page, I ask students to answer three questions: First, what topic did you believe was the most important in the assignment? Second, why do believe that is the most important topic? Third, what problems did you have with the assignment, if any? The students are required to answer each question with a complete sentence, but, otherwise, the cover (and the assignment) is not graded outside of credit for turning it in. I do not look at the actual homework problems unless the students ask me to on the cover sheet, or if I need to see a student's work to fully understand a question that is asked. I do occasionally peruse the assignments to make sure the students are making some attempt at the problems.

The first two questions give me feedback about what the students understand. More important, however, is the third question. Typically students will give me a list of exercises that they could not do, or did not fully understand. This gives me the opportunity to reply specifically to the students' needs. Therefore, I have some confidence that when I give them feedback on these questions, they will actually look at it. If many of the students have the same question, I can go over it in class, saving even more time. At other times, students reply to this question with personal problems external to the class. The cover page gives them an easy way to let me know what is causing them trouble without embarrassment. Occasionally, students will even notice patterns in the homework or will do problems differently than I did, and will want to know if the pattern or their methods will always work.

Of course, there are some students who do not understand problems in the assignment, yet do not write them on the cover sheet. Typically this happens because students thought they understood, because they are too embarrassed to admit the scope of their problems, or because they just don't care enough to ask. The last group would not look at my comments even if I graded the entire assignment, and I approach them just as I would any other unmotivated students.

The students who are too embarrassed to ask their questions probably pose the greatest challenge in any class, but also require more intervention than homework can provide. For these students, the instructor can use the cover sheet to start a more general conversation. The group of students who thought they understood usually self-correct quickly due to feedback from frequent quizzes and in-class discussion of the homework.

While there can be some delay in correcting mistakes on individual problems, over time they also start to take more responsibility for their own learning. They get a better sense of when they do not understand something, and ask more questions later in the course. In the end, they become better learners than they were before.

I have been pleased by the effectiveness of this requirement. In addition to the information that I expected to get, there are other benefits. Since the sheet is due at the beginning of class, students have thought about the problems they are having before arriving which makes the students more prepared. Perhaps most importantly, the sheets start a dialogue, and that makes me more accessible. I think I get more students in my office than previously because of the covers.

In the end, I feel like the time I spend responding to the cover pages is well worth the effort, and is an effective way to communicate with students.

Time spent: About a minute per student per assignment.
Time saved: About 1-5 minutes per student per assignment depending on how much time the instructor would otherwise spend grading.

John Prather is an Associate Professor at the Eastern Campus of Ohio University and would welcome any feedback on this article. He can be contacted at prather@ ohio.edu.

Teaching Time Savers are articles designed to share easy-to-implement activities for streamlining the day-to-day tasks of faculty members everywhere. If you would like to share your favorite time savers with the readers of FOCUS, then send a separate email description of each activity to Michael Orrison at orrison@hmc.edu. Make sure to include a comment on "time spent" and "time saved" for each activity, and to include pictures and/or figures if at all possible.

Educating Future Elementary and Middle School Teachers

By Betsy Darken

The weak mathematical preparation of many elementary and middle school (K–8) teachers is one of the most serious problems afflicting American education — and higher education shares part of the blame. Our schools are caught in a vicious cycle, with students who received very mediocre mathematical educations becoming teachers who perpetuate a ruinous cycle. We in higher education can point fingers—or we can do something about this situation. Specifically, we must seriously reconsider whether the mathematics courses we require of prospective K–8 teachers actually help to break this cycle.

We would like to think that students who complete college courses, especially courses like calculus, have a reasonable understanding of K–8 mathematics; this assumption, however, is not supported by the evidence. This is a head-in-the-sand approach to preparing teachers, as the study described below shows. We either ignore their actual level of mathematical understanding or expect so little of them that we contribute to the cycle of mediocrity. Fortunately, the study also provides evidence that carefully crafted courses can help break the cycle. Improving the preparation of teachers is of critical importance. What follows is one way to make progress toward this goal.

The Conference Board of the Mathematical Sciences (CBMS) made important recommendations on how to improve teacher preparation in *The Mathematical Education of Teachers* (CBMS, 2001). They showed that it is not true that "prospective teachers learn all the mathematics they need to teach mathematics well during their own schooling." Hence, "prospective teachers need mathematics courses that develop a deep understanding of the mathematics they will teach." Similar recommendations were made in *Adding It Up*, published by the National Research Council in 2001. In the latter, *mathematical proficiency* was described as including conceptual understanding and procedural fluency, as well as the ability to formulate and solve problems and the capacity to think logically and coherently.

To develop the mathematical proficiency of K–8 teachers, are specialized courses best? Many specialized courses seem to meet the CBMS recommendations, at least if we judge by the table of contents of popular textbooks. However, such courses have been around for a long time, yet the problem remains.

A New Course for Teachers

In the light of these studies, I developed a specialized course for K–8 education majors. I emphasized both mastery of basic skills and understanding of fundamental ideas, as well as problem solving in the context of important mathematical concepts. I assumed that students would need to review basic computational skills, but that most could review these on their own time. This assumption proved to be correct. About 80% to 85% were able to reach mastery on repeatable skills tests taken outside of class, although most had to take these tests more than once.

Class time was focused on investigating the basic principles of K–8 mathematics, of which most students were quite ignorant. For instance, many (although not all) students could correctly label place values; however, they had little understanding of the foundational "10 for 1" principle of our numeration system. Some students, for instance, did not realize that 10 hundreds are equivalent to 1 thousand, while many students did not know that 1/10 of a hundredth is a thousandth. This was tied to a pervasive lack of understanding of rational numbers. For example, while many students could change 4% to 0.04, they knew only "to move the decimal point two places to the left." The fact that 0.04 means 4 per hundred, and so does 4%, was news to them. In combination with a very weak understanding of the meanings of the basic operations, this failure to understand rational numbers explains why American students have so much trouble with word problems in middle school. When they can no longer rely on multiplying to get larger numbers and dividing to get smaller numbers, things fall apart.

Another major hole was geometry and measurement. For instance, while many students knew the formula for the area of a rectangle, most could not justify it. In fact, LW was often confused with 2L + 2W. Similarly, many students were unaware of relationships among basic area formulas and had limited experience with complex figures, the characteristics of measurements, unit conversions, etc. For these reasons I wove geometric topics throughout the course.

The mathematical principles teachers need to know are not just specific content. Mathematicians know the value of thinking mathematically and the power of mathematics to solve a wide range of problems. These themes permeated my course. Students learned to look for patterns, make conjectures, develop informal proofs, explain why standard algorithms worked, justify answers, and solve many, many problems. They found that it helped a lot to draw diagrams, talk to each other, and ask questions. Thus most of my classes were bad news-good new stories: While students started out knowing far less than I might have hoped, most emerged learning far more about mathematics and mathematical thinking than I had feared they would.

The Study

To investigate how much my education students had learned, I developed an assessment instrument that was given as a pretest and posttest to my classes and to a number of college algebra and Calculus I classes. While this instrument addressed only a small fraction of the content of my specialized course, it corresponded well with the "focal points" recently identified by the National Council of Teachers of Mathematics as deserving primary attention in the K–8 curriculum. Following are selected results.

(1) Factual Knowledge

Success rates on factual knowledge are

listed in the following table. These represented only a few of the facts and skills that my students were expected to learn.

Question	College Alg.	Calculus I	Math for K-8 Teachers	
			Pretest	Posttest
1 mile = ? feet	35%	55%	29%	83%
What is 7 ÷ 0?	30%	73%	46%	88%
Write 33 1/3 % in exact fraction form.	4%	20%	12%	58%
1 cu. yard = ? cu. feet.	4%	20%	12%	58%
0.59¢ = $?	6%	31%	4%	63%

These results show that students in the first three groups, including the pretest education majors, College Algebra students, and Calculus I students, had a pervasive lack of knowledge about facts that many of us would regard as basic. (They have a good excuse for missing the last question: In many grocery stores, 59¢ is often displayed as ".59¢".) Calculus I students did somewhat better, but given the level of these questions, even their performance was not good.

In sharp contrast, posttest K–8 teachers did strikingly better than the first three groups on almost all questions.

