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The Art of Teaching Mathematics

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MAA FOCUS

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On the cover: A tube of coaxial circles tunnels through the San Diego Convention Center. Photo by John Tweed, Old Dominion University.

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MAA's Commemorative River of Bricks

By Ryan Miller

The brick paths that traverse the courtyard in front of the MAA's Carriage House Conference Center in Washington, D.C. represent the confluence of two bodies of water that help define the District of Columbia: the Potomac and Anacostia Rivers. On Nov. 1, 2007, these pathways took on additional significance with the official unveiling of the Paul R. Halmos Commemorative Walk.

To create the Commemorative Walk, the nearly 1370 bricks that now pave the paths will gradually be replaced by bricks inscribed with the names and memories of those close to the MAA. The first 100 commemorative bricks have now been put into place, and they already tell all kinds of stories.

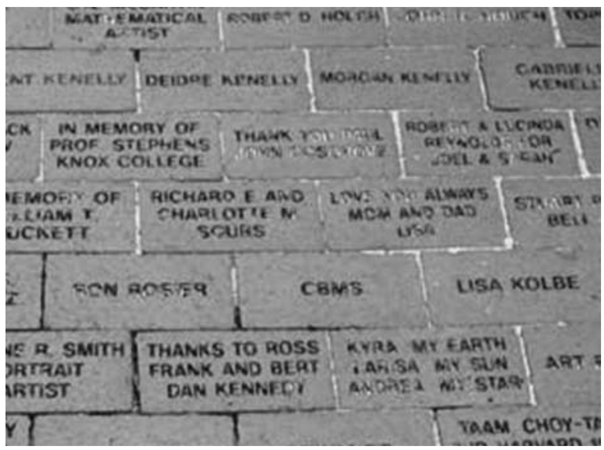
Each member of the MAA's Executive Committee has a brick. John Kenelly bought seven bricks, one for each member of his family. Six MAA sections have purchased bricks. (That leaves only 23 more!) Five current MAA employees who worked for former Executive Director Al Wilcox purchased a brick in his honor. Individual members, colleges, universities, and various organizations with ties to the MAA are all now part of the commemorative walk.

A generous donation in 2003 by Paul and Virginia Halmos made the restoration and renovation of the Carriage House possible. The Conference Center is now actively being used, both by the MAA and by other organizations. The MAA is now raising funds to support the Conference Center and its activities. For just \$303 (the price was chosen to honor Paul Halmos' birthday, on March 3), anyone can have a name or dedication inscribed on a brick to become a part of MAA history. Bricks will be laid in sets of 100 until the walk is completely full.

The response by members thus far has been great, according Lisa Kolbe, the MAA's Development Manager. "I've had nothing but very positive reactions from everybody who has seen the walk so far," she said. The second set of 100 bricks is almost ready to be put down.

The MAA encourages members who are visiting Washington, D.C., to stop by the headquarters, visit the Carriage House Conference Center, and stroll down the Paul R. Halmos Commemorative Walk.

A worker in the process of laying the first 100 bricks.



Some of the bricks that appear in the river of bricks.

MAA Executive Committee and staff members prepare for the unveiling of the first 100 bricks.

MAA President Joe Gallian does the honors.

"Mathematicians Have a Different Perspective" An Interview with Bernd Sturmfels

By Joe Gallian and Ivars Peterson

After receiving his PhD from the University of Washington in 1987, German-born Bernd Sturmfels held positions at Cornell University and New York University before landing at the University of California at Berkeley, where he currently teaches. Sturmfels has received numerous honors, including the MAA's Lester R. Ford Award for expository writing in 1999 and designation as a George Pólya Lecturer. Sturmfels served as the Hewlett-Packard Research Professor at MSRI Berkeley in 2003/04, and was a Clay Institute Senior Scholar in Summer 2004. A leading experimentalist among mathematicians, Sturmfels has authored eight books and about 140 articles, in the areas of combinatorics, algebraic geometry, symbolic computation and their applications. He currently works on algebraic methods in statistics and computational biology.

MAA FOCUS: Did you become interested in mathematics at a young age?

Bernd Sturmfels: I was a pretty good student in school, interested in almost all subjects. There was never anything special about mathematics, no competitions or Olympiads or any such in my high school. After graduating from high school, I was in the German army for 15 months to do my compulsory military service. It was during those lonely evenings in the barracks that I tried to figure out what I was really interested in. That turned out to be mathematics and the emerging field of computer science.

FOCUS: You came from Germany to attend graduate school at the University of Washington. What drew you there?

Sturmfels: My German advisor sent me to Seattle in 1985. I was interested in spending a year abroad, but I was thinking of France or England, something closer to home. My advisor strongly urged me to go to North America. His contacts were primarily at the University of Washington and the University of Toronto, so I was told to go to one of these two schools. He was absolutely right: Victor Klee, a former MAA president, turned out to be a most wonderful thesis advisor for me.

I obtained a fellowship from the German government to study for one year in Seattle. Three months after arriving, I fell madly in love with this wonderful undergraduate English major from Korea, and I just had to stay awhile longer in Seattle. That's why I ended up getting my doctoral degree at the University of Washington. My now-wife and I stayed together all those years, and, after moving around for many years, we finally returned to the West Coast in 1995.

