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**Editor:** Fernando Gouvêa, Colby College; fqgouvea@colby.edu

**Managing Editor:** Carol Baxter, MAA cbaxter@maa.org

**Senior Writer:** Harry Waldman, MAA hwaldman@maa.org

**Please address advertising inquiries to:** Doris Griffin; ads@catalystcom.com

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Letters to the editor should be addressed to Fernando Gouvêa, Colby College, Dept. of Mathematics, Waterville, ME 04901 or by email to fqgouvea@colby.edu.

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# FOCUS

## August/September 2001

Volume 21, Number 6

## *Inside*



*On the cover: Gary Gordon and Liz McMahon's garage doors are painted according to a mathematical scheme. See page 4 for the article.*

### FOCUS Deadlines

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| Editorial Copy | September 14 | October 14 | November 15 |
| Display Ads | September 24 | October 29 | November 26 |
| Employment Ads | September 24 | October 29 | November 26 |

# USA Mathematical Olympiad Team Ties Russian Team for Second Place

The 2001 USA Mathematical Olympiad team, composed of six gifted young mathematicians, faced off in the International Mathematical Olympiad (IMO) against the best high-school students from 82 counties and came in second to the team from China.

*The US IMO team pictured here with Titu Andreescu, Director of the American Mathematics Competitions. Left to right: Dong Shin, Gabriel Carroll, Reid Barton, Tiankai Liu, Oaz Nir and Ian Le. Photograph courtesy of the Clay Mathematics Institute.*

Mathematical Olympiad teams of the USA have done very well in International Mathematical Olympiad competitions since first entering in 1974. In twenty-seven years of competition, USA teams have won three times and finished in the top five twenty-two times. In 1994, all six members of the USA team achieved perfect scores, an unprecedented accomplishment by any other team.

During the first two weeks of July at George Mason University, 475 high-school students from 83 countries competed in the International Mathematical Olympiad. The students were allotted nine hours to solve six difficult problems that are regarded as challenging by most professional mathematicians. As evidence of the difficulty of the IMO problems, only four of the 475 students received perfect scores, Reid Barton and Gabriel Carroll of the USA and Liang Xiao and Zhiqiang Zhang of China.

Barton, a member of four USA Mathematical Olympiad teams, distinguished himself by becoming the first IMO contestant to win four gold medals. In addition to Barton and Carroll, Ian Le and Tiankai Liu of the USA also won gold medals. Oaz Nir and Dong Shin, the other two members of the USA team, won silver medals.

The USA team is selected through a sequence of three examinations of the American Mathematics Competitions, an official program of the Mathematical Association of America presented by the Akamai Foundation. The first exam is taken by more than 350,000 students. The USA Mathematical Olympiad, the last of the exams, involves only 180 students.

*Andrew Wiles speaking at the closing ceremonies of the International Mathematical Olympiad. Photograph courtesy of the Clay Mathematics Institute.*

The twelve students with the highest scores are named winners of the USA Mathematical Olympiad and they are honored at ceremonies held in Washington, DC hosted by the Mathematical Association of America, the National Academy of Sciences, the National Science Foundation, and the US Department of State. The top six performers make up the USA Mathematical Olympiad Team and represent the United States at the IMO. "We are very proud of their achievement," said Titu Andreescu, head coach of the US Team. "It is the result of many years of hard work . All the students and the coaching staff gave their best, and we can see the results. Congratulations to them all."

IMO participants were treated to several gala events, including the Opening Ceremonies on July 4 presented by the Akamai Foundation, and Closing Ceremonies at the Kennedy Center and a lavish dinner at the National Building Museum, both presented by the Clay Mathematics Institute.

The Akamai Foundation was the presenting sponsor of the IMO 2001 USA, with the National Science Foundation, U.S. Department of Education, Wolfram Research, Texas Instruments, and the National Security Agency all as title sponsors. The Clay Mathematics Institute was asked in May 2000 to participate as a partner by planning and executing the closing ceremonies in conjunction with their annual meeting. The University of Nebraska-Lincoln and George Mason University were academic sponsors.

For additional details on participants, results, problems, photos, and history of the International Mathematical Olympiad, go to the following web sites: http://www.maa.org, http://imo.wolfram.com, http://www.claymath.org/events/olympiadevent.htm, and http://www.imo2001.org/. ■

# Orthogonal Latin Garage Doors

*By Gary Gordon and Liz McMahon*

When we moved into our new house in the fall of 1986, the roof was gray, the siding was gray and the two garage doors were white. In addition, the weather in Easton, Pennsylvania is frequently gray, at least during the winter. The four of us (two mathematicians and our two daughters) came to the same conclusion: the exterior of our house needed something colorful to cheer up the neighborhood.

## The Project

The two wooden garage doors are constructed in horizontal sections, with four sections making up a door. Each section has four raised rectangular panels, so each door has 16 panels arranged in a 4 x 4 grid. The doors need to be painted every few years, so we soon hit on an obvious solution to our gray lives: Paint the doors some color that wasn't white.

We talked about the particulars of such a painting project and came up with a few constraints. First, do something mathematical. Since both adults in the house are mathematicians and we frequently have students over for various activities, this seemed important. Second, don't do something that would completely alienate us from our neighbors. We were reasonably sure painting rectangles on the doors solid colors would keep us within the bounds of semi-normal neighborhood behavior. Third, do something colorful. This was the motivation for the project to begin with. Finally, choose colors that we could live with for a long time. We also needed the colors to be easy to distinguish.

## The Math

We decided to paint the panels of the doors to make a pair of 4 x 4 orthogonal Latin squares. A *Latin square* is an $n$ x $n$ array, where each member of the array is one of the numbers from 1 to $n$, so that each number between 1 and $n$ appears exactly once in each row and each column. Two $n$ x $n$ Latin squares are *orthogonal* if, when you superimpose one array on the other to obtain ordered pairs, each one of the $n^2$ possible ordered pairs appears precisely once. (To see these ordered pairs clearly, superimpose one array on the other and then slide one of the arrays a bit to the left.)

Latin squares are important in all sorts of applications in experimental design, geometry and graph theory, and they arise naturally as group multiplication tables. The subject of Latin squares is more than 200 years old; amateurs attempting to design whist tournaments did much of the early development. Almost any text on combinatorics treats this topic; in fact, a pair of orthogonal 4 x 4 Latin squares decorates the cover of van Lint and Wilson's interesting text *A Course in Combinatorics*. It is possible to find a pair of $n$ x $n$ orthogonal Latin squares for every $n$ except 2 and 6. Euler conjectured that no orthogonal Latin squares exist when $n$ is congruent to 2 mod 4, but in 1959, this conjecture was disproved when a pair of 10 x 10 orthogonal Latin squares was found at the University of North Carolina by Parker, Bose and Shrikhande. A nice, short introduction to the topic can be found at http://buzzard.ups.edu/squares.html. The field remains an active area of research, with many interesting open problems waiting for new approaches.

For our purposes, we needed a pair of orthogonal 4 x 4 Latin squares. Algorithms exist for finding orthogonal pairs of Latin squares using projective planes, but, because we wanted one of the doors to have nice symmetry, we used trial and error. We first tried the square below, but unfortunately, we showed that no other Latin square is orthogonal to it.

| | | | |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 2 | 3 | 4 | 1 |
| 3 | 4 | 1 | 2 |
| 4 | 1 | 2 | 3 |

Then we tried a more symmetric square, pictured on the left below. Trial and error produced a square orthogonal to it. (Although it is always possible to relabel the squares so that the first row in each square is 1, 2, 3, 4, we liked the two squares given below better.)

| | | | |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 2 | 1 | 4 | 3 |
| 3 | 4 | 1 | 2 |
| 4 | 3 | 2 | 1 |

| | | | |
|---|---|---|---|
| 1 | 3 | 4 | 2 |
| 4 | 2 | 1 | 3 |
| 2 | 4 | 3 | 1 |
| 3 | 1 | 2 | 4 |

It is not hard to show that there can be at most three pairwise orthogonal 4 x 4 Latin squares, and, in general, at most $n$-1 pairwise orthogonal $n$ x $n$ Latin squares. This maximum number is achieved whenever there is a projective plane of order $n$. All known projective planes have order $n = pk$ for some prime $p$ and some integer $k \geq 1$, so these are the only values of $n$ where the full complement of orthogonal squares is known to exist. Since we only have a two-car garage, our work was done. Is there a third Latin square that is orthogonal to the two given above? Find it!

## The Paint

We were now ready to plan the painting. Rebecca and Hannah (our daughters) felt very strongly about the colors they liked and the color combinations they would not allow. This restriction banished any oranges or yellows. Also, the colors had to look good together, and not be too different (this restriction banned blue and red as two of the colors). Rebecca's favorite color was teal and purple was Hannah's favorite, so those two colors were in. Then we took a short trip to our local hardware store and made final choices for the remaining colors, staying on the blue side

of the spectrum. Our helpful salesman mixed the paints after feigning interest in a short lecture in combinatorics.

When the time came to paint, each of us was responsible for painting their favorite color. The correspondence between number and color (and painter) was

| | |
|---|---|
| Purple | Hannah |
| Light Blue | Liz, who calls it Carolina blue |
| Dark Blue | Gary |
| Teal | Rebecca |

The painting took two days, including a primer and two coats for most of the colors. We applied masking tape to each bounding edge of each rectangle (a non-trivial task, as there are 128 such edges on the two doors). The hardest part of the project was applying and removing this tape from the doors; Rebecca and Hannah were less interested in this part.