(2) Conceptual Understanding

Students were asked to (a) explain why the rows of partial products in the standard multiplication algorithm are not right-justified; (b) devise a word problem for 1¾ ÷ ½; and (c) justify answers to "What is 7 ÷ 0?" The first two questions should look familiar to those who have read the works of Liping Ma and Deborah Ball.

On these conceptual questions, most of the success rates for the first three groups were below 10%; the highest was 20%. Performance was relatively similar across courses, although Calculus I students did slightly better. Commonly, "explanations" were simply statements of rules such as, "It is impossible to divide by 0." Once again, posttest results for the education majors were much better than for the first three groups, with success rates ranging from 56% to 69%.

(3) Problem Solving

Students were also asked to solve eight elementary word problems, such as finding the original price of an item given the sale price, finding a simple volume, and calculating elapsed time. Most students computed the elapsed time correctly — but a surprisingly large number missed this third grade question. College Algebra and pretest teachers did particularly poorly on the remaining problems, with most success rates below 20%. Calculus students did somewhat better, but some of the success rates were below 50% and only 73% solved the simple volume problem. Once again posttest teachers showed major improvements on all questions: Success rates ranged from 37% to 83%, and most rates were above 50%. They outperformed Calculus I students on six of the eight questions.

These impressive improvements were not due to attrition, which was controlled by the pretest-posttest study design. Nor were these students "taught to the test." While versions of these questions were included in the course, so were hundreds and hundreds of other questions. Students were asked to explain the mathematical bases for all computational algorithms, devise word problems for all sorts of numerical expressions, and constantly justify their answers. (These students had a lot of homework!) Their vastly improved performance on the above questions strongly indicates that my students had learned something about thinking mathematically.

The pretest-posttest assessment instrument was also given to prospective teachers taught by instructors using a traditional textbook. In one section there was little change in performance from pretest to posttest. Results were better for a section taught by a more experienced instructor, but not as good as the results in the innovative class. These major differences are certainly due in part to the fact that the assessment instrument was based on topics covered in the innovative materials. Yet even on common topics, students using the traditional text did less well on most questions.

What Needs to Be Done?

The large differences in performance described in this article between students in an innovative course and students in other courses strongly suggest problems with current requirements for prospective K–8 teachers. (They may also suggest problems with the base knowledge of other mathematics students.) Students preparing to teach mathematics in grades K–8 need carefully structured, challenging, specialized courses that concentrate on the key skills and principles of K–8 mathematics. Notice the plural — *courses***.** While results for posttest students in this study were good, there was still room for improvement. Also, in the single course, students expressed concern about the heavy time commitment. To address these problems, requirements for many of our prospective K–8 teachers have been changed from one to two specialized courses. Three courses would be even better, and is recommended by CBMS.

When instituting such courses, one must be careful: Ask too much, and your students will resort to memorizing nonsense; ask too little, and they will do just a little. Ask just right and you will find that many education majors have the potential to be agents for change in our troubled schools.

Betsy Darken is a professor of mathematics at the University of Tennessee at Chattanooga; her specialty is mathematics education. Further information about this study is available at her website at http://www.utc.edu/Faculty/Betsy-Darken/

Teaching with Classroom Voting

By Kelly Cline, Holly Zullo, and Mark Parker

Classroom voting is a new and useful teaching technique in mathematics. The instructor poses a multiple choice or true/false question to the class, waits for a brief period of consideration and discussion, then has the students vote on the answer, either by holding up colored index cards (*a* = red, *b* = blue, etc.) or using a computerized personal response system, where each student registers a vote with a hand-held "clicker." After the vote, the instructor guides a Socratic discussion, asking several students to explain their thinking. The instructor gets immediate feedback on the state of the students' understanding. The voting gets the students to actively engage in the class, to discuss the issues with their peers and to express an opinion. Students confront common misconceptions before doing the homework.

Student reaction to this teaching technique is generally quite positive: They enjoy playing an active role in the classroom, they have fun clicking in with their votes, and often attendance improves.

A growing body of research demonstrates that not all questions and not all methods of using classroom voting are equally effective at promoting student learning. A recent study at Cornell (http://www.math.cornell.edu/~maria/mathfest_eductio n/preprint.pdf) showed that when instructors chose to focus on questions that probed conceptual issues and used these questions to motivate student discussions before each vote, there was a significant improvement in student learning, as demonstrated by an analysis of scores on common exams.

What makes a really good voting question?

How can a multiple-choice question probe important underlying issues? A carefully crafted question really can get at the deeper concepts. For example, suppose you're teaching first-order differential equations and have introduced the idea of equilibrium. You could pose this question:

The amount of a drug in the bloodstream follows the differential equation $c^{1} = -kc + d$, *where d is the rate at which it is being added intravenously and* k *is the fractional rate at which it breaks down. If the initial concentration is given by a value* $c(0) > d/k$, *then what will happen?*

a) This equation predicts that the concentration of the drug will be negative, which is impossible.
b) The concentration of the drug will decrease until there is none left.
c) This means that the concentration of the drug will get smaller, until it reaches the level $c = d/k$, *where it will stay.*
d) This concentration of the drug will approach but never reach the level d/k.
e) Because $c(0) > d/k$ *this means that the concentration of the drug will increase, so the dose d should be reduced.*

In a recent class, our students were divided fairly evenly between *c* and *d*, with a few voting for other answers. The discussions both before and after the vote were very rich, with the students actively trying to decide whether the level of the drug would actually reach equilibrium. In the post-vote discussion, they came to understand that *d* was correct, and that the level of the drug would asymptotically approach, but never quite reach equilibrium.

Questions posed with a context and in natural language are particularly good at provoking discussion, in particular because students have to translate the mathematical ideas into ordinary speech. Rather than asking students what happens "in the limit as *t* approaches infinity," ask them what happens "in the long run" and then watch them grapple with the meaning of the mathematical ideas.

How do you make it work?

Classroom voting is a fun technique that can really change your classroom in positive ways, but how do you make it work? One easy way to get started is to hand out a numbered list of questions to the students at the beginning of the course or unit. That way, the instructor simply calls out a question number to get each vote going. We've found that before the first vote takes place, it's important to explain to the students what's going on and why. Emphasize that the main purpose of classroom voting is to get them to discuss the mathematics in small groups before each vote. To promote this, it is generally useful to give the students plenty of time to work things out, up to four minutes if necessary, and only close the voting when most students have registered in, or if the relevant discussion peters out.

After the vote, it is important to guide a Socratic discussion, calling on different people and asking them what they voted for and why. Sometimes students will try to avoid the issue, saying that they just guessed and they don't know. At this point, it helps to emphasize that it doesn't matter whether you are right or wrong, as long as you have something to say, some idea, some insight to offer. "If you don't have any ideas, ask the people around you, and if they don't have any, it's okay to get up and ask around until you learn something."

In the post vote discussion, don't give away the correct answer too quickly: Be coy! Call on a variety of students and try to let them figure it out themselves. Often when the right explanation comes out, the answer is clear and you'll hear students say "ah!" around the room.

Who has the time?

Classroom voting takes time, roughly one to four minutes for the pre-vote discussions, and usually a similar amount of time for discussion afterward. This means that a few votes can easily eat up half of a class period, so who has time for voting? The key to using classroom voting without slowing your pace is to use the voting to teach many of the ideas that would otherwise be taught via lecture.

Instead of doing several examples on the board, try doing one, and then use voting to get the students to work through the others themselves. Just give the students the bare essentials in a short lecture segment, and then let them figure out the rest. You might be surprised at how well your students can connect the dots when they are working together to figure out a voting question.

Use questions to provoke common misconceptions and pitfalls, or special cases when the usual techniques don't work, and then after the vote they'll be ready to listen when you explain the way out. In calculus, ask the students to work out the antiderivative of $1/x$ and watch them notice how the power rule fails.

We've been using classroom voting in our calculus classes for the past several years, covering exactly the same syllabus and giving the same types of exams as we did before. Rather than viewing classroom voting as an add-on to be crammed in at the end of the class period, we let the voting replace about half of each lecture and intersperse the questions throughout the period. The same concepts are taught but in a more student-centered way.