FOCUS: How does mathematics education at the college and graduate school level in the U.S. differ from that in Germany?

Sturmfels: The main difference is that in Germany, students declare their major before entering university. There are few breadth requirements, so once someone is a university student most of the classes taken are in mathematics. This makes for very focused studies; students tend to reach a higher level rather quickly. In the traditional German system, the first degree was called the "Diplom," and one obtained this degree after about five years. It used to be a rather rigorous program, comparable to a strong Masters program with a written thesis.

In the last 20 years, there have been many changes in the university systems in Europe, not just in Germany, and now most schools offer Bachelor and Masters Degrees more similar to the system in the States. Not everyone is happy about these changes, needless to say.

FOCUS: How do you describe your research area?

Sturmfels: I work in combinatorics and algebraic geometry, with a special emphasis on applications outside of pure mathematics. Recently, I have been especially interested in applications in statistics, optimization and computational biology. Computational biology offers fascinating opportunities to mathematicians, and can ultimately lead to new and unexpected developments within mathematics.

FOCUS: Which mathematicians have had a large influence on you?

Sturmfels: Victor Klee, my advisor in Seattle, ranks first. Others that have influenced me greatly include Louis Billera, Richard Stanley, I.M. Gel'fand and Bill Fulton.

FOCUS: You have been involved in "experimental mathematics." What, to you, is experimental? What are the experiments that you are doing?

Sturmfels: Well, computer experiments. I can experiment by hypothesis testing or it could be just plain old exploration, just to see what happens. "Gee I wonder what properties the following mathematical object has." Actually, that's often the first step. I think you can use computation as a tool to form hypotheses, or to test.

I don't trust humans a lot. You know, people think that a written proof is the gold standard. I think many mathematical papers and arguments contain errors and gaps and the only reason we don't find them is because they don't get read. On the whole, the building of mathematics is sound, but if a mathematical statement works out in a computer test, then I believe it a lot more. So I would say exploration, verification, and falsification. And then the last stage is once you have the conjecture or hypothesis then you can sort of go case by case and see: Is it true for $n=8$? And so on.

The design of experiments is very important. I think that's where I sort of see my strength. Just like a lab scientist, a lot of work needs to go into creating a well thought out model system and model organism, to design the experiment, to pick a range of test problems that are not too easy and not too hard, which will reveal the right phenomenon. That's the challenge that distinguishes a good experimentalist from one that's maybe not so good.

FOCUS: Is that influenced by changes in technology?

Sturmfels: Definitely! Certainly now you can do a lot more than when I started. But I would say that experiments in mathematics are not as technology-driven as in, say, molecular biology. Our technology is not progressing at the rapid rate it is in molecular biology, where it's crucial to have the latest equipment just to compete… It's a little less crucial in mathematics. You don't need the biggest computer!

FOCUS: What about on the software side?

Sturmfels: The software side… that's actually quite hard because developing and maintaining software is extremely difficult in an academic math environment. It's a little bit easier in the old German system where you have a professor who has many of these diploma students; that setting lends itself more easily to maintaining software. So the software in my field is quite difficult for an academic math person to develop and even more difficult to maintain. That's a real challenge. I admire anybody who does it and hope they get a lot of support.

FOCUS: Now that you're at Berkeley, a prestigious institution that attracts very good students, how do you find the students and their capabilities?

Sturmfels: I think the students are wonderful, but of course we have a large program in Berkeley. Compared to some of the smaller private schools we compete with, we have more of a spectrum, simply because our program is much larger and also because we try to be open. We have a tradition of letting in students that might not otherwise make the cut, so there's a spectrum. But I would say that the students I worked with are wonderful. I've learned a lot from, and with, them.

FOCUS: And it sounds like you work a lot with them.

Sturmfels: Yeah, it's the best part of the job.

FOCUS: I've known faculty who take the approach of identifying the graduate students they want and approaching them. Is that similar to your approach?

Sturmfels: Yeah I think that's probably similar. It's a little bit like dating. It helps to be proactive. But finding a good match is a two-way street. I think it helps the student along if this relationship is built early on, so I try to play as active a role as possible, both in recruiting when they come to Berkeley, and also in the first year, to identify who might be a good fit.

FOCUS: Has the kind of student you want changed over the years?

Sturmfels: That's a good question. Since I have become a bit more of an applied mathematician, I would also expect my students to be open to engage with people outside of math. Also, I want them to have good communication skills! I've learned over the years the value of communication skills. Of course you have to be good in math, but I think when I was younger I wasn't as keenly aware of how important social skills and communication skills are. One doesn't think about it in the math context, but that's something that I also pay attention to. So if there's a student I feel would have a very hard time communicating in either writing or verbally, then I'm more cautious.

FOCUS: Have you had any significant involvement with undergraduates in research?