The Reactions

We love our doors! More fun has been the reaction of other people, which has been almost uniformly positive. (On the other hand, would you approach a stranger and tell them their garage doors are hideous?)

The reactions to the project began while we were painting. One neighbor stopped by and asked "What are you doing?" We gave a fairly short explanation, and he seemed satisfied and allowed that it seemed a good family project. A passing driver slowed down long enough to shout "My daughter thinks it's the coolest!" and a British neighbor said "Actually, it's rather neat," (read this with a British accent). An artist (who was selling us a car) got out his sketchbook to write the patterns down.

People understand the Latin square property quickly; it's easy to see that each color appears once in each row and column on each door. It's harder to explain orthogonality; we tell them to focus on the positions of the purple rectangles (for example) on one door and to find the corresponding positions on the other door. They can see that all four colors appear in these corresponding positions on the second door. Then they can check that this property holds for the other three colors, if they want, or they can take our word for it.

*Another view of the orthogonal Latin garage doors.*

Most people who study the doors find the symmetry on the left door. There is also symmetry on the right door, but it's harder to see. Sarah McMahon (a historian at Bowdoin College, and the sister and sister-in-law of the authors) realized that the positions of each individual color on the right door are the same up to rotation, reflection or both rotation and reflection. She was very excited when she discovered that pattern.

Teenagers like the doors; most comments are on the order of "They're really cool!" or "I think they're funky." Our favorite reaction was last Halloween, though. A trick-or-treating teen said, "Your garage doors are really nice. I heard there is a mathematical pattern to them." Maybe next year we'll pass out reprints instead of candy.

The Moral

Neighbors are surprisingly tolerant of mathematical home improvement. Without painting numbers, equations or theorems, we helped spice up the street and we also made it much easier to give directions to our house: "look for the colorful garage doors." One of us offers a prize for anyone (excluding mathematicians) who can figure out the pattern; no one has claimed it yet. We are certainly not the only mathematicians who have decorated their house in a mathematical theme, but we are fairly certain that we are the only ones on our block.

There are other possible themes we (or you) could explore. We could mow crop circles in our lawn, or paint the Fano configuration on the front door. Finally, all of us can all find inspiration in the ideas of the mathematician Carl Frederick Gauss. The great Gauss once suggested the following enormous project: By cutting down a massive number of trees in Siberia, he hoped to give the largest proof ever of the Pythagorean Theorem. The goal of such a project was also to impress the neighbors, but on a grand scale. Presumably, such a figure would be visible to extraterrestrials, who would then assume that intelligent life existed on Earth. We have no plans to undertake this project. ■

*Liz McMahon (mcmahone@lafayette.edu) and Gary Gordon (gordong@lafayette.edu) teach at Lafayette College and live in an easy to recognize house in Easton, PA. Their research interests include combinatorics, algebra and geometry, and their teaching includes courses outside of the mathematics curriculum. They have plenty of non-mathematical interests, including biking and indoor rock climbing with their daughters Rebecca and Hannah. They are also involved in Lafayette's REU program in mathematics, to which they invite the applications of interested undergraduates.*

## Duke University Featured in MAA Exhibit for Congress

Each year, the Council on National Science Funding (CNSF) sponsors an exhibition and reception that showcases research projects supported by the National Science Foundation. This past spring, 30 booths displayed a wide range of scientific research and education projects, and university researchers and educators were on hand to describe their work to interested members of Congress and their staffs. In the past exhibits focused mostly on basic research, but now they are balanced between research and education.

*Pictured left to right: Jennifer Baucom, Elena Strauss, Milena Mihaylova, Congressman David Price and David Smith.*

This year, the MAA, a member of CNSF, showcased three educational projects being carried out by faculty at Duke University. One of these projects is Duke University's *Post CALC Project*, which is developing online mathematics materials for high school students who have finished a year of calculus but still have time left in their high school careers. The materials feature a wide range of applications of mathematics, from the modeling of musical sounds to the spread of epidemics. Materials available at the table also described MathDL, the MAA Mathematical Sciences Digital Library project, and other curriculum materials being developed at Duke.

Presenting at this year's exhibit were Lang Moore, David Smith, and Jim Tomberg, all mathematics faculty at Duke University and PIs of the featured projects. The booth featured three students from East Chapel Hill High School, in Chapel Hill, NC, Jennifer Baucom, Elena Strauss, and Milena Mihaylova, who had used materials in an Advanced Math Topics course taught by Tomberg. Preceding the exhibit, the Duke faculty, high school students and MAA Executive Director, Tina Straley visited with members of Congress and their staff persons to tell them about the Duke projects and the importance of NSF funding. The MAA/Duke exhibit proved to be very popular. Many Representatives, Senators, and staff persons stopped by specifically to visit it. The young people were a big hit and were instrumental in bringing people to the MAA table, and they did a great job of explaining the project. ■

## National Academy Elects 72 New Members, Including Six Mathematicians

The National Academy of Sciences (NAS) announced in May the election of 72 new members of the Academy. The size of this year's class, 20% larger than in the past, reflects, according to NAS Home Secretary Stephen Berry, "the changing nature of science and the birth of new areas." Six new sections have been added to the NAS's existing 25: computational biology, computer and information science, environmental sciences, human ecology, immunology, and systems neurobiology. The NAS expects to elect 72 members every year for the next 6 years.

This year's class includes six mathematicians: Leo Breiman (Statistics, U. C. Berkeley, Emeritus), Robion C. Kirby (Mathematics, U. C. Berkeley), Gregory A. Margulis (Mathematics, Yale), Donald G. Saari (Economics and Mathematics, U. C. Irvine), Leslie G. Valiant (Computer Science and Applied Mathematics, Harvard), and Efim I. Zelmanov (Mathematics, Yale). The Academy also elected several Foreign Associates, including Jacob Palis of the Instituto de Matemática Pura e Aplicada in Rio de Janeiro, Brazil.

## ICMI Study on Teaching and Learning of Mathematics at the University Level Featured in Special Journal Issue

The International Commission on Mathematical Instruction recently sponsored an ICMI Study on the "Teaching and Learning of Mathematics at the University Level." In addition to a book that is forthcoming from Kluwer Academic Press, the study produced several interesting research papers. These have been collected in a special issue (January-February 2000, volume 31, number 1) of the *International Journal of Mathematical Education in Science and Technology*. The papers deal with a wide range of issues, from "Redesigning the Calculus Sequence at a Research University: Issues, Implementation, and Objectives" to "A Metacognitive Intervention in Mathematics at University Level." Past ICMI Studies have dealt with many issues in mathematics education, such as assessment (1993), gender equity (1996), the role of the history of mathematics (1999), and teaching geometry (1998). ICMI's forthcoming (twelfth) Study, on "The Future of the Teaching and Learning of Algebra," was the subject of an article in the December 2000 issue of FOCUS. ■

# MAA Writing Prizes Announced at MathFest 2001

**Carl B. Allendoerfer Awards**

James N. Brawner
"Dinner, Dancing, and Tennis, Anyone?"
*Mathematics Magazine*, Vol. 73, No.1 February 2000, 29-36.

Rafe Jones and Jan Pearce
"A Postmodern View of Fractions and the Reciprocals of Fermat Primes"
*Mathematics Magazine*, Vol. 73 No. 2, April 2000, 83-97.

The Carl B. Allendoerfer Awards, established in 1976, are made to authors of expository articles published in *Mathematics Magazine*. The awards are named for Carl B. Allendoerfer, a distinguished mathematician at the University of Washington and President of the Mathematical Association of America, 1959–60.

**Trevor Evans Awards**

Ira Rosenholtz
"One Point Determines a Line"
*Math Horizons*, November 2000, Volume 8, No. 4 pp. 20–24.

James Tanton
"A Dozen Areal Maneuvers"
*Math Horizons*, Volume 8, No. 3 September 2000, pp. 26-30, 34

The Trevor Evans Awards, established by the Board of Governors in 1992 and first awarded in 1996, are made to authors of expository articles accessible to undergraduates and published in *Math Horizons*. The awards are named for Trevor Evans, a distinguished mathematician, teacher, and writer at Emory University.

**Lester R. Ford Awards**

Keith Kendig
"Is a 2000-year-old Formula Still Keeping Some Secrets?"
*American Mathematical Monthly* Vol. 107, No. 5, May 2000, pp. 402-415.

E.R. Scheinerman
"When Close is Close Enough"
*American Mathematical Monthly* Vol. 107, No. 6, June–July 2000 pp. 489-499.

The Lester R. Ford Awards, established in 1964, are made to authors of expository articles published in the *American Mathematical Monthly*. The awards are named for Lester R. Ford, Sr., a distinguished mathematician, editor of the *American Mathematical Monthly*, 1942-46, and President of the Mathematical Association of America, 1947-48.

**George Pólya Awards**

Chip Ross and Jody Sorenson
"Will the Real Bifurcation Diagram Please Stand Up!"
*College Mathematics Journal*, Vol. 31 No. 1, January 2000, pp. 2-14.

Ezra Brown
"Three Fermat Trails to Elliptic Curves"
*College Mathematics Journal*, Vol. 31 No. 3, May 2000, pp. 162-172.

The George Pólya Awards, established in 1976, are made to authors of expository articles published in the *College Mathematics Journal*. The awards are named for George Pólya, a distinguished mathematician, well-known author, and professor at Stanford University.