Where do you get the questions?

Writing multiple-choice questions that push students' understanding of the concepts behind the mathematics isn't easy. Some publishers are now offering collections of voting questions, sometimes called *ConcepTests*, to supplement their texts. If these exist for a text you use, that can be useful; however sometimes these questions focus on straight-forward computations and more basic applications of the main ideas — not the deeper issues that have the greatest educational impact. Just holding votes isn't enough!

The research shows that high quality conceptual questions are the ones that make a real impact. Fortunately there are some good sources out there: The NSF funded *GoodQuestions* project at Cornell, at http://www.math.cornell.edu/~GoodQuestions/, has developed and tested a library of classroom voting questions that are specifically designed to get students to grapple with the key ideas of calculus.

More recently, the NSF has funded our *Project Math QUEST: Math Questions to Engage Students* (see http://mathquest.carroll.edu/), and we are writing and testing a library of questions to use in differential equations and linear algebra courses. We have working drafts of these questions up and are looking for collaborators at other institutions who would be willing to try out some of them. If you'd like to get involved, please visit our website and take a look.

Give classroom voting a try!

Classroom voting is a powerful new teaching method that engages students, getting them to actively participate in the classroom. It takes a little preparation, but the results are well worth the effort. To get the most out of this technique, first use the best questions that really push the students' understanding of the key mathematical ideas. Second use the voting to replace parts of your lecture, allowing the questions to draw out the ideas that you would otherwise have to present. Third emphasize that the pre-vote discussions are the real engine of this process: When your students are debating and discussing the mathematical ideas with their peers, then real learning is taking place.

Kelly Cline, Holly Zullo, and Mark Parker teach at Carroll College in Helena, Montana and have received an NSF grant for Project MathQUEST, to develop and test classroom voting question for linear algebra and differential equations.

Math Doesn't Suck

Danica McKellar, the young actress who appeared in *The Wonder Years* and who graced the cover of *Math Horizons* in April, 2001, has written a book intended to get "tween" girls excited about mathematics. (For those not up on this particular bit of modern jargon, "tweens" are children between 8 and 12 years old, who are not little kids any more but not yet teenagers.) Entitled *Math Doesn't Suck*, the book will be released in early August. The promotional material describes the book: "Danica uses situations from real life not only to illustrate how useful math can be, but also to give girls little "tricks" to help them grasp some of math's tougher concepts. Topics range from buying lipstick (factoring) to making beaded bracelets (prime numbers) to trying to figure out if you're really over your last crush (greatest common factors). It's an engaging way to show girls that exercising their brains will give them a power that no amount of physical beauty can match." MAA Reviews has been promised a review copy.

"The Best Math Course Ever"

By Brian Birgen

Like many schools, Wartburg College offers a May Term, in which students take a single class for just under four weeks. Unlike a summer semester, this term is required of all students. Many majors take advantage of this class to travel: The Spanish department will offer a language course in Mexico, the Social Work department will offer an Urban Ministry course in San Bernadino, the Music department will offer a performance course which tours the country, and so on. In this setting, there was discontent among the mathematicians: Our majors wanted a travel course like everyone else.

In 1999, Lynn Olson, our department chair, first offered a course titled "The Historical Roots of Math and Physics." Twice he led classes to Germany and once to the British Isles, after which he decided to pass on the mantle of leadership to me. In May 2006, I led a group of 13 students to Germany to teach the same "Historical Roots" class. The goals of the course included:

- To develop an understanding of how society and politics influence the development of math and physics.
- To gain an appreciation for the struggles some individuals have faced in order to pursue mathematics or science as a field of expertise.
- To experience the similarities and differences between German culture and American culture.

We spent three weeks traveling throughout Germany. In an attempt to save money as well as get a deeper exposure to German culture, we stayed primarily in youth hostels (Jungendherberge). Students shared rooms with between three and eight people, with dormitory quality facilities. Everyone was expected to provide towels, but bedding and breakfast was provided by the hostel. We traveled on the train system (Deutsche Bahn) which is extensive and reliable.

The travel course students at the IBM museum.

We needed to purchase the tickets in the US beforehand, but these enabled us to travel all around Germany for a reasonable price. Students were therefore expected to pack only what they could carry and were encouraged to use backpacks for their luggage.

This was our itinerary:

Day 1: Our flight arrived at 10 a.m. in Frankfurt. We took the train to Heidelberg and spent the day exploring the city and the castle. The University museum is a possibility, but like many places in Germany, it is closed on Mondays.

Day 2: After a train ride to Stuttgart, we visited the Kepler Museum in Weil der Stadt where Dr. Manfred Fischer gave a tour. In the afternoon we visited the Porsche Museum, although there is also a recently renovated Mercedes-Benz Museum.

Day 3: We visited the House for the History of IBM Computing in Sindelfingen and received a tour from many former IBM employees. This museum is run by former computer engineers who keep the old machines running and was very popular with the students. In the afternoon we visited the Württembergisches Landmuseum in the Alte Schloss in Stuttgart.

Day 4: We took a day trip to Tübingen, to visit the university where Kepler was educated. Dr. Gerhard Betsch showed us around the city and explained much of the history of the city and university, including the impact of the Reformation on the city of Tübingen. It is possible to visit Haiderloch, Heisenberg's World War II research facility, which is not far from Tübingen.

Day 5: We traveled by train to Munich and spent the afternoon at the Deutsches Museum. This museum is so extensive that it is possible to spend a full day in the museum and still not see everything. Dinner was in one of Munich's many beer gardens, followed by a trip to the Deutsches Theater. Students were able to purchase discounted tickets to see *Cats* (in German) which interested a number of students.

Day 6: In the morning we took a trip out to the Dachau concentration camp memorial. We spent about four hours at the site and were emotionally drained afterwards. Students had the afternoon and evening to explore Munich.

Day 7: The next stop on our trip had little to do with math and physics. The Wartburg castle, which our college is named after, is located in Eisenach, and Waverly, Iowa (where Wartburg College is located) is the sister city to Eisenach. We took the train to Eisenach where I had arranged home stays with German families. On this day, we met with the host families and socialized with them.

Day 8: We visited the Wartburg castle followed by an afternoon tour of the house where Johann Sebastian Bach was born.

Day 9: We took the train to Leipzig, where Dr. Rüdiger Thiele showed us around town. We visited the St. Thomas Church where Bach is buried as well as the St. Nicholas Church where the peace marches which led to the reunification of Germany started. We also visited the Stasi museum in the "Runde Ecke." I learned that today's undergraduates have no memory of East Germany and need some historical background to contextualize these sites.

Day 10: We took a day trip to Dresden. This is a city full of cultural attractions. We visited the recently rebuilt Frauenkirche, which had been destroyed during World War II. We visited the collection of clocks and scientific apparatuses in the Zwinger Museum. The students were given the opportunity to visit some of the many other cultural sites in Dresden individually.

Day 11: We traveled to Berlin. In the evening we visited Museum Island, consisting of the Art Museum, the Pergamon Museum and the Antiquities Museum. The other two museums were under renovation, but our visit was scheduled for Thursday evening when admittance to all the museums was free. Another interesting site to visit in Berlin is Humboldt University.

Day 12: We traveled to Potsdam to visit the Einsteinturm, a solar observatory. While we were not able to arrange a tour, there were extensive grounds which we were able to tour. We also made a trip to San Souci, the summer palace of Frederick the Great. A few students attended part of the German Open tennis tournament in the evening, which happened to be in Berlin then.

Day 13: My favorite day of the trip was when we went to Hannover. We visited the Leibniz archive and Dr. Herbert Breger showed us a number of items from their collection, including some books from Leibniz's personal collection in which he had made numerous notes. Our hostel was close to the soccer stadium and a number of our students were able to attend a Bundesliga match.

Day 14: The second home stay which we had organized took place during two days in Göttingen. We had made a connection through one of the local Lutheran churches to provide host families for our students (Wartburg is a Lutheran college). We met our families at St. Albani's and attended services. The students met in the afternoon to visit the city museum which contained information on the history of the city and the university.