Sturmfels: Some, but not as much as I would like to. Lior Pachter and I are teaching an upper division undergraduate course on mathematical biology at Berkeley, where the students work in teams on specific projects. This replaces the final exams, and some interesting research projects have sprung out of that. In fact, I just taught that course in the spring of 2007, and I think that three or four students have continued their research over the summer and beyond. However, I must say that supervising undergraduate research in mathematics is challenging, and essentially impossible for me, if and when it requires very regular one-on-one meetings. A laboratory setting, where undergrads learn from graduate students and post-docs, always works better for the problems of interest to me.

FOCUS: What about the sense of doing mathematics in a broader context, for example in biology and so on. Do students come in with that kind of interest or do they develop it?

Sturmfels: It works both ways. I had some students who were very pure and then found it interesting. There's a good example of a student I work with. He just finished his first year in graduate school. He was an undergraduate at Harvard, and he had a very strong undergraduate math background: a very pure, typical Harvard math undergraduate background. Then he went back to his hometown and worked in the biotech industry for a while. So he got a job and worked for a small private company that was involved in the Grape Genome project, so they got funding from the province of Trento in Northern Italy and they sequenced the pinot noir grape. That was a two and a half year project and in the course of that work he picked up a lot of statistics, genetics, and computational biology. Then he wanted to go back and get a math PhD, so he ended up working with me in Berkeley and it's a very good fit, because he has the biology background but he's now interested in pure algebraic geometry studies. He has the option to go both ways.

FOCUS: How did you become interested in mathematical biology?

Sturmfels: It all started with my junior colleague Lior Pachter. Lior is a computational biologist who ended up in Berkeley's mathematics department. Four years ago, we started talking about phylogenetics, and we soon discovered that the combinatorial structures he was using for problems such as gene prediction or sequence alignments are very similar to things I knew about. We started a joint seminar in the fall of 2003 and it has been a fascinating journey for me and my students ever since. Last year, we published a book called *Algebraic Statistics for Computational Biology*.

FOCUS: When there's a need for communication between mathematicians, and for example, biologists, what kinds of barriers are there? What makes it difficult?

Sturmfels: The language and the background are both very difficult and very different. First of all, people don't understand that mathematicians will speak about biology as a single discipline. But the concept of biology being one field makes no sense to biologists, because obviously there are a thousand different branches that are vastly different from each other. And conversely! At this stage most serious senior researchers in molecular biology in particular realize that they have massive data sets and that they need quantitative help, so often they will say "we are really interested in working with mathematicians," but they don't quite know what mathematics is. As mathematicians, we think that partial differential equations and combinatorics are very different subjects, and that statistics, computer science, theoretical physics, and mathematics are very *very* different subjects. To a typical biologist these are indistinguishable.

So I think we have a lot of educating to do and to explain that there are different areas of mathematics like there are different areas of biology, and they have different points of view. Partial differential equations can do this while combinatorics will do that. And so I think that is very important to explain just what it is you do and what techniques you use, and it's a long process, but an interesting one.

FOCUS: In terms of say, computational biology, what do you see as the important questions and the places where progress is possible?

Sturmfels: I think in evolutionary biology there are key questions. How does evolution really work for biological systems? What drives it? What's the notion of fitness landscapes? I think for the first time people have serious data, so there's statistical genetics. Evolutionary theory has existed for 80 or 100 years, going back to Fisher and Wright and other people in the early 20th century, but I think for the first time we really see a significant amount of data and I think there's some really interesting problems we can now address. Basically, how does evolution work?

FOCUS: Some recent genome comparisons were showing that there isn't that much difference in the genomes of related species, and that more and more important is the significance of what parts are turned on and off. That whole process is changing.

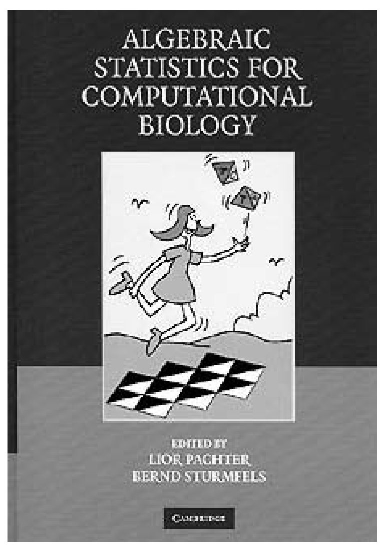
Sturmfels: Exactly, the networks and the regulatory mechanisms are what really differentiate cells, and differentiate organisms and species. I think the amazing variety we see in living systems cannot be explained by a static sequence which is relatively short. The human genome is less than 3 billion base pairs. If you see the complexity of us, that's not enough to explain it.

FOCUS: I think Dick Karp and others have spoken very strongly about the computer side of these things and how important those questions are. Are there similar things on the math side?

Sturmfels: I think so. I think mathematicians have a different perspective. Mathematicians can contribute a lot by clarifying the notions and helping to gain precise definitions of the objects and concepts involved, and that's kind of where I see my role. In the conversation, as a mathematician, I think I'm trained to give precision and rigor to the concepts and to the discussion, while computer scientists thinks more about the large scale model and the complexity of carrying out a certain computation. A mathematician would ask "what's meaningful?" or "what is it we're really computing?" A mathematician would say: "suppose we had a suffiently powerful computer, what would you do with the output?"