**Merten M. Hasse Prize**

Francis Edward Su
"Rental Harmony: Sperner's Lemma in Fair Division"
*American Mathematical Monthly* Vol. 106, No. 10, December 1999 pp. 930–942.

The Merten M. Hasse Prize, established in 1986, honors a noteworthy expository paper appearing in an Association publication, at least one of whose authors is a younger mathematician. The prize is named after Merten M. Hasse, an inspiring and dedicated teacher, and aims to encourage younger mathematicians to take up the challenge of exposition and communication.

For citations, biographical sketches of the prize winners, and responses, see online at http://www.maa.org/news/mfawards01.html. ■

# *Proof* wins Pulitzer and several Tony Awards

David Auburn's play *Proof*, which was reviewed a year ago in FOCUS (August/September 2000, p. 8), has won the Pulitzer Prize and several Tony Awards. The play, which had a successful run off-Broadway early last year and then moved on to an even more successful run at the Walter Kerr Theater on Broadway, is a dramatic mystery about the daughter of a brilliant but unstable mathematician.

The play received the 2001 Pulitzer Prize for Drama, and shortly afterwards received Tony Awards for Best Play, Best Actress (Mary Louise Parker), and Best Director (Daniel Sullivan). For more about the play, check out its web page at http://www.proofonbroadway.com/. ■

## Have You Moved?

The MAA makes it easy to change your address. Please inform the MAA Service Center about your change of address by using the electronic combined membership list at MAA Online (www.maa.org) or call (800) 331-1622, fax (301) 206-9789, email: maaservice@maa.org, or mail to MAA, PO Box 90973, Washington, DC 20090.

# Four Forums Will Address Mathematics at the School/College Transition

Over the next six months, four national forums will address issues in precalculus mathematics, including arguments that significant reforms are needed in school and college mathematics. The forums will focus on three major topic areas: quantitative literacy, college algebra, and preparation for calculus. Since mathematics in these areas is taught in both school and college, articulation issues will be part of all the discussions.

Among the motivations for holding these meetings are the changes in school mathematics prompted by the NCTM Standards and the impact of technology. Three of the four forums are invitational events, but the proceedings of each of these will be published, and all four forums are designed to initiate a broader discussion within the collegiate mathematics community.

**Preparation for Calculus**

Chronologically, the first forum is "Rethinking the Preparation for Calculus." It will be held October 4–6 at the offices of the National Science Foundation (NSF) in Arlington, Virginia. Approximately fifty participants will be invited to this NSF-supported workshop which is being organized by a Steering Committee chaired by Jack Narayan of SUNY at Oswego. The purpose of the workshop is to rethink the preparation for calculus given that: (1) school mathematics has changed in response to the NCTM Standards; (2) college expectations have changed; (3) technology is providing tools for teaching and learning; and (4) college algebra courses are changing.

The workshop aims to develop some principles for reforming precalculus courses and to provide cohesion for individual reform projects in order to have a larger impact on the mathematics community. Problems and needs will be identified to give funding agencies direction. The workshop proceedings will be compiled and submitted for publication as a volume in the **MAA Notes** series.

Lynn Steen (former MAA President) of St. Olaf College will keynote "Rethinking the Preparation for Calculus." In addition to Narayan, members of the Steering Committee are Nancy Baxter-Hastings (Dickinson College), Steve Dunbar (University of Nebraska), Sheldon Gordon (SUNY at Farmingdale), Christopher Hirsch (Western Michigan University), and Jo Ann Lutz (North Carolina School for Science and Mathematics).

**Achieving Quantitative Literacy**

The second forum, "Quantitative Literacy: Why Numeracy Matters for Schools and Colleges," will be held December 1–2 at the National Academy of Sciences in Washington, DC. This invitational forum for approximately 100 persons will be the center of an effort to start a national conversation on the growing importance of numeracy in all aspects of American life.

We all now live in a world awash with data, and daily civic discourse teems with quantitative measures. Education for quantitative literacy is simultaneously more necessary and more difficult. School and college curricula, dominated by traditional disciplinary offerings, face a daunting challenge of adapting to meet this growing educational need. Nowhere is this more evident than in mathematics curricula. The purpose of the forum is to examine the relationship between quantitative literacy and mathematical competence and to address how this relationship bears on the aims of education in high school and college.

The discussion was initiated by the publication of a book, *Mathematics and Democracy: The Case for Quantitative Literacy,* containing a case statement prepared by a National Design Team led by Lynn A. Steen and twelve responses to that case statement. In addition, several issue papers have been commissioned. The papers and proceedings of the forum will be published and distributed widely. *Mathematics and Democracy* is available from the MAA. (See page 7 of the 2001 Spring/Summer Catalog.)

This forum is sponsored by the National Council on Education and the Disciplines at the Woodrow Wilson Foundation with financial support from The Pew Charitable Trusts. The Mathematical Sciences Education Board is hosting the forum with the cooperation of the MAA.

**Reforming College Algebra**

The third forum, "Reforming College Algebra," will be held February 7–10, 2002, at the ExxonMobil Conference Center in Arlington, Texas. The hypothesis here is that the traditional college algebra course should be changed. To what it should be changed is not clear. College algebra courses are serving both as general education courses and as prerequisite courses for subsequent courses such as finite mathematics and calculus. Consequently, the topic of this conference reaches over into both the precalculus discussion and the quantitative literacy discussion.

"Reforming College Algebra" is being organized by Don Small of the US Military Academy. He is being advised by the MAA Task Force on the First College-Level Course. Support is from the ExxonMobil Foundation. This forum will be keynoted by Arnold Packer, director of the SCANS 2000 Center at Johns Hopkins University. Dr. Packer is a former Assistant Secretary of Labor and co-author of *Workforce 2000*.

**AAAS Symposiums**

Finally, two complementary ninety-minute symposiums have been scheduled as a part of the Annual Meeting of the American Association for the Advancement of Science (AAAS) in Boston, February 14–17, 2002. One symposium is "Articulation in Mathematics: Smoothing the Road from School to College," and the second is "Living with Data: Achieving Quantitative Literacy."

The Articulation symposium is being organized by Bernard L. Madison and will have three speakers. Stephanie Pace

Marshall, President of the Illinois Mathematics and Science Academy, will speak on the report of the National Research Council's Committee on Advanced Science and Mathematics Courses in American High Schools. Dr. Marshall was a member of this Committee which reviewed Advanced Placement courses, International Baccalaureate courses, and courses for dual college and high school credit.

Joan Ferrini-Mundy, Chair of the NCTM Standards Impact Research Group and principal author of the 2000 NCTM Standards, will describe educational characteristics of graduates of NCTM Standards-based mathematics programs. The third speaker, David Lutzer, will report on the results of the 2000 CBMS survey of undergraduate mathematical sciences. Dr. Lutzer was director of this survey.

The Quantitative Literacy symposium is being organized by Lynn A. Steen. Three speakers will address some of the issues in education for quantitative literacy that are the subject of the National Academy of Sciences forum described above. The three speakers are Joan Leitzel, President of the University of New Hampshire, Richard Schaeffer, President of the American Statistical Association, and Arnold Packer, described above as the keynoter of the college algebra conference. ■

## Letters to the Editor

Not a Klein Bottle

I noticed the caption on page 4 of the latest FOCUS issue incorrectly describes the Oberwolfach sculpture as a "Klein Bottle," when it is actually Boy's surface, an immersion of the real projective plane. If the readers of FOCUS are interested in seeing more images of Boy's surface, I would recommend these web sites:

The Geometry Center:
http://www.geom.umn.edu/zoo/toptype/pplane/boy/

A student page at Smith College:
http://math.smith.edu/~jposson/

My very own site:
http://www.ipfw.edu/math/Coffman/steinersurface.html

Adam Coffman
Indiana University Purdue University Fort Wayne

Fat Nerds Typo

There is a typo in the URL for the *London Times* piece about mathematicians as "fat nerds" on p. 26. It should be http://www.thetimes.co.uk/article/0,,2-61352,00.html. The hyphen between "2" and "6" got lost.

Norman Richert
Mathematical Reviews

*Due to production problems at our end, the May-June issue of FOCUS contained a great many typos and other errors. We'd like to apologize to our readers and to thank the many readers who contacted us with corrections.*

*With respect to the note about students viewing mathematicians as "fat nerds", let me add that a discussion of the research in question can be found in J. S. Berry and S. Picker, "Your pupil's images of Mathematicians and Mathematics",* Mathematics in School, *29 (March 2000), 24–26.* ■

## Ed Burger is Pólya Lecturer

*Ed Burger*

The MAA has named Ed Burger of Williams College as the Pólya Lecturer for 2001–02 and 2002–03 academic years. Burger, who received one of last year's Deborah and Franklin Tepper Haimo Awards for Distinguished Teaching of Mathematics, is well known as a dynamic speaker, talented teacher, and effective writer. (He has even written for FOCUS – see our December 2000 issue.) Dubbed the "ambassador of mathematics" by the President of Williams College, Burger is an engaging and entertaining speaker who is sure to be a big hit with MAA Sections throughout the country.

The George Pólya Lectureship was created in 1991. Named for George Pólya, a renowned teacher and writer who embodied the high quality of mathematics exposition that the MAA seeks to encourage, the award provides funds for the Pólya Lecturer to give talks at several meetings of the Sections of the MAA.

Each MAA Section is entitled to a Pólya Lecture approximately once every five years. For more information, including a list of past Pólya Lecturers, visit http://www.maa.org/awards/polyalecturers.html.