Day 15: This was a full day in which we visited the grave of Gauss and his Sternwarte (it was under construction, so we were unable to go inside). Dr. Axel Wittmann and Dr. Sam Patterson were very helpful in showing us around the city and university. We were able to visit some of the classrooms where Hilbert and Courant had lectured. They were not significantly different from large classrooms at any major university, but for students from a small liberal arts college, they were quite impressive.

In the afternoon we visited the old library where they had the archives from Gauss, Riemann, and Hilbert (and many others) and were able to see items from their collection. It is also possible to take a tour around town to see the houses where Hilbert, Minkowski, and others lived, as noted by commemorative plaques on many of the buildings.

Day 16: We said goodbye to our Göttingen families and traveled to Kassel for one night. There is a collection of astronomical and scientific equipment in the Orangerie, which we toured. It is possible to arrange a tour of the Martini Brewery, but I learned email contact is not enough to reserve a guide.

Day 17: We spent three days in Cologne. On the first day we explored the city, which included a visit to the cathedral and the Lindt chocolate museum.

Day 18: We took a day trip to Bonn. We visited the Deutsches Museum Bonn, a museum focused on recent scientific development. Another option is the Arithmeum, a museum devoted to calculating machines.

Day 19: We took a day trip up to Duisberg. In the city museum there is an extensive display on the map making of Mercator and his method of projection, with a delightful tour by Werner Pöhling.

Day 20: We spent our last day in Frankfurt shopping and sightseeing before leaving Germany.

Day 21: Our flight left at 8:30 a.m. out of Frankfurt.

As a result of the course, my students developed a much deeper appreciation for the history of mathematics and the relationship between world history and the development of mathematics. Additionally, my small-town Iowa students developed the confidence to travel in Europe and expanded their worldview. I am looking forward to my next opportunity to teach this class and I hope others will be encouraged to try a similar course.

Brian Birgen is Assistant Professor of Mathematics at Wartburg College in Waverly, Iowa.

A Song for 7/7/07

By Larry Lesser

The mass media are already reporting much hoopla about the approaching date of July 7: 7/7/07. Couples are planning weddings for that date, to be followed by honeymoons on a Boeing 777 to a resort where they will hope to play a slot machine that comes up 777 for a big jackpot. Also, that day is apparently when the "New Seven Wonders of the World" will be announced in a ceremony in Portugal, and that month is when the seventh (and last!) Harry Potter book will be released.

As a mathematical songwriter (see my web page at http://www.math.utep.edu/Faculty/lesser/Mathemusician.html), I offer another option for celebrating the day — a musical exploration of a rich variety of mathematical and real-world connections to the number 7. It may be sung to the tune of Jimmy Page and Robert Plant's (7-verse) song "Stairway to Heaven," the Led Zeppelin song that has been played most on the radio.

As Monte Zerger says in the March 2002 *College Mathematics Journal* (p. 74): "A mathematical exploration into the 'life' of a natural number can not only be an entertaining and refreshing diversion, it can lead to engaging questions and unexpected discoveries as well." (This originally appeared in the August 2001 *Humanistic Mathematics Network Journal* and is reprinted with permission.)

Stairway to Seven

There's a student who's sure if she rolls two fair dice,
The most likely sum is 7.
On the 7th day she knows many stores will be closed
'Cause lots of folks call it the day of rest.
Ooh, ooh, she's inquiring: "Where is there a 7?"

Well there's a 7 on the wall, but she wants to be sure
'Cause you know uncrossed sevens can look like ones.
From 7 notes in a scale, there's a songbird who sings—
It's the first sour note in the harmonic series.
Ooh, it's quite a number. Ooh, 7 wonders.

There's a feeling I get from the 7 continents
And shuffles needed to mix the cards:
Snow White's dwarves all could be a water polo team –
It's the limit of short-term mem'ry.
Ooh, it's quite a number. Ooh, telephone number.

It's the steps in ballet's art, it's the Big Dipper stars,
And it's how many times you can fold paper.
First polygon to elude the classical tools
And it's how many patterns for borders.

If a track meet takes a long time, don't be alarmed now—
It's just what's called a heptathlon.
Can you remember when the 7th month was September?
Then Caesar added August and July! And it makes me wonder...

7 verses make this song maybe too long,
The piper fights for airplay!
First whole number whose reciprocal does use
Its maximum block of digits.

And as we wind on down the road, with 7 chakras I am told,
And 7 colors of the rainbow make white light when they all show.
If you listen to this rhyme of this odd Mersenne prime,
May it make you want to find each number's special shine…
And she's buying a stairway… to 7th heaven!

To the tune of "Stairway to Seven" all rights reserved

Forbes, Akamai, and Number Niftiness

By Fernando Q. Gouvêa

The April 5 issue of *Forbes* magazine included an article about Akamai Technologies, which they described as "the cyberworld's ubiquitous courier." Akamai, through the Akamai Foundation, is one of the major sponsors of the MAA's American Mathematics Competitions (AMC) program, providing scholarships for the top three scorers in the USA Mathematical Olympiad and funding a portion of the Mathematical Olympiad Summer Program (MOSP) that brings 25 young students together each summer to further enhance their problem-solving skills. As a supplement to the article, noting that Akamai supports the AMC program, *Forbes* posted a mathematics quiz to its website. Entitled "How Number Nifty Are You?", the quiz included questions from several of the AMC's competitions. Readers can determine how number nifty they are by going to http://www.forbes.com/technology/2007/04/05/akamai-math-internet-tech-cx_0405mathquiz.html. For more on AMC, visit the MAA website and click on the "Competitions" tab on the upper right.

MathNerds Will Create Mathematics Mentoring Networks

MathNerds, a company that offers free help with mathematics questions through its web site at http://www.mathnerds.com, has been asked by the Texas State University System to create Mathematics Mentoring Networks within the numerous Texas State Universities. The goal of these mentoring networks is to use the Internet to connect public school district students to local university students majoring in mathematics education. Pre-service teachers will get the opportunity to interact with students at the curricular and age levels they will eventually be teaching. Pre-service teachers will answer mathematics questions over the Internet, with the guidance of a team of educators. The expectation is that the program will help students prepare better for teaching careers while simultaneously providing a useful service to the schools.

AP Courses to be Audited

By Fernando Q. Gouvêa

The College Board has announced that it will be conducting an audit of all high school advanced placement courses to make sure that they are indeed as demanding as the college courses they are intended to replace. In November, a list of approved AP courses will be posted to the College Board website and will be provided to colleges and universities.

In the past, schools were free to decide whether to label their courses as "AP." College admission officers have tended to look favorably on students having taken such courses even if they did not take the actual AP Exam. This led to a proliferation of AP courses. After complaints that some such courses were not up to the standard of the corresponding college courses, the College Board has changed the system. Schools now need to request authorization for labeling courses as AP, and the audit is the process through which they have to go. Schools that wish to designate their courses as AP need to submit their syllabi to the College Board by June 1.

Of course, none of this implies any changes for the AP Exam, which certifies that students have learned the appropriate material and is the ultimate "quality control" for AP courses. For more information on the AP audit process, visit the College Board's AP Central web site at http://apcentral.collegeboard.com/.

Profiles Needed for MAA Career Brochure and Website

By Fernando Q. Gouvêa

One of the most popular parts of the MAA's website is the one called "We Do Math! Careers in the Mathematical Sciences." This page presents profiles of people who studied mathematics and went on to do something interesting, exciting, innovative, or just fun. The same profiles also appear on the MAA's career brochures, which are available for schools and universities and distributed nationally. The purpose of the brochure and website is to show high school students and undergraduates that there are many careers using mathematics "outside the classroom." The website is at http://www.maa.org/careers/.

In order to keep the site interesting, we need to continually add new profiles. The ideal profile is of someone who has recently completed an undergraduate degree in a math-related field and is now utilizing the skills that they learned in the workplace. Hal Nesbitt of the MAA Programs Department is looking for suggestions of persons who fit this description. If you know someone who seems appropriate, ask them to send a brief biography and some information about how they are using mathematics in their work to hnesbitt@maa.org.

Women Count: A Conference for Directors of Mathematics Outreach Programs for Young Women

The fourth Women Count Conference will be held this year in San Jose, California, on August 2, 2007, just before the opening of this year's MathFest. Applications are invited from those who would like to attend. Applications will be reviewed after May 21, 2007.