FOCUS: What kind of questions can biology suggest for mathematicians?

Sturmfels: I wrote an opinion piece on this for the Clay Institute called, *"Can biology lead to new theorems?"* and I highlighted four examples of such theorems. One that I was involved in was computational algebraic geometry and the study of certain families of algebraic varieties that come from phylogenetics. It turns out that statistical models for evolution can be described by algebraic varieties (in the sense of algebraic geometry). These are



generalizations of classically known varieties, but very interesting new objects. In the last couple of years, we've seen four or five really interesting papers. So I think biology and models for studying biological systems can suggest new and interesting mathematical objects that generalize known objects that have already been classically studied in math.

FOCUS: On a side issue, one of the things mathematicians feel compelled to become involved in are issues about math education, especially at pre-college levels. Do you have any interests or concerns in that way?

Sturmfels: Many concerns. My kid is in school right now so I can see it from that end, but I have not done much with that. I feel that it is more important to build a continuous spectrum of research. We now have K–12 and education research programs, and I feel it is all a little disconnected from the mathematics research community. I think there should be a layer in between; maybe the MAA could play a big role. Maybe also high school math teachers who are very interested in more advanced issues can help bridge the gap. For instance, there is the Park City Mathematics Institute, the summer program where they have a high school program and a college program, and that I think overall works pretty well. They have some joint activities that I think are pretty good. I personally don't see myself diving into the deep sea and the deep waters of K–12 education.

FOCUS: You were saying before that your impression is that too few MAA members participate in NSF and institute programs.

Sturmfels: And conversely, I think the NSF and the institutes could do a better job in reaching out to the MAA community. And in fact I just discussed this with Peter March and he agrees, so I hope that Peter and Joe Gallian will get together and have a chat about this.

FOCUS: Is it just more participation in the actual programs? That means taking time off to spend time for workshops and that kind of thing.

Sturmfels: Yeah, I don't necessarily have the ideal answer; I think that should be a discussion… which format works best? Workshops could work, but maybe other formats too? As a Pólya Lecturer, I've seen a lot of faculty at four-year colleges interested in doing research with undergraduates to stay connected to the research community, maybe to engage in interdisciplinary research with faculty at their college in say, biology for instance. The institutes, for instance MBI at Ohio State, could help find a way to facilitate this. Perhaps they can bring in people, give people a chance to speak about research results, to learn new things. I don't have the answer, but I'd like to raise it as a question. I feel that MAA members are amazing and that they are a slightly underrepresented group at these institutes.

FOCUS on Students: Networking for the non-Networker

By Robert W. Vallin

What comes to mind when you think of the phrase 'working the room?' Maybe you just think, 'That's not something I could do.' For me, it brings to mind Eric Stratton (played by Tim Matheson), a character in the classic movie *National Lampoon's Animal House*. There is a pledge party in full swing, but Stratton, president of Delta House, wants to skip out for a date. Walking through the crowded room, he shakes every hand he finds on the way out each time stating, 'Eric Stratton, damned glad to meet you,' with absolutely zero sincerity.

This is networking, but it's really bad networking. To network is not to meet everyone as superficially as possible, nor is it a game of gathering more names and email addresses than anyone else, nor is it to exhaust yourself doing something which makes you horribly uncomfortable. So what is networking? The *Oxford English Dictionary* reads, 'network/nétwerk (n. & v.) group of people who exchange information, contacts, and experience for professional or social purposes.' Is this helpful? Not really. So we'll just say this: networking is mostly doing the things you'd do anyway, but in such a way as to help you know more people whom you can help and who can help you.

Networking is a very funny thing. In a survey given to students at the Joint Mathematics Meeting in 2007, 65.7% of undergraduates rated networking *very important* or *important*, while 80.8% of graduate students ranked networking in those categories. However, almost half of the undergraduates rated the social events as *somewhat important* or *unimportant* and over half felt that way about the Student Hospitality Center. Almost

This is the fourth in a series of short articles for students. The overall title for the series is **FOCUS on Students**. Some of these articles will be for undergraduates, others for graduate students, and many for all students. These articles will also be posted in the Student section of the MAA web site.

Illustration by Brad Fitzpatrick

60% of the graduate students echoed the feelings of the undergraduates on social events, the Student Hospitality Center, and SIGMAAs (Special Interest Groups within the MAA). In other words, they say networking is important, but feel that these events —where they could be doing it — are unimportant.

Why does networking get such a bad rap? Probably because of the dread that fills the body of the networker as he/she enters the room. The sweaty palms, nervous stomach, feeling of having nothing to add to the conversation, and idea that somewhere there is something more important to be doing are all symptoms of this dread. That's why we want to talk about how to network so you can realize successful communicating is within your grasp.