# Quantitative Literacy: Everybody's Orphan

*By Bernard L. Madison*

The world is awash with data, and civic discourse teems with quantitative measures. Political arguments use, misuse, confuse, and spin various rates of change. Statistical analyses of how voters thought they voted have filled recent newspapers. Risk factors are quoted for tire failures, truck crashes, and lung cancer. However, many (if not most) US citizens do not understand the analyses of these quantitative concepts.

The heavy and increasing use of quantitative ideas and language in civic discourse means that quantitative literacy, or numeracy, is needed by all. However, numeracy education is claimed by no discipline and suffers accordingly in the discipline-dominated school and college curricula. This is the basic premise of a national conversation on quantitative literacy and mathematics sponsored by the National Council on Education and the Disciplines (NCED) at the Woodrow Wilson Foundation. The yearlong discussion will center on a national forum, *Quantitative Literacy: Why Numeracy Matters for Schools and Colleges*, to be held at the National Academy of Sciences on December 1–2, 2001. (See the *Four Forums* article on page 8 of this issue of FOCUS for more details.)

The literacy rate in the US, which is the result of our policies of universal education, has been a source of national pride. Some international survey evidence shows that we are slipping badly, however, and the biggest culprit may be quantitative literacy.

The International Office of Economic Cooperation and Development (OECD) considers that literacy has three components: prose literacy (interpreting words), quantitative literacy (using arithmetic and proportional reasoning), and document literacy (interpreting tables, charts, and graphs). The OCED International Adult Literacy Survey, conducted from 1994–1998, placed the US literacy rate as second lowest of 18 European/North American countries (only Poland is lower). Moreover, the US has the highest underachievement rate (58% compared to a median for other countries of about 20%). Here, "underachievement rate" is defined to be the percent of high school graduates whose performance on literacy tasks is below the minimum level needed to cope adequately with the complex demands of daily life. In contrast, the US is second only to Canada in the percentage (36%) of adults aged 30-34 who have some postsecondary degree. This indicates that many of the 3 out of 5 US high school graduates that do not meet the OECD standard for literacy have some postsecondary degree or certification.

Much of the responsibility for traditional education for quantitative literacy has rested on the mathematics curriculum in schools and colleges. In fact, quantitative literacy and mathematical literacy have been considered by many as one and the same.

With the advent of computing power over the past few decades, analysis of data became manageable, and the discipline of statistics flourished. So, since much of the public discourse on quantitative matters concerns statistical measures, statistics has a share of the responsibility for quantitative literacy. Some data analysis and statistics have entered the school curriculum, spurred on by the NCTM Standards, and some colleges and universities have instituted courses in quantitative literacy or a requirement in quantitative literacy that can be satisfied by various combinations of courses, some mathematics and some not. But according to various reports current education for numeracy is not sufficient.

Quantitative literacy is discussed in a new publication, *Mathematics and Democracy: The Case for Quantitative Literacy*, published by NCED in May 2001. The book, containing a case statement for quantitative literacy written by a National Design Team led by Lynn A. Steen and twelve responses to that statement, is available from the MAA.

Numeracy, or quantitative literacy, is neither mathematics nor statistics, and it is not watered-down mathematics. It is a way of thinking that uses and enhances tools from mathematics and statistics to describe or understand everyday occurrences. As such, numeracy becomes indispensable to an informed citizen and conceptually and operationally difficult because of its use in so many different contexts.

One major difference between quantitative literacy and mathematics is that quantitative literacy is richly contextual while mathematics students are asked to rise above context and learn mathematics. The power of mathematics is in its abstractness and generality. The theory is that the students will be able to use the mathematics in various contexts, but, as we know, this is enormously difficult. Neither of the arts of applying mathematics and communicating mathematics is easily learned, so contextual use of mathematics as in quantitative literacy requires educational attention.

By and large, college mathematics faculties have considered quantitative literacy someone else's problem, often believing that quantitative literacy is remedial at the college level. That may have been the case in the distant past when numeracy was roughly equivalent to simple arithmetic, but it is no longer the case in our data-laden and quantitative-measure happy society. Even college graduates who major in some mathematically intensive subject, say science or engineering, may have trouble understanding the context-laden quantitative language of public discourse. Many of these have followed the calculus-driven sequence for their mathematics and have applied, often with difficulty, that mathematics in the context of their major discipline. No wonder they have difficulty in all the rich contexts in which mathematical concepts occur in the daily press—in health reports, federal budget analyses, sports reports, drug effectiveness studies, crime

statistics, and a thousand other places.

Mathematics, as traditionally taught, is being challenged as appropriate for literacy, not only by those worrying about quantitative literacy but also by those worrying about scientific literacy. In 1985, the year of the last visit of Halley's Comet, AAAS initiated *Project 2061* to analyze what science all Americans should know. (Halley's Comet will return in the year 2061.) The first publication was *Science for All Americans* in 1990. This year, Project 2061 released a new book, *Designs for Science Literacy*, which basically is a how-to book on designing a K-12 curriculum to achieve scientific literacy—what science everyone should know.

Most educators would agree with *Designs* assertion that there can be some thinning of the curriculum in science and mathematics. Agreement on which are the topics that could go would be less likely. Among the long list of mathematics topics *Designs* considers expendable are factoring quadratics and polynomials. Most mathematicians would consider such omissions absurd, but they look at the world through a different lens than does *Project 2061*. Again, traditional mathematics is being challenged, and the days of automatic acceptance of much of what we have traditionally taught are over.

Several questions are being posed in this national conversation about quantitative literacy, and these questions deserve the attention of the US mathematics faculty. Such attention will certainly help find good educational answers, but it may also help keep mathematics a vital, growing collegiate discipline.

What mathematics is most important for quantitative literacy? Much of the content of the calculus-driven sequence would not be considered effective in achieving quantitative literacy. The major reason cited is the context-free nature of this sequence and its emphasis on algebraic and calculus techniques. One of the aims of calculus reform was to move towards more contextual calculus problems. That effort has been met with only limited success, mainly because of the dilemma of choosing either to cover the ideas of calculus or to cover the contexts for calculus problems.

Can we develop a sequence of school and early college mathematics that will simultaneously prepare students for advanced work in mathematics and prepare them to be quantitatively literate citizens? Most school college preparatory mathematics sequences consist of algebra, geometry, and trigonometry. Students who are not headed for a college curriculum needing calculus or who may have no need for calculus (other than as a general education course) are usually steered toward calculus because that is the route that leads to credentials for college entrance. School sequences that are not calculus bound are usually weaker, but they need not be. As long as the calculus-driven sequence is the road to entry into selective colleges, it will be the choice of parents and competitive students. Even an alternative track that is stronger for general education, particularly quantitative literacy, would not compete well with calculus and its reputation as being a good measure of student achievement.

What other disciplines share responsibility with mathematics and statistics for quantitative literacy? Certainly economics, the physical and biological sciences, and engineering. The social and behavioral sciences are increasingly quantitative; and even the humanities have quantitative components. Unfortunately, many of the quantitative concepts and measures used in disciplinary courses are tightly tailored to those disciplines, not context-free as in mathematics, but context-bound to a discipline, so transfer of learning to different contexts is difficult. What may be necessary is that institutions coordinate quantitative learning across the curriculum, analogous to the writing across the curriculum programs.

The analogy between quantitative literacy and writing is fairly strong. Writing in college has gained a status distinct from the traditional disciplines, most notably English and the other humanities, over the past several decades, primarily because it was critical for success in many areas and not successfully taught in any single discipline. One difference between the writing/literature situation and the numeracy/mathematics situation is that literature faculty expect their students to write well while mathematics faculty often ignore the numeracy of their students. If numeracy and mathematics goes the way of writing and English, then education for numeracy will be external to mathematics programs, even if not in a coordinated program across the curriculum.

Two models of teaching writing are WAC (writing across the curriculum) and WID (writing in disciplines). Mathematics and statistics in disciplines is pervasive in universities now, as students encounter mathematics and statistics in economics, social sciences, sciences, and engineering. The lack of coherence and connections of these encounters prevents achieving broader, more generally applicable quantitative understanding. If "across" implies more coherence and less discipline-bound approaches than does "in," then mathematics and statistics across the curriculum would approximate education for quantitative literacy.

Education for quantitative literacy appears to be a difficult problem, beset with dilemmas within the context of traditional discipline-dominated curricula. But a numerate citizenry is critical for today's democracy, and citizens need a high degree of literacy to seek out information, critique it, and use it. Lynn Steen has written that an innumerate citizen is as vulnerable today as the illiterate peasant of Gutenberg's time was in the 15th century. School and college mathematics curricula have a major role to play in numeracy education. The mathematics community must join this national discussion. ■

*Bernard L. Madison is MAA Visiting Mathematician during 2001, on leave from the University of Arkansas. His e-mail is* bmadison@maa.org.

## Travel Grants for ICM 2002, Beijing, China

The American Mathematical Society has applied to the National Science Foundation for funds to permit partial travel support for U.S. mathematicians attending the 2002 International Congress of Mathematicians (ICM 02) August 20-28, 2002, in Beijing, China. In anticipation of the availability of funds, the AMS is preparing to administer the selection process, which would be similar to previous programs funded in 1990, 1994 and 1998.