Women Count is organized by the Women and Mathematics Network, under the auspices of the MAA Committee on the Participation of Women. This year's conference will focus on disseminating information about successful outreach programs for young women. The hope is to encourage the establishment of more such programs throughout the nation and to equip those who might want to do so. By sharing their expertise, those currently engaged in outreach programs can offer real help to those establishing new programs.

The conference is scheduled the day before MathFest and at the same location. The hope is that this will make it easier to attend and also make the conference more visible. Women Count can thus serve both as a professional development opportunity and as a way to publicize outreach efforts to the broader mathematical community.

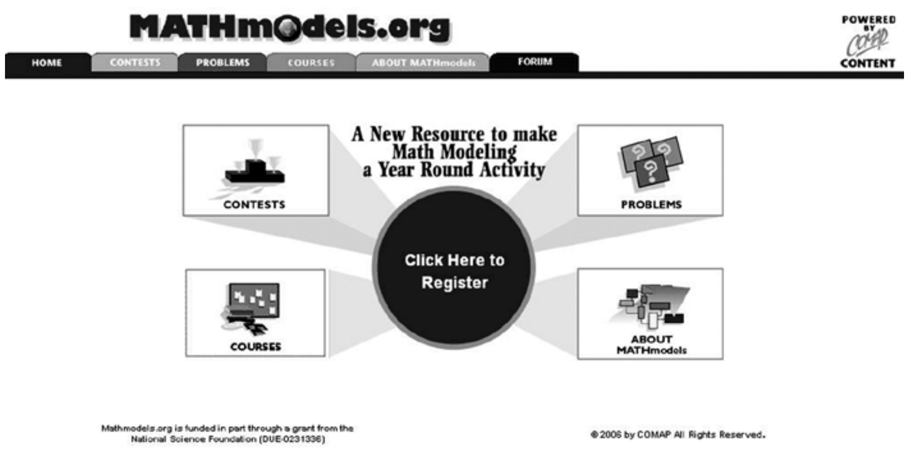
Support for the conference is being provided by the Association for Women in Mathematics, the National Security Agency, and the Tensor Foundation. Participants in the Women Count Conference will be selected from the applications of experienced and prospective program directors. Team entries that pair an experienced director with a prospective director from the same geographic region are particularly encouraged because this enhances the opportunities for continued mentoring following the conference. Partial travel support will be provided for participants. This conference will include a workshop on grant writing, and breakout sessions for programs for high school students versus those with a middle school focus. Guest speakers will lead sessions on such issues as selection of program format, recruitment of young women, types of hands-on activities, possible funding sources, and assessment procedures.

Representatives from the National Security Agency, the Mathematical Association of America, the Tensor Foundation, and the National Science Foundation will be invited to speak on their programs that assist and support mathematics outreach activities.

Information about this conference and an application form may be found on the MAA website at http://www.maa.org/wam/.

COMAP Announces MATHmodels.org

By Fernando Q. Gouvêa



The Consortium for Mathematics and Its Applications (COMAP) has announced a new website, MATHmodels.org, which offers Mathematical Modeling resources for teachers and students. The site gives students a chance to work on modeling problems posted by faculty and others who use mathematics in their professions. Students can submit papers with solutions or partial solutions and receive commentary on their work from either a faculty mentor or the poser of the problem. Some student papers will be selected to appear on the site.

COMAP hopes that the site will help students to prepare to participate in its mathematical modeling contests, and that it will also help faculty members interested in finding good modeling problems to use in class. Practitioners tell COMAP that they will use the site "to raise their organizational and industry profile among bright high school and college students around the world, while gaining a fresh prospective on their industry's quantitative problems. Many industry professionals find that volunteer mentoring on MATHModels.org is a great way to give back to the academic world."

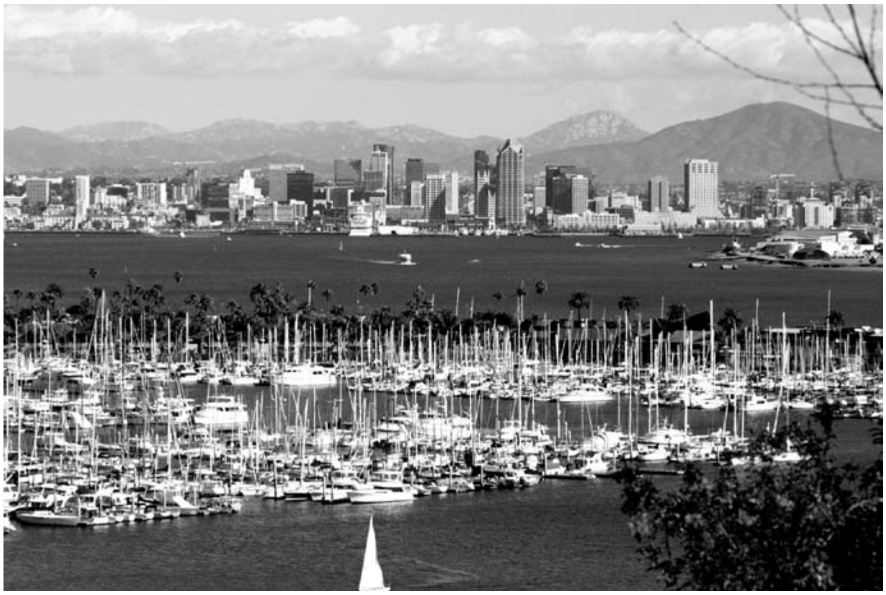
For more information, visit the site at http://www.mathmodels.org. COMAP's home site is at http://www.comap.com.

The San Jose Museum of Art
Photo courtesy of the San Jose Convention and Visitor's Bureau

MAA Contributed Paper Sessions
San Diego Joint Mathematics Meeting, January 6-9, 2008

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 a computer projector, an overhead projector, and at least one screen. Please note that the dates and times scheduled for these sessions remain tentative.



San Diego from Point Loma. Photograph of courtesy of the San Diego Convention and Visitors Bureau.

Preparing Faculty for Success in a Problem Solving and Technology Rich Curriculum

Sunday morning
Alex Heidenberg
United States Military Academy
Gerald Kobylski
United States Military Academy
Barbra Melendez
United States Military Academy
Rodney Sturdivant
United States Military Academy

Preparing faculty to teach in a problem solving and technology rich environment is becoming increasingly difficult. At the department level, we often spend time discussing new mathematical content with our faculty; however, most do not address pedagogical issues. Faculty might not often take time to reflect on teaching and learning.

This session invites presentations about faculty development programs that focus on preparing faculty, experienced and inexperienced, adjunct faculty, and/or teaching assistants to teach in a problem solving curriculum that leverages the use of technology. Of particular value will be presentations which inspire teacher and student creativity, gauge teacher effectiveness, programs that integrate new faculty into the department, and programs that prepare new faculty to teach mathematics. Each presentation should address the specific goals of their institutions' faculty development program and their techniques used to attain these goals.

Great Activities for an Introductory Statistics Class

Sunday morning
Patricia B. Humphrey, Georgia Southern University
Chris Lacke, Rowan University
Ginger Holmes-Rowell, Middle Tennessee State University

Learning activities can play an important role in teaching an introductory statistics class. For example, they can promote conceptual understanding, encourage active participation, and generate student interest. We invite submissions that provide details about learning activities that have proven successful in teaching introductory statistics courses. Activities described in this session could include hands-on data collection, simulations, and visual demonstrations that help exhibit important themes and concepts of statistics. Particularly, activities that can be used during the first few meetings of an introductory statistics course to attract the attention and interest of students, and to help the students overcome misconceptions and stereotypes about the course, would be valuable contributions to the session. Submissions of innovative and new activities that improve learning at any point in the course are also encouraged.

The session is sponsored by the SIGMAA on Statistics Education. In order to be considered for this session, applicants should submit a one page summary of the presentation to Pat Humphrey at phumphre@georgiasouthern.edu, along with the abstract to AMS. Presenters in the session will be considered for the SIGMAA on Statistics Education's Best Contributed Presentation Award.