First off, where do you network? Meetings are a great place. That's pretty obvious. Another place, quickly gaining on first place, is on the Internet. Most students already do some form of social networking by having an account on Facebook or MySpace. Not only can you do social things there, but professional as well. Check out the MAA's Facebook group at http://www.facebook.com/group.php?gid=5110769515. As for 'professional' networking sites, the premiere one is LinkedIn. Created in 2001, LinkedIn, at http://www.linkedin.com, has over 12 million users. It's a free service; you just have to fill out an online profile. This is perfect for the nervous networker, you can 'work the room' at your own pace and communing on the Internet does not have the negative stereotype of chit-chat with people you don't really know. Some other online places to look include the alumni sites for your schools, professional association web pages, resource sites (e.g. directories of people of the profession), and bulletin boards where you can post questions and comments. Remember when emailing or communicating online you need to make a good impression. Be clear, concise, honest, and courteous. Don't use slang or even worse, text language; 'plsd 2 meet u,' gets you nothing.

Suppose you are at the Joint Meetings. You want to go to the First Timer's Reception, but don't know how to mingle. Let's go over some rules. To begin with, building a network takes time. You will not leave the room with a network in place. That is okay. Also, there is no recipe for success, this is not one size (or one rule) fits all.

Say your name clearly. Smile.

Make sure you have a good handshake — firm grip, eye contact, right duration.

It's not just for you, think of what you can do for others.

Listen. Listen for real, it's not just nod your head time.

Ask people about themselves. Then let them answer.

Be prepared to talk about yourself. Introverts find this difficult, so have something already in mind. You can even practice what you want to say. (See the discussion of the elevator talk below.)

If you connect well with someone, get an email address. Then, within 24 hours of getting home, email the person reiterating how nice it was to meet.

Don't stay too long in one spot, but stay long enough to make a good impression. Don't be an Eric Stratton.

You don't have to go it alone. If you want, bring a friend, but just remember, you are not there to talk with your friend, but to meet others.

Now, on to the elevator talk. A lesson from Business School, the premise is simple. You have a project that you think is dynamite. One morning you find yourself riding up in the elevator with the company CEO. During that 30-second ride you have the undivided attention of the boss of bosses. What will you say, in that time, to convince the CEO to approve your project? That's exactly what you want to do when you meet someone except what you're selling is yourself. The elevator talk is not some over the top 'Look at ME!' rehearsed speech, but instead something that will tell the people around you that you're an interesting person. Talk about where you are in school and what subjects you really like. If you are giving a talk or presenting a poster, tell that. This can be difficult for introverts, who like to talk about ideas rather than themselves, but it is necessary.

Some last tips for the reticent. Join a group and participate. Although it can be tough to be active in professional organizations there are ways to be successful. Like learning a foreign language, the key is immersion. If you can help out in some position in the group, then you get to learn about the organization from the inside. Then people will be seeking you out. Also, if there is an event, go early, if possible, even volunteer to help set up. This helps because if you are among the first to arrive the crowd will be small and not so intimidating. Set an achievable goal; e.g. by the end of this meeting I will know five new people having chatted with each for at least 5 minutes and leaving them with my card. Lastly, networking does not just happen at official events. Talk to people. People you meet on airplanes, people waiting in line with you, the guy in the seat next to you at the game, just talk with them. You may be surprised where it leads.

Robert W. Vallin is the MAA Associate Director for Student Programs. He welcomes questions and comments by email at rvallin@maa.org.

Correction

At the August meeting of the Board of Governors only Mary Sheppard was elected to the Audit Committee. We apologize for the incorrect information in the October issue of MAA FOCUS.

The Art of Teaching Mathematics

By Garikai Campbell, Jon Jacobsen, Aimee Johnson, and Michael Orrison

On June 10–12, 2007, Harvey Mudd College hosted *A Conference on the Art of Teaching Mathematics*. The conference brought together approximately thirty mathematicians from the Claremont Colleges, Denison, DePauw, Furman, Middlebury, Penn State, Swarthmore, and Vassar to explore the topic of teaching as an art. Assuming there is an element of artistic creativity in teaching mathematics, in what ways does it surface and what should we be doing to develop this creativity?

The first day of the conference focused on the art of teaching and the second day focused on building community within this craft. The conference was organized by Jon Jacobsen and Michael Orrison at Harvey Mudd College with assistance from John Harris and Mark Woodard (Furman), Ben Lotto (Vassar), and Lew Ludwig (Denison). It was funded by a grant from the Andrew W. Mellon Foundation.

Maria Klawe (Harvey Mudd) opened the conference with "Lessons Learned from a Third Grade Classroom." Maria recounted her four years collaborating with a third grade teacher to explore the effectiveness of mathematical computer games and other activities in enhancing the motivation and learning of mathematics among the students. It was, she said, an experience that not only significantly broadened her understanding of both teaching and learning mathematics and improved her own teaching, but also one that confirmed her sense that teaching mathematics is an incredibly artistic endeavor.

After Maria set the tone for the conference, George Andrews (Penn State) framed the discussion by challenging the notion of teaching as a science and arguing why we must consider teaching as an art. Although there are many lessons we can learn from scientific studies of teaching, George maintained that because of the personal nature of teaching, there will always be aspects of these studies which fail to be repeatable or transferable.