Applications for support will be printed in the September issue of the *Notices*, and forms will be available on the AMS website (at http://www.ams.org/careersedu/icmapp.html) beginning August 1, 2001. All completed application forms must be mailed to the AMS by October 31, 2001. This travel grants program, if funded, will be administered by the Professional Services Department, AMS, P.O. Box 6248, Providence, RI 02940. You can contact them at ICM02@ams.org, 800-321-4267, ext. 4105 or 401-455-4105.

This program is open to U.S. mathematicians (those who are currently affiliated with a U.S. institution). Early career mathematicians (those within six years of their doctorate), women, and members of U.S. groups underrepresented in mathematics are especially encouraged to apply. ICM-02 Invited Speakers from U.S. institutions should submit applications, if funding is desired.

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

Should the proposal to the NSF be funded, the following conditions will apply: mathematicians accepting grants for partial support of the travel to ICM 02 may not supplement them with any other NSF funds. Currently, it is the intention of the NSF's Division of Mathematical Sciences to provide no additional funds on its other regular research grants for travel to ICM in 2002. However, an individual mathematician who does not receive a travel grant may use regular NSF grant funds, subject to the usual restrictions and prior approval requirements.

All information currently available about the ICM 02 program, organization, and registration procedure is located at http://www.icm2002.org.cn/. ■

## Scientific Societies Present Public Service Awards

Three major scientific societies presented their 2001 Public Service Awards at a ceremony at the Rayburn House Office Building in Washington, DC, on Wednesday, May 16. The honorees were Congressman Vernon Ehlers (R-MI) and Dr. Neal Lane, former Assistant to the President for Science and Technology. The awards, for committed and sustained efforts in support of science, are given jointly by the American Astronomical Society, the American Mathematical Society, and the American Physical Society, which collectively represent more than 100,000 scientists and mathematicians.

Congressman Ehlers, one of two physicists in Congress, has been a champion for science research and education throughout his congressional career. Recently he has concentrated on K-12 science and mathematics education, introducing several bills to facilitate improvement in science and mathematics learning and teaching. Congressman Ehlers is a member of the House Committee on Education and the Workforce, as well as the House Committee on Science, and Chair of its Subcommittee on Environment, Technology and Standards.

Dr. Lane is a former Director of the National Science Foundation. He was instrumental in raising science research and education to a high priority in the Clinton Administration. The FY 2001 Federal budget, in which science agency budgets received much larger increases than in recent years, reflected Lane's efforts. Currently, Lane is University Professor and Senior Fellow at the James A. Baker III Institute for Public Policy at Rice University.

Past recipients of the AAS-AMS-APS Public Service Award include Senators Bill Frist (R-TN) and Joseph Lieberman (D-CT), and Dr. Harold Varmus (former director of the National Institutes of Health). For more information on the award, visit the AMS web site at http://www.ams.org/government/pubservaward01.html. ■

## AWM Sponsors Essay Contest

The Association for Women in Mathematics is sponsoring an essay contest for middle school, high school, undergraduate, and graduate students. The essays should be brief biographies of contemporary women who are pursuing a career in the mathematical sciences. The biographies should be based primarily on an interview with the woman in question, and should be between 500 and 1000 words long. Winners will receive a prize, and their essays will be published online at the AWM web site. The AWM is also seeking volunteers who are willing to be interviewed by students wishing to write essays for the contest. Women mathematicians wishing to volunteer should contact the contest director, Victoria E. Howle, at the address below.

Essays for the contest should be submitted to Victoria E. Howle in plain text format, either by email at vehowle@sandia.com or in hard copy to Victoria E. Howle, Sandia National Labs, MS 9217, P. O. Box 969, Livermore, CA 94551. For more information, visit the AWM web site at http://www.awm-math.org/biographies/contest.html. ■

# Clay Mathematics Institute Announces Long Term Fellows, Olympiad Scholar, IMO Awards

The Clay Mathematics Institute, a non-profit foundation dedicated to increasing and disseminating mathematical knowledge, recently announced the names of four Long Term Prize Fellows, two Research Award winners, one Olympiad Scholar, and four winners of its IMO Award. By awarding these Fellowships to research mathematicians and the Olympiad and IMO awards to high school students, the CMI continues its extensive support for mathematics at many different levels.

*Roman Bezrukavnikov*

*Alexei Borodin*

*Sergei Gukov*

*Mircea Mustata*

The CMI Long Term Prize Fellows are all young (under 30) research mathematicians who have already contributed profound new ideas and had major achievements in mathematical research. The Fellows are each hired by CMI for terms ranging from one to five years, depending upon factors including age and experience. Current Fellows are on the cutting edge of research ranging from exploration of the intricacies of the theory of numbers to error correction in quantum computation. Fellows carry out this research at whatever location they believe will best advance their work.

This is actually the second year in which CMI is naming Long Term Fellows, but it is the first year in which the awards have been made public. This year's Fellows are Roman Bezrukavnikov (age 27, appointed for one year), Alexei Borodin (age 25, appointed for four years), Sergei Gukov (age 23, appointed for five years), and Mircea Mustata (age 29, appointed for three years). The CMI also announced last year's Long Term Prize Fellows: Manjul Bhargava (age 27 at time of appointment, appointed for five years), Dennis Gaitsgory (age 26, appointed for three years), Daniel Gottesman (age 30, appointed for one year), and Terence Tao (age 24, appointed for three years).

CMI President Arthur Jaffe (of Harvard University) pointed out that the work of the award winners has the potential to change how we view ourselves and the universe around us. "Mathematical achievements have always blazed trails in science and philosophy that eventually filter down to everyday life in the form of new technologies and even social outlooks," he said. The main point, however, is simply that these are among the best young mathematicians, and CMI's support should allow them to fulfill their early promise as researchers. As David Eisenbud of the University of California at Berkeley pointed out, "The Fellows are the most brilliant people in their field, and these awards will give them the freedom to expand their talents."

The CMI has also recently announced the 2001 winners of the Clay Research Award, which recognizes outstanding achievement in mathematical research. This year's winners, announced at the closing ceremonies of the International Mathematical Olympiad in Washington, DC, were Edward Witten of the Institute for Advanced Study at Princeton and Stanislav Smirnov, a senior lecturer at the Royal Institute of Technology in Stockholm and a researcher at the Swedish Royal Academy of Science. For more on the winners, check online at http://www.claymath.org/awards/clayresearchaward.htm.

At the other end of the spectrum, the American Olympiad Scholar award goes to the student with the most ingenious and elegant solution to a problem on the USA Mathematical Olympiad. This year's award went to Michael Hamburg, an 11th grader from South Bend, Indiana. Michael was one of only 9 out of the 270 finalists to answer Problem 6 on the exam correctly. His solution, which was virtually a "proof without words," won unanimous praise from the judges. (The proof can be seen online at http://www.claymath.org/awards/cmiolympiadscholar.htm.) CMI's award includes a cash prize and placement at an exclusive two-week "mathematics boot camp" in Washington, DC this June.

In July, CMI announced that its CMI-IMO Award would go to the four students who had perfect scores in the 2001 International Mathematical Olympiad (see article on page 3): Liang Xiao and Zhiqiang Zhang from China, Reid Barton and Gabriel Carroll from the United States.

The mission of The Clay Mathematics Institute is to increase and disseminate mathematical knowledge, to educate mathematicians and other scientists about new discoveries in the field of mathematics, to encourage gifted students to pursue mathematical careers, and to recognize extraordinary achievements and advances in mathematical research.

To learn more about CMI, visit their web site at http://www.claymath.org, which also contains more information about the awards and winners, including photographs. ■

*Photographs courtesy of the Clay Mathematics Institute*

## MAA National Election Results

The results from this year's MAA elections are in. Ronald L. Graham has been elected President-Elect. As per the MAA bylaws, he will serve as President-Elect for a one-year term, beginning after the January meeting in 2002 and concluding at the end of the January meeting in 2003, at which point he will begin a two-year term as MAA President. Carl Cowen has been elected First Vice President and Joe Gallian has been elected Second Vice President. Both will serve two-year terms beginning at the end of the January meeting in 2002.

*Ronald Graham*

Ronald Graham has had many roles within the MAA, ranging from a term as First Vice President in 1982–83 to participation in several committees and editorial boards. He has been a Hedrick Lecturer, a Pólya Lecturer, and a Presidents' Lecturer. He has won both the Lester R. Ford Award and the Carl Allendoerfer Award; both for expository writing.

Outside the MAA, Graham has been President of the American Mathematical Society and had many other roles within the AMS. He is the winner of several awards, and has given invited talks at all sorts of meetings, from the International Congress of Mathematicians to the American Association for the Advancement of Science.

One of Graham's goals as President will be to address issues such as the preparation of students for the increasingly varied mathematical opportunities available in the emerging high technology economy, the development of appropriate curricular material, and increased outreach to the broader public.

Carl Cowen has also had many roles within the MAA, from being Governor of the Indiana Section to being a member of various committees and councils. He is a distinguished research mathematician specializing in Operator Theory, but he also has a deep concern for mathematics education. "While this is the 'New Golden Age of Mathematics' and NSF sees mathematics playing a central role in progress in science in the coming years," he observes, "our children's mathematical education is in crisis, a shortage of qualified teachers looms, and fewer graduates choose careers in mathematics, especially women and minorities. MAA works at the center of this ferment!" He emphasized the importance of cooperation between the MAA and other organizations in order that these issues may be successfully addressed.

*Carl Cowen*

*Joe Gallian*

Joe Gallian has also had a wide range of activities within the MAA, but perhaps he has been most visible as a lecturer and as a co-director of Project NExT.