Ethnomathematics and its Uses in Teaching

Sunday morning

Dorothee Blum
and Ximena Catepillan, Millersville University
Robert E. Jamison, Clemson University
Shemsi I. Alhaddad, University of South Carolina
Amy Shell-Gellasch, Pacific Lutheran University

This contributed papers session is sponsored by the History of Mathematics SIGMAA. We solicit talks that describe research in ethnomathematics or the mathematics and the mathematical sciences of non-western cultures, as well as talks that describe ways to use ethnomathematics in the classroom. Talks may present actual mathematical practices of other cultures or cultural endeavors such as art and architecture that reveal significant mathematical thinking. Presentations may be historical in nature or present current practices.

Using Ideas from Asian Mathematics in the Classroom

Sunday afternoon

Victor J. Katz, University of the District of Columbia
Kim Plofker, Brown University
Frank Swetz, Pennsylvania State University, Harrisburg

Historically, there was much mathematics developed in China, India, and the Islamic World in the time period from the beginning of our era through the fifteenth century. Although some of these mathematical ideas were transmitted to Europe during that same time period, many other Asian mathematical accomplishments were not translated into any European language until the nineteenth or twentieth century. But today, much of the corpus of Indian, Chinese, and Islamic mathematics is available in English translation. And given the increasingly multicultural makeup of our student bodies, it is important that college teachers be familiar with these ideas so that they can use them in their teaching. They will then not only understand that mathematical thinking has been a part of every literate culture of which we are aware, but also be able to communicate to their students the worldwide nature of mathematics and how its history plays a vital role in its current use and future development. We therefore solicit contributions which display the use of topics from the mathematics of China, India, and Islam in the undergraduate classroom. This session is sponsored by HOMSIGMAA.

Serving Students Who Have Taken Calculus in High School

Sunday afternoon

Ann Watkins, California State University, Northridge
Dan Teague, North Carolina School of Science
and Mathematics

The number of students taking calculus in high school is growing rapidly. Over 250,000 students took an AP Calculus exam last year and an almost equal number of students took calculus in high school but did not take an AP exam. Further, students are taking calculus earlier in high school—last year over 50,000 students who were not yet seniors took an AP Calculus exam. Thus both high schools and colleges now are seeing large numbers of students who have completed calculus. The MAA-NCTM Committee on Mutual Concerns invites contributed papers that describe ways that these students are being served, after they finish calculus, by high schools and colleges. We seek presentations from college or high school instructors that:

describe advanced courses or other alternatives offered by high schools,

explain modifications to freshman-level calculus courses, describe special courses for entering freshmen who have completed calculus in high school, or

offer data on what happens to these students in high school or once they enter college.

This session is sponsored by the MAA-NCTM Committee on Mutual Concerns.

The Power of Inductive and Recursive Thinking

Sunday afternoon

Bill Marion, Valparaiso University

Mathematics has sometimes been defined as the study of patterns. If this description is not unreasonable, then it is incumbent upon us as mathematics faculty to help students think inductively: observe patterns and make conjectures about what they have observed. In addition, for some problems that fit the inductive model a more elegant solution can be expressed in the form of a recursive description. Beyond conjecturing, we must help students to develop sound mathematical arguments that demonstrate the correctness of their conjectures. A variety of proof techniques are available, but one that has become ever more useful, especially in the discrete world, is the principle of mathematical induction.

This session solicits papers highlighting innovative strategies to improve students' ability to think inductively and see the world recursively. Hands-on activities, paper and pencil exercises, and computer lab exercises are welcome. Creative examples that help students understand when and why induction works and/or that give them practice in how to correctly use the technique in its variety of forms—weak, strong, and structural — are encouraged. These examples should go beyond or expand upon those usually found in traditional textbooks.

Philosophy of Mathematics

Monday morning

Kevin Iga, Pepperdine University
Bonnie Gold, Monmouth University

This session, sponsored by the SIGMAA for the Philosophy of Mathematics, invites papers on any topic in the interaction between mathematics and philosophy excluding formal logic/set theory. Possible topics include: the nature of mathematical objects, philosophical issues and controversies around the notion of mathematical proof and the development of mathematical knowledge, what characterizes mathematics as a discipline as distinct from other disciplines, the relation between mathematics and the physical world, the meaning of probability, the philosophical issues involving the interface between statistics and mathematics, or the role of esthetics in the development of mathematics. The papers that stem from some specific problems are encouraged, and so are the ones cutting across disciplines.

Demos and Strategies with Technology that Enhance Teaching and Learning Mathematics

Monday morning

David R. Hill, Temple University
Scott Greenleaf, University of New England
Mary L. Platt, Salem State College
Lila F. Roberts, Georgia College & State University

Mathematics instructors use an ever expanding variety of instructional strategies to teach mathematical concepts. As new technologies emerge instructors employ them in interesting ways as a means to boost creativity and flexibility in lesson design. Tools an instructor utilizes may include specialized computer applications, animations (possibly with audio), and other multimedia tools on standard delivery platforms or handheld devices.

This contributed paper session will focus on novel demos, projects, or labs that mathematics instructors have successfully used in their classrooms that support conceptual understanding. Presenters are encouraged to illustrate their approach with the technology, if time and equipment allow, and to discuss how it is employed in the classroom. Proposals should describe how the presentation with technology fits into a course, the affect it has had on student attitudes toward mathematics, and include a summary of any assessment techniques employed.

Topics and Techniques for Real Analysis

Monday morning

Erik Talvila, University College of the Fraser Valley
Robert Vallin, Slippery Rock University
James Peterson, Benedictine College

Real analysis is a core subject in the mathematics program. We need to keep the course relevant and we need to ensure that students are actually learning something in their real analysis courses. This session is about topics that we might like to add to real analysis courses and about how we can improve presentation of traditional and new topics.

College Algebra: Concepts, Data, and Models

Monday morning

Florence S. Gordon, New York Institute of Technology
Laurette Foster, Prairie View A&M University
Mary Robinson, University of New Mexico Valencia Campus
Yajun Yang, Farmingdale State College of New York

The MAA committee on Curriculum Renewal Across the First Two Years (CRAFTY), is conducting a national initiative to refocus the courses below calculus to better serve the majority of students taking these courses. The goal is to encourage courses that place much greater emphasis on conceptual understanding and realistic applications compared to traditional courses that too often are designed to develop algebraic skills needed for calculus. We seek to address all the college level courses below calculus, with particular emphasis on offerings in college algebra and precalculus that focus on conceptual understanding, the use of real-world data, and mathematical modeling. We seek presentations that:

present new visions for such courses,

discuss experiences teaching such courses,

discuss implementation issues (such as faculty training, placement, introduction of alternative tracks for different groups of students, transferability issues, etc),

present results of studies on student performance and tracking data in both traditional and new versions of these courses and in follow-up courses,

discuss the needs of other disciplines and the workplace from courses at this level,

discuss connections to the changing high school curricula and implications for teacher education.

This session is co-sponsored by CRAFTY and the Committee on Two Year Colleges (CTYC).

Mathematics and the Arts

Monday afternoon

Douglas E. Norton, Villanova University

This session invites presentations on connections between mathematics and the arts: from geometry in quatrains to group theory on quilts, from perspective in paintings to patterns and plane tilings, from composition to cartography, sewing to symmetries, tessellations to textual analysis, weaving fabrics to word fashioning, dance to decorative arts, theater and film to theorems on fractals, beadwork to baskets to batiks, architecture to applications of the arts in algebra.

We invite explorations of old and new connections, from ancient Islamic tilings to contemporary folk arts to manifolds and Klein bottles, as well as the use of new technologies to illustrate links between mathematics and the various arts. Mathematical concepts increasingly inform artistic presentation, while artistic presentation can often illuminate deep and interesting mathematics. New technologies often provide new tools for exploring these possibilities. Altogether, new approaches, new tools, and new looks at old examples provide new opportunities for working with and teaching mathematics, as well as providing modes of outreach to the general public about the often underappreciated place of mathematics in relation to the arts, culture, and society. This session is sponsored by the SIGMAA-ARTS.