The classroom environment is filled with empathy, self-awareness, subtle adjustments, and other tacit knowledge that is communicated but not stated. Alluding to the work of the philosopher Michael Polanyi, George said, "We know more than we can tell." George prompted us to consider, for example, creating a violin. One needs to work with wood, cat gut and a number of other materials with high degrees of variations. Teaching one to create a violin from these raw materials requires a hands-on sort of training in which one learns to accommodate for all these variations. This parallels the subtle variations we see in our students, classrooms, and college environments. To this end, George argues we should be developing our teaching through the relationship of master and apprentice.

With this in mind, the conference turned to theater to discuss ideas from that realm that carry over to the classroom. Ann Woodworth, a theater professor from Northwestern University introduced these ideas in "The Classroom as a Stage," a workshop in which we both talked about and were required to perform the physical act of teaching.

Garikai Campbell

Ann Woodworth

Tom Garrity

Ann pointed out that according to some, much of what we communicate is nonverbal and of the remainder, up to half is tone. So, in the end, a very small percentage of what we actually communicate is content. Ann demonstrated this, for example, by saying the same simple phrase in three different tones with three distinct sets of body language. The mathematicians in the audience recognized, perhaps surprisingly, the multitude of similarities and connections between acting in theater and teaching in the classroom and the value of paying attention to one's physical presence and voice. This is not to suggest that we don't do this already, but there are tricks one can employ to do even better.

From there, the conference shifted focus and on the second day, concentrated on building community. Garikai Campbell (Swarthmore) reflected on community building through the Professional Development Program (PDP) Summer Math Institute at Berkeley. The program was developed by Leon Henkin and Uri Treisman to, in part, encourage underrepresented minorities to consider pursuing a PhD in mathematics. Garikai talked about his sense of the key communal components of the program that made the year he spent there as a student, one of the most rewarding, exciting, and invigorating mathematical experiences he has ever had.

In particular, he recalled that the intellectual engagement instigated by the organizers, encouraged by the faculty and actualized by the students extended well beyond the courses being taken — students talked about mathematics as a whole; mathematical ideas that were related to things touched on in other students' classes; and even meta-mathematical and philosophical ideas.

Students talked walking back from classes, over meals, on the way to concerts, and out at the weekend picnics. Moreover, the program seemed to be built around a triumvirate of high intensity, high expectations and high accountability and on the principle that a truly successful community should provide students the opportunity to transform how they see themselves so that 'student of mathematics' has the potential to be one's primary identity.

Participants at a breakout session.

Group photo.

Finally, Tom Garrity (Williams) talked on "Using Mathematical Maturity to Shape Our Departments." Other disciplines don't seem to have a corresponding notion of mathematical maturity, he argued, so what is this thing we seem to have so uniquely in mathematics? One can trace through the time a student is in elementary school through undergraduate years, through graduate school to beginning professor to full professor to emeritus and outline the specific skills and reasoning ability one should have minimally attained at each level. Once one does this, a good question one could ask is: what are the ways a department can facilitate the continued development of this mathematical maturity? Tom shared examples from Williams such as Faculty Jam Sessions, in which a few people give talks, in one sitting, around a single topic, and Faculty Dadaism, where over lunch, the department picks three areas out of a hat and tries to make connections.

An interesting theme that appeared throughout the conference was the importance of tacit knowledge in learning — whether it be from the teacher, the classroom environment, the social environment on campus, or the college environment. There was a common thread throughout the conference that suggests we need to do more thinking about what is happening outside our classes. Focusing only on the lectures and homework is a limiting factor.

In our mathematical culture teaching is generally not viewed as an art or craft and master teachers are somewhat reluctant to take on the title and/or to articulate what makes them a master. However programs based on this concept such as Project NExT clearly demonstrate the progress that can be made by embracing this model.

Garikai Campbell and Aimee Johnson are Associate Professors of Mathematics at Swarthmore College, where Garikai is also Associate Dean for Academic Affairs. Jon Jacobsen is an Assistant Professor of Mathematics, and Michael Orrison is an Associate Professor of Mathematics, at Harvey Mudd College.

What Students Say About Their REU Experience

By Frank Connolly and Joseph A. Gallian

In 2006, the American Mathematical Society sent a 30-question survey to 444 individuals who had been student participants in a Research Experience for Undergraduates program (REU) between 1997 and 2001 asking about the value of the programs. Responses were received from 262 students (59%). Of these, 55% were male, 9% were Latino, and 2% were African Americans. Almost without exception, these respondents were reporting on a summer research program, and for a large majority (75%) this program was held at a college or university different from their own. Because the respondents were commenting on an event at least five years past, they had had time to gain perspective on their undergraduate research experience, and were unlikely to be swayed in their responses by an emotional afterglow of a summer's camaraderie.

The first striking result emerges when these students are asked whether they think their REU was valuable to them. They were offered three choices: *Not valuable, somewhat valuable,* or *valuable*. The answers exhibit a strong consensus. Fully 84% answered that it was *valuable*; only one respondent said it was *not valuable*; the rest answered *somewhat valuable*. (Interestingly, 100% of Hispanic students declared their REU experience to be *valuable*.) This is a clear endorsement of REU programs.