His statement on challenges facing the MAA highlighted the importance of providing leadership in increasing public awareness of mathematics, attracting new members at the graduate and undergraduate level outside academia, and offering professional development opportunities. "Project NExT has been enormously successful with the generous support of the Exxon/Mobil Foundation," he notes. "The MAA must make this program self-sustaining." ■

## Undergraduate Student Poster Session

San Diego Joint Mathematics Meetings
Tuesday January 8, 2002
4:30 PM to 7:30 PM
Organized by Mario U. Martelli
Claremont McKenna College

As has been the case in several recent years, there will be an undergraduate student poster session at the forthcoming Joint Mathematics Meetings in San Diego, CA. These sessions have been very successful in the past, and students and their teachers are encouraged to take advantage of this opportunity.

To participate, send title and half-page abstract to Mario Martelli either by e-mail (mmartelli@mckenna.edu) or by regular mail (Mario Martelli, Mathematics Department, Claremont McKenna College, Claremont, CA 91711, Tel. 909-607-8979). Please include the following information: author(s) name(s), presenter(s) if not all authors will attend, affiliation, address, phone number and e-mail of all presenters, and of the advisor(s). Clearly indicate the presenter, who should keep in touch with Prof. Martelli and receive all information regarding the poster. Make sure that your submission does not arrive later than December 10, 2001. Notification of acceptance will be e-mailed within 20 days after the abstract has been received. Let the organizer know if you did not receive it. Apply early! Space is limited and will be filled up on a first-come, first-serve basis. The session is reserved to undergraduates. First year graduate students may submit posters on work done while undergraduates. Poster contents should not be purely expository. Each poster will be evaluated by a panel of judges and the best posters will receive monetary prizes provided by the MAA, AMS, CUR and NSA. Tri-fold self standing 48" by 36" table-top poster board will be provided. Additional material or equipment is the responsibility of the presenter. Let the organizer know if an electrical outlet is needed for your presentation.

See you in San Diego on January 8! ■

## Short Takes

Carnegie Foundation Studies Teacher Education

The Carnegie Foundation for the Advancement of Teaching has started a five-year study of teacher education. They want to find out how teacher education classes are taught, how aspiring teachers learn, and how their work is evaluated. The project is part of a broader effort in which the foundation is looking at the training of lawyers, engineers, doctors, social workers and clergymen. Many education specialists welcomed the new study, feeling that the comprehensive information it will generate may be of great value to continuing attempts to improve teacher education. For more information on the Carnegie Foundation program, visit their website at http://www.carnegiefoundation.org/TeacherEd/index.htm.

**Plus: An Online Magazine on Mathematics**

There is much mathematical material on the internet. One of the most interesting is *Plus Magazine*, at http://plus.maths.org.uk. The magazine, which is targeted at those who are 16 or older and have an interest in mathematics, includes a wide range of articles and news items. It's definitely worth adding to one's collection of bookmarks. *Plus* started life as *PASS Maths* in 1997, published by the Department of Applied Mathematics and Theoretical Physics at the University of Cambridge. It now runs under the aegis of the Millennium Mathematics Project —a group that incorporates elements of the DAMTP, the Cambridge Department of Pure Mathematics and Mathematical Statistics and the School of Education. When FOCUS went to press, *Plus* had been nominated for a Webby Award for Science. Visit them to see if they won.

**Other Internet Newsletters**

The internet has made it very easy to publish electronic newsletters, and a great number of them have sprung up. An interesting one is the *Newsletter on Proof*, which is described as "a newsletter published every other month, dedicated to the theme of the teaching and learning of proof in mathematics. This newsletter mainly contains bibliographical information, not only references to new material, but also old references pointed out by readers which do not appear in the bibliographical portion of the site." The newsletters are available at http://www.cabri.net/Preuve/.

Also worth noting is the *Newsletter of the International Study Group for the History and Pedagogy of Mathematics*, often known as "HPM." The HPM newsletter used to be published on paper and mailed to HPM members, but that has become too expensive, resulting in the move to publication on the web. You can find it on the Americas Section Web Site at http://www.sju.edu/~ambruso/hpm/Welcome.html.

**Maryland Ph.D. Program Gets National Attention for Success with Minorities**

In its February 16 issue, the *Chronicle of Higher Education* published an article entitled "A University Beats the Odds to Produce Black Ph.D.s in Math" (page A14). The article features Ray Johnson and the University of Maryland program. The Chronicle returned to the subject in its March 16 issue (page B12), and also posted an interview with Ray Johnson on its (subscribers-only) web site. All this attention is due to Maryland's success in attracting African-American students and in supporting them all the way to the Ph.D.

More information on the program can be found in a book chapter by Duane A. Cooper, "Changing the Faces of Mathematics Ph.D.s: What We Are Learning at the University of Maryland," in *Changing the Faces of Mathematics: Perspectives on African Americans*, M. Strutchens, M. Johnson, W. Tate, eds. (Reston, Va.: NCTM, 2000).

**EDC Announces Making Mathematics Project**

*Making Mathematics* is an NSF-funded project of the Education Development Center in Newton, MA. The project brings together mathematicians with secondary students and teachers to work on research-like problems in mathematics. The idea is that while frontline mathematical research problems are out of reach for non-specialists, the methods used by research mathematicians are accessible to almost all young people. Developing the habits of mind used by working scientists and mathematicians is of immense and lasting value to all students, no matter what they do with their lives.

Since this kind of work is unfamiliar to many students and teachers, the involvement of mathematicians is crucial. Mathematicians will serve as online mentors whose role is to help students and teachers ask themselves the right questions, point them to available resources, help them build their mathematical background when necessary, and help them navigate their path through the problem solving and research process.

The project is actively seeking mathematicians who might be interested in taking part in this effort. For more information, visit their web site at http://www2.edc.org/makingmath/, email to dmrs@edc.org, or contact Jean Benson, Making Mathematics, Education Development Center, Inc., 55 Chapel Street, Newton, MA 02458; (617) 969-7100.

Achieve, Inc. Announces Mathematics Package for Middle School

Achieve Inc., a nonprofit group backed by political and corporate leaders, has announced a plan to put together a package of services aimed at improving mathematics achievement in the middle school grades. The plan was sparked by American 8th graders' disappointing performance on the TIMSS study. (See our May/June issue for an analysis of the study's results.) The package to be produced by Achieve will include an 8th grade test that will show states how they compare with international standards, professional development programs for teachers, and a buyer's guide to textbook and curricular materials. Achieve plans to work with the College Board to offer the package to the 14 states that have joined the Mathematics Achievement Partnership. Achieve's home page is at http://www.achieve.org; you can read more about their plans to

*Short Takes continued on page 16*

address mathematics in middle school at their website: http://www.achieve.org/achieve/achievestart.nsf/pages/partnr.

**NExT News**

In a recent ad in the op-ed section of the *New York Times*, ExxonMobil discussed their involvement with mathematics and science education. MAA's Project NExT, which has been funded by ExxonMobil for many years, is one of two projects that are highlighted in the article. You can access the ad online at http://www.exxonmobil.com/news/opeds/120401.pdf.

MAA has continued to seek funding for Project NExT, with the hope of allowing the project to fully fund all participants. Recent donations of $15,000 from the Education Advancement Foundation and $25,000 from the Dolciani-Halloran Foundation will fund 16 NExT fellows for 2001-02, and efforts are underway to secure more funding.

**Happy Birthday, Fermat**

This year marks the 400th anniversary of the birth of Pierre de Fermat. A conference in Toulouse, France, entitled "Fermat, quatre cents ans apres," will mark the event in October. For more information, check their website at http://borel.ups-tlse.fr/Fermat/index.html.

**John H. Marburger III may be Bush Science Advisor**

President Bush announced that he intends to nominate John H. Marburger, III as Director of the Office of Science and Technology. Marburger is currently the Director of the Brookhaven National Laboratory and President of Brookhaven Science Associates. He is presently on a leave of absence from the State University of New York at Stony Brook where he served as President and Professor from 1980 to 1994 and as a University Professor of Physics and Electrical Engineering from 1994 to 1997. Marburger, who is a graduate of Princeton University and received a Ph.D. in Applied Physics from Stanford University, will need Senate confirmation before he can take up the job. His statement about his nomination can be found on the BNL web site at http://www.bnl.gov/bnlweb/pubaf/pr/bnlpr_JHMstatement.htm.

**Tom Banchoff Receives Honorary Degree**

Tom Banchoff, who was president of the MAA in 1999–2000, received an honorary Doctor of Science degree from Rhode Island College in recognition of his contributions to mathematics education. Banchoff, a mathematician with deep interests in education and in the use of technology to communicate mathematical ideas, teaches at Brown University in Providence, RI. He described the event as a rare case of "a minor prophet being honored in his own country."

**San Francisco Exploratorium Highlights Mathematics**

This October, the *Exploratorium*, a science museum in San Francisco, will open a new exhibition entitled *Mathematica: A World of Numbers and Beyond*. The exhibition, designed by Charles and Ray Eames, explores mathematics as a tool, a science, and a work of art. The ideas, imagery, and history of mathematics will be portrayed by an array of demonstrations, devices, and other materials. The exhibition will open on October 6. See their web site at http://www.exploratorium.edu for more information. ■

## From the Sections

Pictured above are the Secretary-Treasurers of the OK-AR Section of the MAA. Collectively they represent 27 years of service in this position from as early as 1966 to the current Secretary-Treasurer in 2001.