Research and Professional Development Activities for Math Majors

Monday afternoon

Suzanne Lenhart, University of Tennessee
Mike O'Leary, Towson University
Margaret Robinson, Mt. Holyoke College

This session will feature a variety of activities that enrich the education of math majors beyond the usual curriculum. Talks about internships and research experiences would be included. Activities which help to educate the students about the spectrum of the mathematics community are also appropriate. The session is sponsored by MAA CUPM Subcommittee on Research by Undergraduates.

Curriculum Materials for Preservice Middle School Mathematics Teachers

Monday afternoon

Laurie Burton, Western Oregon University
Maria Fung, Western Oregon University
Klay Kruczek, Western Oregon University

This session invites papers describing curriculum materials, intended for publication and/or sharing with other institutions, designed specifically for the mathematical education of preservice middle school teachers. These materials should be significantly different than standard pure mathematics materials that cover the same topics. Papers contributed to this session should:

Focus on materials for a specific course.

Describe the table of contents of the materials and how this syllabus was chosen and designed.

Describe the content and structure of the materials and give central examples.

Describe how the authors envision the materials should be used in the classroom and other pertinent pedagogical information.

Describe the placement of the materials in an effective program for preservice middle school teachers (foundational, special topic, capstone, etc.).

Describe student support materials (if any).

Describe instructor support materials (if any).

Describe progress towards completion and dissemination of materials.

Course materials designed for in-service middle school teachers may also be considered. This session is sponsored by the Committee on the Mathematical Education of Teachers (COMET).

Assessment of Student Learning in Undergraduate Mathematics

Monday afternoon

William Martin, North Dakota State University
Bernie Madison, University of Arkansas
Kimberly Vincent, Washington State University
Maura Mast, University of Massachusetts-Boston

Assessment continues to be an important issue for the mathematical sciences, with increasing faculty involvement in assessment activities. Departments are expected to document assessment activities focusing on student learning in general education, the major, and graduate programs for program review and institutional accreditation.

Project SAUM and the SIGMAA-QL encourage faculty to disseminate information about their experiences by inviting contributed papers that (a) describe assessment projects on student learning in undergraduate mathematical sciences programs, including the areas of quantitative literacy, general education, and the major; (b) report findings of those projects; and (c) describe faculty and departmental responses to those findings.

Papers are solicited from any individuals or groups actively involved in assessment of student learning and are not restricted to members of the SIGMAA-QL or participants of Project SAUM workshops. The SIGMAA-QL and Project SAUM are sponsors of this event.

Mathematics Experiences in Business, Industry and Government

Tuesday morning

Phil Gustafson, Mesa State College
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).

Innovative and Effective Ways to Teach Linear Algebra

Tuesday morning
David Strong, Pepperdine University
Gil Strang, Massachusetts Institute of Technology

Linear algebra is one of the most interesting and useful areas of mathematics, because of its beautiful and multifaceted theory, as well as the enormous importance it plays in understanding and solving many real world problems. Consequently, many valuable and creative ways to teach its rich theory and its many applications are continually being developed and refined. This session will serve as a forum in which to share and discuss new or improved teaching ideas and approaches. These innovative and effective ways to teach linear algebra include, but are not necessarily limited to:

- hands-on, in-class demos;
- effective use of technology, such as *Matlab*, *Maple*, *Mathematica*, *Java Applets* or *Flash*;
- interesting and enlightening connections between ideas that arise in linear algebra and ideas in other mathematical branches;
- interesting and compelling examples and problems involving particular ideas being taught;
- comparing and contrasting visual (geometric) and more abstract (algebraic) explanations of specific ideas;
- other novel and useful approaches or pedagogical tools.

Presenters should discuss their own experience in using their presented idea or approach in their own teaching.

Countering "I Can't Do Math": Strategies for Teaching Under-Prepared Math-Anxious Students Interested in Business and the Sciences

Tuesday morning
Kimberly J. Presser and J. Winston Crawley
Shippensburg University

How can we create a comfortable learning environment for under-prepared or math-anxious students? One option many schools have chosen is to create general education mathematics courses which expose students to new and different types of mathematics. These liberal arts mathematics courses have been very effective in changing student attitudes about math and are effective options for students in majors that are not mathematically intensive. However, for students with math anxiety issues who are interested in math intensive majors such as business or science, remediation programs or courses need to prepare them for a whole series of mathematics courses, which include calculus. What remediation programs or courses are effective for preparing math-anxious students to succeed in math intensive majors? What classroom practices are effective with such students and how does research in student learning inform these practices? This session invites papers on all aspects of "what works" in teaching under-prepared, math-anxious students with majors that require a significant amount of mathematics.

Biomathematics in the Undergraduate Curriculum

Tuesday afternoon
Timothy D. Comar, Benedictine University
Lisa Townsley, Benedictine University
Glenn Ledder, University of Nebraska
Olcay Akman, Illinois State University

Reports including *BIO 2010: Transforming Undergraduate Education for Future Research Biologists* (National Research Council, 2003) and *Math and BIO 2010: Linking Undergraduate Disciplines* (L. A. Steen, ed., MAA, 2005) emphasize that aspects of biological research are becoming more quantitative and that life science students should be introduced to a greater array of mathematical and computational techniques and to the integration of mathematics and biological content at the undergraduate level.

This session is designed to highlight successful implementations of biomathematics courses for life science students in the undergraduate curriculum, course projects for biomathematics courses, recruitment of students into biomathematics courses, involvement of these students in biomathematics research, preparation for graduate work in biomathematics and computational biology, and assessment of how these courses and activities impact the students.

Topics may include the issues related to the design of effective biomathematics courses for life science students; integration of biology into existing mathematics courses; collaborations between mathematicians and biologists that have led to new courses, course modules, or undergraduate research projects; collaborations between two-year and four-year institutions; effective use of technology in biomathematics courses; and assessment issues. We encourage submissions from teams of mathematicians and biologists. This session is sponsored by the BIO SIGMAA.

Cryptology for Undergraduates

Tuesday afternoon
Chris Christensen, Northern Kentucky University
Robert Edward Lewand, Goucher College

In increasing numbers, cryptology courses are being developed to serve the needs of undergraduate mathematics and computer science majors. For mathematics majors, cryptology fits into the undergraduate curriculum in much the same way that number theory does. In addition, cryptology is appearing as a topic in mathematics courses for non-majors, as it is a hook to interest these students in mathematics. This contributed paper session solicits presentations that address topics appropriate for undergraduate cryptology courses for mathematics or computer science majors, or presentations of cryptological topics that could interest and motivate non-mathematics majors.

Guided Discovery in Mathematics Education

Tuesday afternoon
Jerome Epstein, Polytechnic University
Chris Rasmussen, San Diego State University

There is strong research evidence in many fields, particularly mathematics and physics, that non-lecture based approaches to teaching are more effective in providing conceptual understanding of the subject. NSF currently supports extensively new curricula, validation, and research in this area. Physics has extensive published research on the efficacy of such programs. Mathematics education has been much slower to embrace this movement, rightly or wrongly. This session presents papers on work in this area, emphasizing reports with serious evidence, positive or negative, going beyond anecdotal. Sharing information on development and evaluation of such programs can provide a strong spur to further progress.

Contributed papers are solicited from programs that have developed serious evidence of the validity of their evaluations and the efficacy of their programs at all levels of mathematics. Mathematics clearly needs much more hard data available to judge the efficacy of such programs and to point the way to real improvements. This has dramatically been the case in physics. This session is co-sponsored by SIGMAA on RUME and the session organizer.

Building Diversity in Advanced Mathematics: Models that Work

Wednesday morning
Abbe Herzig
State University of New York at Albany
Patricia Hale
California State Polytechnic University, Pomona

Papers presented at this session give models of programs that have been successful at supporting diverse groups of people (women of all races, African Americans, Latinos, and Chicanos, and Native Americans) in their pursuit of advanced mathematics study and careers. Presentations will span the educational pathway, since issues of diversity need to be addressed at every educational and professional juncture.

Proposals are sought that 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.

The session is co-sponsored by the MAA Committee on the Participation of Women, the MAA Committee on the Participation of Minorities, and the AMS-ASA-AWM-IMS-MAA-NCTM-SIAM Joint Committee on Women.