The most important question about REUs is whether they are successful in achieving their goals. Of course goals vary. But the goal of the National Science Foundation and the National Security Agency, the two principal financial sponsors of the REU programs, is to enhance the research infrastructure of mathematics within the United States. It is therefore impressive that 78% of all of these respondents entered graduate school intending to obtain a PhD, and 14% more entered graduate school with the intention of obtaining a Masters degree. Nearly all of those entering graduate school (93%) were seeking degrees in one of the mathematical sciences. These are remarkably high numbers.

It is sometimes said that REUs are only getting the students who have already decided to go to graduate school in mathematics. But the survey results do not support that viewpoint. Out of 262 respondents, a total of 231 entered graduate school (82%), and of these, 78% said that the REU was definitely a factor, or somewhat a factor, in their decision to do so. Only 32% of those who did not go to graduate school say the REU was definitely or somewhat a factor in their decision. This might be the most significant finding of the whole survey. It suggests that REU's are valuable precisely in the way they nurture the *commitment* of a student to pursue a career in mathematics.

The respondents seem quite clear-eyed, however, about what an REU can and cannot accomplish. An overwhelming majority (82%) of those going to graduate school say the REU did not shorten their time there. Another clear majority (53%) of these say the REU did not influence their choice of a thesis area (although 36% report their REU had at least some influence on their choice). But two out of every three of these say that the REU had some effect in accelerating their development as research mathematicians.

Most respondents believe that graduate admissions committees saw their REU experience as valuable. Three out of every four say that it helped them get into a better graduate program. Moreover two out of every three respondents who had won a fellowship thought that the REU was a factor in the award.

This article is adapted from one with the same title written by the authors that appeared in the *Proceedings of the Conference on Promoting Undergraduate Research in Mathematics*, edited by Joseph A. Gallian and published by the American Mathematical Society. The volume can be downloaded free at http://www.ams.org/employment/REUproceedings.html. Free bound copies are available by writing to Dana Chyung, Assistant to the Associate Executive Director, at the American Mathematical Society (201 Charles St., Providence, RI 02904). Copies will also be available at the Joint Mathematics Meetings.

Frank Connolly has been director of an NSF funded REU at Notre Dame since 2000 and has been director of Notre Dame's Seminar for Undergraduate Mathematical Research for many years. Joe Gallian has been been director of an REU program at the University of Minnesota Duluth since 1977 and is currently President of the MAA.

Costs and Benefits of Undergraduate Research to Faculty and the Institution

By James Davis, Suzanne Lenhart, and Margaret Robinson

Opportunities for undergraduates to do mathematics research have increased dramatically over the past twenty years. The National Science Foundation and the National Security Agency sponsor programs to encourage involvement in summer and regular semester programs, and individual schools have supported local efforts. The Subcommittee on Research by Undergraduates of the Committee on the Undergraduate Program in Mathematics (CUPM) feels that the community and administrators have accepted the value of this research to the students, but many administrators are not aware of the difference between this work and research by undergraduates in other fields.

Administrators are encouraging departments to increase the involvement of faculty and students in research activities, but are not always aware of the likely resulting costs and benefits to the faculty. This subcommittee wrote a document, *Mathematics Research by Undergraduates: Costs and Benefits to Faculty and the Institution*, with the goal to provide a framework for students, faculty, and administrators to follow as they seek to participate in undergraduate research activities in mathematics.

Here is an example of a difference between undergraduate research in mathematics and in other disciplines. "While undergraduate researchers in other disciplines often assist the project mentor in his/her own research projects, undergraduate research projects in mathematics are often created specifically for undergraduates. Thus, time spent on leading an undergraduate research project is often time taken away from the mentor's own research endeavors. While undergraduate research is extremely beneficial to the student and to the department, it does not always advance the faculty member's own research program."

Of course, we note that in some projects, publications do result with significant contributions from the undergraduates involved. The benefits to the faculty have a wide range in the mathematics community, and many faculty need to be supported and rewarded for their supervision of student work. Possibilities of such support would be one course teaching reduction or a light load of service duties. Rewards might include summer salary or travel funding to visit a collaborator. This work should contribute positively to tenure and promotion decisions. Thus institutional support is a critical component for a sustainable undergraduate research program in mathematics.

The committee's document which has been approved by the CUPM can be found at http://www.maa.org/cupm/CUPM-UG-research.pdf. The CUPM Subcommittee on Research by Undergraduates would be glad to have input and continuing dialogue about these issues. Please contact the authors of this article with your comments.

Suzanne Lenhart is the chair of the CUPM subcommittee on research by undergraduates; she can be reached at lenhart@math.utk.edu. *James Davis (*jdavis@richmond.edu*) and Margaret Robinson (*robinson@mtholyoke.edu*) are committee members.*

Recommendation on Interviews at the Joint Meetings

At its meeting in San Jose in August 2007, the MAA Board of Governors approved a resolution dealing with procedures for job interviews at the Joint Mathematics Meetings and at MathFest. The resolution reads as follows:

The MAA strongly discourages the use of personal hotel sleeping rooms as the site for professional interviews of prospective employees. This practice is intimidating for some job-seekers, particularly those who find the situation uncomfortable and possibly unsafe.