Top left (back row) shows Stan Eliason, University of Oklahoma, (Sec-Treas 1991-96), Harold Huneke, University of Oklahoma, (Sec-Treas 1966-1970), John Jobe, Oklahoma State University, (Sec-Treas 1978-1991). Front row from the left shows Robert McMillan, Oklahoma Christian University, (Sec-Treas 1996-2001), and John Watson, Arkansas Tech University, (Sec-Treas 2001- ).

The Section began in 1933 and was known as the Oklahoma Section. Arkansas did not have a section and many members of the mathematics community met with the Oklahoma Section. In 1956 Professor O. P. Sanders, University of Arkansas, was elected Chairman of the Section; the first Chairman from Arkansas.

In 1965, Professor George M. Ewing, of the University of Oklahoma, made a motion to change the Section's name to the Oklahoma-Arkansas Section in recognition of the regular participation of Arkansas people. The motion was seconded by R. B. Deal and passed without a negative vote.

For 68 years the Secretary-Treasurers have been from Oklahoma. John Watson is the first to be elected from Arkansas. All Secretary-Treasurers were from either Oklahoma University or Oklahoma State University until 1996 when Robert McMillan was elected. He was the first from a private university. Professor Deal has been active in the OK-AR Section and a member of the MAA for 57 years. He presented a paper at the section meeting in March of this year. The OK-AR Section home page is at http://www.uca.edu/divisions/academic/math/maa/maa.htm. ■

## Award for Distinguished Service to Mathematics: Call for Nominations

The Committee on the Yeh-Gin Gung and Dr. Charles Y. Hu Award for Distinguished Service to Mathematics is seeking nominations for this award. The Gung-Hu Award is the MAA's most prestigious award for service. It is awarded for service to mathematics that has been widely recognized as extraordinarily successful. The contribution should be such as to influence the field of mathematics or mathematical education in a significant and positive way on a national scale. Recipients of this award must be members of the Association who reside in the United States or Canada.

Any member of the MAA can nominate candidates for the award. The nomination should be no more than two pages in length, and should include justification. Send nominations to the Committee on Distinguished Service to Mathematics, c/o Martha Siegel, Towson University, Stephens Hall 302, 8000 York Road, Towson, MD 21252, or by email to siegel@towson.edu. To be considered for the next award, nominations should reach the committee by November 30, 2001. Questions should be addressed to Henry Alder, the chair of the Committee, at hlalder@ucdavis.com. For more on the award and a list of past winners, vist MAA Online at http://www.maa.org/awards/gunghu.html. ■

## D'Ambrosio and Yong Share Kenneth O. May Prize

The fourth Kenneth O. May Prize, awarded by the International Commission on the History of Mathematics, went to Ubiratan D'Ambrosio of Brazil and Lam Lay Yong of Singapore for their many publications and scholarly contributions on the study of non-Eurocentric mathematics. The prize was awarded at the 21st Intenational Congress on the History of Science, held in Mexico in July. Past recipients of the K. O. May Prize include Dirk J. Struik, A. A. Youschkevitch, Christoph J. Scriba, Hans Wussing, and René Taton. The award is named for Kenneth O. May, the founder *Historia Mathematica*, the official journal of the International Commission on the History of Mathematics.For more information on the ICHM, see http://elib.zib.de/IMU/ICHM/index.html. ■

# Evaluating Undergraduate Programs: Indicators of Departmental Health

*By John A. Dossey and Kenneth J. Travers*

The teaching of undergraduate mathematics in the first two years is currently in a state of transition. At the department level, the student population is changing, both in its composition and in the mathematics that has been taken prior to college. Student goals and aspirations for enrolling in mathematics courses are different and more diverse than ever before. At the same time, the needs of the traditional partner disciplines of mathematics are also changing to reflect disciplinary advances and the impact of technology on teaching and learning across the disciplines. Recommendations based on recent research on how humans learn call for changes in instructional programs and learning environments. As mathematics departments attempt to deal with these issues, there are demands from central administration, government and funding agencies, the public, and students themselves that mathematics departments become both more responsive to the needs of their various constituencies and more accountable for their actions.

Most mathematics department chairs, curriculum committees, and concerned faculty recognize that providing quality programs involves far more than simply offering courses. Syllabi must be developed, qualified instructors (tenure or tenure-track faculty, adjuncts, teaching assistants, etc.) must be identified and assigned, and decisions must be made about such matters as class size, use of discussion sections, selection of textbooks, and inclusion of technology (graphing calculators, computer algebra software, etc.).

In the current climate of change and accountability, mathematics departments are searching for ways to make decisions that are educationally sound. However, the stark reality is that the sources of data, at both the local and national levels, for this kind of decision-making are either nonexistent or largely ineffective. In order to help address this problem, the National Science Foundation funded the Indicators Project at the University of Illinois at Urbana-Champaign to develop a set of indicators for use by mathematics departments as they undertake self-assessment activities. For details of this project go to: http://www.mste.uiuc.edu/indicators with an updated website, full reports, as well as illustrative data, to be available on-line at the site in December 2001.

**What are education indicators?**

We are all familiar with the use of economic indicators to describe the health and direction of the nation's economy. These indicators—for example, the Dow-Jones Industrial Average—reflect "performance characteristics" of the economy. Even when these data have complex relations with other aspects of the economy, they provide "benchmarks" —comparisons of the condition of the economy with itself over time. Sets of these indicators and associated benchmarks help inform judgments of the economy's strength and of the direction of its movement (for example, prediction of more likely economic trends on the basis of the past performance of the economy).

Indicators also have a corresponding role to play in education. As Shavelson and his colleagues (see Shavelson, R., McDonnell, L., Oakes, J., Carey, N., with Picus, L. (1987). *Indicator Systems for Monitoring Mathematics and Science Education*. Santa Monica, CA: RAND, 1987) have stated:

*Education indicators are single or composite statistics that reflect important aspects of the education system (as economic indicators reflect aspects of the economy). They are expected to tell a great deal about the entire system by reporting the condition of particularly significant features of it…. [An education indicator] should provide insight into the 'health', quality or effectiveness of the system; and it should be useful in the educational policy context* (Shavelson, et al, 1987, p. 8).

As part of the Illinois Indicators Project, three mathematics departments each carried out an extensive assessment of its lower division (first two years) mathematics programs. The assembled data provided an opportunity to identify issues in the development of program indicators, the kinds of data to collect in the light of these issues, how to go about collecting data, how to organize the collected data, and, finally, how to communicate and use the information gathered. The mathematics departments were located at a community college (CC), a newly founded (1989) comprehensive state university (SU), and a Level I research university (RU). The choice of three such very different kinds of institutions was deliberate. It permitted one to see how self-assessment plays out in three very different kinds of institutions.

Surveys were developed to provide data relative to five different facets of undergraduate programs: institutional and department goals and priorities, curriculum, instructional staff, classroom practices, and student issues. For more information on the survey's instruments themselves, refer to the URL listed above.

**Story Lines Emerging From the Data**

Comparisons of the data from the three institutions provide some interesting similarities and differences. The first is that, across the institutions, the departments have been responsive to keeping their curricula up-to-date through syllabus revisions and new textbook adoptions across the courses normally taught in the first two-years. However, one interesting fact emerged from this analysis. It appears that departments tend to consider the revision of course goals and content, then choose a text in the following year, and come out with a new syllabus in the following semester or year. This, along with other responses, indicates that there is at least the core of a curricular planning process.

Other data collected at the institutional/departmental level provide demographic overviews of the departments and help situate the department and its programs in the overall milieu of the university at large. They provide a background against which the departmental directions can be compared and contrasted with the institution's direction and overall mission.

A second major story line deals with in-

struction. The instructional staff was asked to describe the extent to which they make use of instructional technology across those courses commonly found in the first 2-years and how they made use, if at all, of a variety of pedagogical approaches in teaching these courses. Their responses are summarized in Table 1 below.

Other questions dealt with the use of specific teaching strategies. The data were quite similar with respect to the frequency with which instructors used lecture, question and answer approaches, homework, and individual working time in classes. However, substantial differences were found in the use of group work, guided discovery activities, and calculator or computer demonstrations. For example, around 40% of the comprehensive university and research university instructors report using group work while only around 10% of the community college instructors did so. However, while 100% of the community college instructors reported use of calculators in their classes, only about one-third that proportion of the state university and research university instructors reported calculator use. Hence, it appears that relatively similar use of lectures, question-and-answer approaches, homework, and individual working time in classes characterize instruction at these three campuses.

Pictures and stories also emerge showing contrasts in the types of assessment employed, different patterns of interaction between instructors and their students, and other issues of classroom climate. Questions to students about the degree to which their instructors are responsive to their needs and seem to have an awareness of their needs as students in differing majors reveal general student satisfaction across the board. These data are somewhat different from what one hears in the lore and myths repeated about mathematics department instructional staff and their interactions with their students.

All in all, the surveys and reporting methods developed in the project, the manners of comparing and contrasting the results, and the development of a data base for different levels of institutions provide a basis for other departments to consider. Other departments may wish to examine themselves and look for ways of responding to calls on their campuses for departmental self-evaluations or for justifications of departmental existence in this age of value-added accountability.