Using Innovative Technologies to Implement Active Learning in Mathematics (and in other STEM disciplines)

Wednesday morning
Marilyn Reba, Clemson University
Beth Simon, University of California, San Diego

Innovative technologies — tablet PCs, wacom boards, smartboards, sympodiums, clickers, projectors, and classroom interaction software — are being used to implement active learning in mathematics and other STEM disciplines. These technologies support instructors, individual students, or teams of students in various ways. For example, "digital ink" can be used to "hand write" solutions – avoiding equation editors and supporting in-class graph sketching. But the digital nature of this ink supports solutions that can be projected, discussed, annotated, and saved. Some systems support electronic, simultaneous participation by students, allowing instructors to gauge student understanding while maintaining the pace of the course. By integrating with electronic projection of lecture materials, instructors can project and discuss student work--sometimes anonymously.

This session invites reports on creative uses of this technology in the classroom to support active learning — spanning various technologies, whether you use public-domain or commercial classroom interaction software or none at all, whether you move the equipment in and out of different classrooms or anchor it in one, and whether you teach in mathematics or another STEM discipline. Our goal is to demonstrate how these technologies can improve the teaching and learning of mathematics, for example, by assisting in the demonstration of difficult concepts, by providing new ways for students to participate (even anonymously) in class, and by redefining active learning in both small and large enrolment courses.

Crossing the "Bridge to Higher Mathematics:" What Works and Why

Wednesday morning
George J. Davis, Georgia State University

It has been recognized that students can have a difficult time progressing from the calculus sequence to more advanced theoretical courses in algebra and analysis. A number of courses have been created to help bridge the gap. With titles similar to "Bridge to Higher Mathematics," "Transition to Higher Mathematics" or "Mathematical Reasoning," the intention is to give students an introduction to thinking about mathematics at a higher level. Most faculty agree that the object of such a course should be to instill the idea of proof. There is far less agreement on exactly how the sense of proof should be developed, and what content areas should be chosen for illustration. It is the purpose of this session to bring together faculty who have experience with such a course to discuss what works for their students and why.

A typical presentation would begin with a brief sketch of the speaker's student population, followed by a description of their particular course. Emphasis should be given to exactly why the course was designed the way it was, how it is working, and whether or not changes are planned. Presenters are strongly encouraged to provide data to support their claims of success.

Mathlets and Web Resources for Mathematics and Statistics Education

Wednesday afternoon
Thomas E. Leathrum, Jacksonville State University
Patricia Humphrey, Georgia Southern University
Chris Lacke, Rowan University
David Strong Pepperdine University
Joe Yanik, Emporia State University

This session seeks to provide a forum in which presenters may demonstrate mathlets, activities, and related materials they have created, further developed, and/or successfully used in mathematics or statistics classes. 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 concepts in mathematics and statistics, and they can be easily shared by instructors around the world.

We invite submissions that detail the following about one or more items found on, or developed for, the World Wide Web: what it is, what resources are required (for students, instructors, or developers), how it can be used in a classroom, time involved (in and out of class), success or failure in terms of pedagogical intent, assessment methods and issues, and suggestions for improvement. Presenters should provide a web address where the materials can be found.

The session is jointly sponsored by the SIGMAA on Statistics Education and MAA CTiME (Committee on Technology in Math Education). Presentations related to statistics will be considered for the SIGMAA on Statistics Education's Best Contributed Presentation Award — presenters wanting to be considered for the award should also send a one-page summary of their presentation to Patricia Humphrey, phumphre@georgiasouthern.edu, by the abstracts deadline.

Research on the Teaching and Learning of Undergraduate Mathematics

Wednesday afternoon
David Meel, Bowling Green State University
Michelle Zandieh, Arizona State University
Chris Rasmussen, San Diego 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.

General Session

Sunday, Monday, Tuesday, and Wednesday mornings and afternoons
Sarah Mabrouk, Framingham 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) who will automatically receive a copy from the AMS). Please read the session descriptions thoroughly as some organizers require an additional summary of your proposal be sent to them directly. 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. Abstracts must reach the AMS by Tuesday, September 20, 2007.

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 select the San Diego meeting, fill in the number of authors, and proceed with the step-by-step instructions. 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

NEW YORK

Niagara University
www.niagara.edu
The Mathematics Department at Niagara University, a private Catholic institution sponsored by the Vincentian Community seeks an Assistant Professor, tenure track, August 2008 start.

Requirements: Strong commitment to undergraduate teaching, ability to do scholarly research, Ph.D. in Statistics or related field.

Applications from candidates interested in working with students outside of the classroom including student research are particularly welcome.

Applicants must have strong teaching credentials and ability to teach a variety of undergraduate classes in statistics and mathematics; Ability to maintain research in the field.

Located near scenic Niagara Falls, Niagara University is a predominantly undergraduate liberal arts university.

Application letter, vitae and three recommendation letters: Dr. Richard Cramer-Benjamin, Chairperson, Mathematics Department, Niagara University, NY 14109-2044. Applications review begins November 1st. AA/EOE. http://www.niagara.edu/hr.

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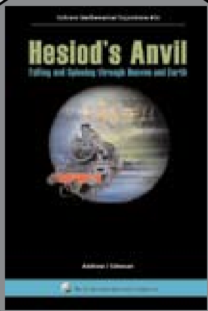
Hesiod's Anvil: Falling & Spinning Through Heaven & Earlth



Andrew J. Simoson

This book is about how poets, philosophers, storytellers, and scientists have described motion, beginning with Hesiod, a contemporary of Homer, who imagined that the expanse of heaven and the depth of hell was the distance that an anvil falls in nine days. It is aimed at students who have finished a year-long courses in calculus, but can be used as a supplemental text in calculus II, vector calculus, linear algebra, differential equations, and modeling. It blends with equal voice romantic whimsy and derived equations, and anyone interested in mathematics will find new and surprising ideas about motion and the people who thought about it.

Some of the things readers will learn is that Dante's implicit model of the earth implies a black hole at its core, that Edmond Halley championed a hollow earth, and that Da Vinci knew that the acceleration due to the earth's gravity was a constant. There are chapters modeling Jules Verne's and H.G. Wells' imaginative flights to the moon and back, the former novelist using a great cannon and the latter using a gravity-shielding material. The book analyzes Edgar Alan Poe's descending pendulum, H.G. Wells' submersible falling and rising in the Marianas Trench, a train rolling along a tunnel through a rotating earth, and a pebble falling down a hole without resistance. It compares trajectories of balls thrown on the Little Prince's asteroid and on Arthur C. Clarke's rotating space station, and it solves an old problem that was perhaps inspired by one of the seven wonders of the ancient world.

Dolciani • Catalog Code: DOL-30 • 250 pp., Hardbound, 2007 • ISBN 13: 978-0-88385-336-8
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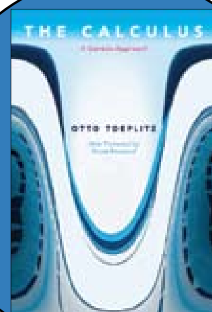
The Calculus: A Genetic Approach

Otto Toeplitz • *With a new Foreword by David Bressoud*



Published jointly with the University of Chicago Press

Reissued for the first time since 1981 and updated with a new foreword, this classic text in the field of mathematics is experiencing a resurgence of interest among students and educators of calculus today.

When first published posthumously in 1963, **The Calculus: A Genetic Approach** radically altered how the subject was introduced to students and inspired a revolution in how it was taught. In sharp contrast to the methods of his time, Otto Toeplitz did not teach calculus as a static system of techniques and facts to be memorized. Instead, he drew on his knowledge of the history of mathematics and presented calculus as an organic evolution of ideas beginning with the discoveries of Greek scholars, such as Archimedes, Pythagoras, and Euclid, and developing through the centuries in the work of Kepler, Galileo, Fermat, Newton, and Leibniz. Through this unique approach, Toeplitz summarized and elucidated the major mathematical advances that contributed to modern calculus.

Classroom Resource Materials • Catalog Code: CGA • 194 pp., Paperbound, 2007 • ISBN: 978-0-226-80668-6
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