*John A. Dossey is Distinguished University Professor of Mathematics Emeritus at Illinois State University and former chair of the Conference Board of the Mathematical Sciences (CBMS). Kenneth J. Travers is Professor of Mathematics Education and Director of the Office for Mathematics, Science, and Technology Education at the University of Illinois at Urbana-Champaign.*

| School | Course | Technology | | Instructional Approaches | | |
|---|---|---|---|---|---|---|
| | | Graphing Calculator | Computers | Small Group Work | Written Assignments | Project/Lab Assignments |
| CC | College Algebra | Used Always | Not Used | Used Rarely | Not Used | Not Used |
| SU | College Algebra | Used Always | Not Used | Not Used | Used often | Not Used |
| RU | College Algebra | Used Always | Not Used | Not Used | Not Used | Not Used |
| CC | Math for Elem. Ed | Used Often | Used Rarely | Used Rarely | Used Rarely | Used Often |
| SU | Math for Elem. Ed | Used Rarely | Used Often | Used Often | Used often | Used Rarely |
| RU | Math for Elem. Ed. | Used Often | Used Often | Used Always | Used Always | Used Always |
| CC | University Calculus | Used Always | Not Used | Used Rarely | Used Rarely | Used Rarely |
| SU | University Calculus | Used Often | Used Always | Used Rarely | Used Often | Used Always |
| RU | University Calculus (for all categories, depends on version) | Used Often | Used Often | Used Often | Used Often | Used Often |

*Table 1. Uses of technology and various instructional approaches at three kinds of campuses*

# A Different Pencil: Use Technology Wisely

*By Dick Jardine*

This is a confession. I am guilty of the crime of "bludgeoning our students with technology," to quote Gary Sherman of Rose-Hulman. Gary was offering some caveats in a talk about implementing calculus reform. Before being aware of reform, I had long been an advocate of the use of computer technology in mathematics education.

In the mid-80s, I wrote Pascal programs for the Apple II and TERAK (can you believe an 8-inch floppy disk!) microcomputers to demonstrate concepts for my probability and statistics course. I used the computers in my classroom as an electronic blackboard to display various discrete and continuous distributions and to compute the associated probabilities, in the same way that I used the TI-83 Plus in my class last semester. I continue to advocate the use of technology in the teaching of mathematics, but would like to offer some "lessons learned" so that others do not make the same mistakes I have made.

Make perfectly apparent to your students the appropriate use of technology. During a recent elementary statistics class, I demonstrated the use of the TI-83 to plot the histogram of a data set and then had students produce a similar histogram as a group activity. After class, a student noted that she could have just as easily done the plot by hand rather than push all the buttons required to generate the graph on the calculator. She was right! I had failed to make clear to the class that since the data was now in the machine, I could not only plot histograms but also do a wide variety of other graphs and analyses of the data with ease, far faster than anyone could do with paper and pencil. Our students must be clearly informed of the advantages that technology offers, so that they do not just see it as a "high-tech" way of doing the same old thing.

In one reform calculus text, the authors' first example of the use of Euler's method to solve a differential equation is not only done incorrectly, but also is applied to a problem, $y' = y + 1, y(0)=2$, that our students can solve exactly more quickly than they can iterate to obtain the numerical approximation. It is not difficult to find a differential equation that students cannot solve analytically, for example $y' = et2, y(0)=2$, but can solve readily using the numerical method. Additionally, a computer algebra system can easily generate a slope field for the latter problem, leading to a complete demonstration of analytical, numerical, and graphical solutions of mathematical problems. Require students to generate one slope field by hand and they will quickly appreciate the advantage of using the computer and calculator.

A second lesson learned is that we must be careful not to overwhelm our students with technology at the expense of their learning mathematics. Recalling Gary Sherman again, this lesson is better expressed with an analogy: "Do not fall in love with the technological backpack at the expense of the mathematical hike—mathematics atrophies!"

At the start of a differential equations course I taught five years ago, I spent far more time at the beginning of my course demonstrating how to use the new computer algebra system (CAS), getting the CAS to work on our campus network, and making the CAS work on the variety of student and classroom computers on campus than I spent doing the mathematics. It followed that the mathematical content of the course suffered appreciably.

Additionally, I have taught in an environment in which undergraduates were expected to learn not only a CAS, but also the use of an advanced spreadsheet and the use of a high-end graphing calculator. Some students were up to the challenge, but many were overburdened with "technological backpacks" that were too full. As a result, the depth of the mathematical learning suffered in the process of learning how to do the mathematics with technology. Most of our students could generate eigenvalues and eigenvectors with their calculators; few understood the special role of eigenvalues in analyzing mathematical relationships.

Keeping the last lesson in mind, we owe it to our students to allocate course time to the learning of technology. Our students have too many demands on their time to do otherwise. We can develop carefully designed worksheets which can aid in the learning process (many are available on the WWW. Just search on the CAS or calculator you'd like to use and you'll be overwhelmed with the quantity and quality of the work that has been done so that you "do not have to reinvent the wheel").

Allocating an appropriate amount of classroom time for demonstration is important. Assigning group activities that can be done in a laboratory setting during class hours or outside of class, as graded and ungraded homework is essential. Early in the semester, maximum use should be made of available computer laboratories and computer-equipped classrooms.

In addition to allocating time in the course, be sure to allocate plenty of preparation time toward developing worksheets, web pages, and other technology-based learning activities. The time spent must be worth the increment in learning made possible by the technology. Experience reduces the time spent in completing subsequent activities, but many of us have the shared experience of spending way too much time developing a learning activity that was technologically dependent. Also, in addition to the primary technology-based lesson plan, always have a back-up plan for when the technology fails.

Invariably, the network will go down, batteries will die, the projector bulb will burn out, the monitor will go blank, the software will not load as it did when you last checked it, some student will find just the right wrong keystroke to push to ensure the calculator or computer demonstration fails. All of those crises have happened to me. Technology fails sometimes. Plan on it.

In students' evaluations of my courses,

they report that my modest web pages facilitate their learning. But crafting effective CAS worksheets and web pages is a time-consuming activity, and creating them is an artistic endeavor that is developed only with a significant commitment of time on the part of the instructor.

I often think I spend far too much time on technology-based activities when I could be creating paper and pencil discovery activities for students to explore and learn mathematics. It's a trade-off that each of us must decide based on the needs of our particular students.

There's an old saying that a turtle never makes progress unless it sticks its neck out. I will continue to attempt to stay on the leading (hopefully, not "bleeding") edge of the use of technology in teaching mathematics to my students. My neck is prominently out, because I owe it to my students to keep it out. Don't be guilty of the offense cited by Gary Sherman, but use technology wisely in teaching mathematics so that your students, like mine, learn that technology is not a panacea, but can be a wonderful partner in doing mathematics. ■

*Dick Jardine is an assistant professor at Keene State College, with interests in using the history of mathematics to enhance mathematical learning and using technology appropriately to facilitate mathematical learning. In his spare time, he runs the roads and trails of New Hampshire and plays the guitar badly, but with a smile.*

## ExxonMobil and NSF Join MAA in Supporting Teacher Preparation

Several national reports have called for better preparation of school mathematics teachers. These same reports have recognized the major role that collegiate mathematics faculty should play in this improvement. To help address this need, the MAA is developing a multi-year, multifaceted program to aid college faculty in teacher preparation and support.

With funding from the ExxonMobil Foundation and the National Science Foundation, the MAA is spending a year planning a program with the central purpose of helping collegiate mathematical sciences faculty teach better courses for future teachers. The program, called *Mathematicians Educating Future Teachers* (MEFT), will be outlined in a proposal to be submitted for funding near the end of 2001.

*The Mathematical Education of Teachers*, the CBMS report about to be issued, makes recommendations on the content and nature of courses for prospective teachers, emphasizing the mathematics of teaching. The MAA program is to follow through on the MET report and to help college faculty members implement such courses. Although all the components have not been determined, the program will include workshops, minicourses, and electronic networking support for college faculty who design or teach courses for future teachers. Components will also promote providing professional development opportunities for school teachers through college and university mathematics departments.

The general strategy for MEFT, including a year of planning, came from a September 2000 gathering at the MAA of approximately thirty leaders in mathematics education. The planning Leadership Team consists of Judith Covington, Virginia Bastable, Ed Dubinsky, Glenda Lappan, and Alan Tucker (Chair).

MEFT originated in the MAA Committee on the Mathematical Education of Teachers (COMET), as did the MET report, which was later shifted to CBMS to secure broader support. The idea for MEFT came from Ed Dubinsky and Olaf Stackelburg. Judith Covington is Co-Chair of COMET, and Ed Dubinsky and Glenda Lappan are members. Virginia Bastable is a former K-12 teacher who directs SummerMath for Teachers at Mount Holyoke College. Alan Tucker was the principal author of the MET report. Bernard L. Madison, MAA Visiting Mathematician, is directing MEFT from the MAA offices.

MEFT planning will have two major public components. In September, the Leadership Team will convene a conference of approximately forty K-12 teachers, college faculty, and curriculum developers to advise on the components of MEFT. The second component will be a pilot workshop to be held January 9–14, 2002, following the Joint Mathematics Meetings in San Diego. The workshop, *Teaching Future Teachers*, will be directed by Ed Dubinsky and have Deborah Ball and Hyman Bass as faculty.

Based on the experience of the September 2000 and September 2001 conferences, the MET report, and *Teaching Future Teachers: A Pilot Workshop*, MEFT will have a solid foundation. This foundation work should result in a program to provide continuing support and encouragement for collegiate mathematics departments to become more fully engaged in teaching future teachers and supporting them after they graduate. ■