This recommendation will appear in MAA FOCUS before each national meeting of the Association. The Board has also requested that it be printed in the official materials provided for employers and job seekers using the Employment Register at the Joint Mathematics Meetings.

Top Ten Signs of Retirement

By Roseanne Hoffman

I attended a very small grade school: 5th and 6th grades in one classroom, one teacher. I was in 5th grade and my teacher handed me the chalk and said to go to the 6th grade side of the classroom and teach decimals, while she worked with the 5th graders. I think that determined my future.

I have been teaching since 1963, the last 29 years at a community college, at four year universities before that. I still love teaching, but realized it was time. I have been asked how I knew it was time to lay down my chalk. You should certainly not wait until you don't enjoy teaching! This is the list I created.

Signs that one needs to lay down their chalk (or electronic pen)

1. When a former student sees you and asks: "Are you *still* teaching?"
2. When a student asks, "Do we need to know this?" and you reply *no*.
3. When *all* the students get the correct answer when you use the polling devices in the classroom.
4. When you create a mathematics lesson so that you can incorporate the *Wii* in the classroom.
5. When you need two carts to get your course materials into the classroom.
6. When you need space on the H drive and you can't decide which files to delete, so you delete them all.
7. When you realize you will never get that grant of 25 tablet PCs for students to use for a semester.
8. When you finally get a classroom with individual tables and chairs (not tablet chairs) for students to use.
9. When you get the *biggest* SMART-Board on campus.
10. When you ask for a "rotating" laptop computer loaded with mathematics software for mathematics faculty to borrow over weekends and the answer is "*yes*."

Roseanne Hoffman laid down her chalk at Montgomery County Community College.

CSMC Hosting International Conference

The Center for the Study of Mathematics Curriculum (CSMC) is hosting an international conference on the subject "Future Curricular Trends in School Algebra and Geometry" on May 2-4, 2008, at The Field Museum in downtown Chicago and on The University of Chicago campus. The conference will feature international experts from Australia, Europe, and South America, and national expertise from the United States.

The conference is open to all, but limited in size. Registrations will be accepted on a first come/first-served basis. If you are interested in attending, please check the CSMC web site, http://www.mathcurriculumcenter.org/conferences.php,for further details and a registration form.

MAA on the Road: At the AMATYC Annual Meeting in Minneapolis

By Michael Pearson and Candace Baumann

The American Mathematical Association of Two-Year Colleges (AMATYC) held its 33rd Annual Meeting in Minneapolis on Nov. 1–4, 2007. The meeting had originally been scheduled for New Orleans, but the facility that was to host the meeting was permanently closed as a result of Hurricane Katrina. AMATYC decided to move to the other end of the Mississippi River and hold "New Orleans in Minneapolis, 2007."

Michael Pearson talks with a visitor to the MAA's booth at the 33rd AMATYC Annual Meeting. Photo by Candace Baumann.

About 1,000 people attended this year's conference. Highlights of the meeting included Bernie Madison's invited lecture on the increasing importance of quantitative literacy for effective participation in the modern world, both in the workplace and as a citizen. Wayne Roberts' talk, "The Derivative as a Linear Transformation" was well-received. Wayne also spoke about the importance of his experience as a student (and later as a teacher) at Morton Junior College to his outlook as a faculty member at Macalester College.

Dan Kennedy gave a delightful early-morning lecture, "My Year with NUMB3RS: Mathematics Goes to Hollywood" describing some of the interesting mathematical ideas from that show. He also noted other examples from recent popular culture, including *A Beautiful Mind* and *Proof*, in which mathematics plays a significant role. As Dan observed, the mathematical community should not miss the "teachable moments" afforded by these events.

The 2007 conference marked the end of the MAA's formal involvement with Project ACCCESS (Advancing Community College Careers: Education, Scholarship, Service), an early-career professional development program modeled on Project NExT. The first three years of this program were funded by ExxonMobil in response to a proposal submitted jointly by MAA and AMATYC. Project ACCCESS is currently led by Karen Gaines of St. Louis Community College and Brad Chin of West Valley College. Fellows participate in workshops and sessions at two consecutive AMATYC meetings. Alhough the initial funding period is over, AMATYC plans to continue the program, and the MAA will continue to support Project ACCCESS Fellows by providing a one-year membership and limited funds for travel to MAA Section meetings.

The MAA booth buzzed with activity throughout the entire meeting, and several MAA members volunteered their time at the booth to talk to AMATYC members about the benefits of MAA membership. Thanks in particular to to Steve Blasberg, Joanne Peeples, Abe Mantell, Ray Collings, Dennis Ebersole, and Jay Malstrom.

Keep Up with ICMI News

ICMI News is the new electronic newsletter of the International Commission on Mathematical Instruction (ICMI). It aims to improve communication between ICMI and people interested in mathematics education worldwide. It will include information about actions and recommendations of ICMI, highlighting issues that are under discussion and reporting about ongoing activities.

ICMI News will also report on major activities by the ICMI Affiliated Study Groups (HPM, PME, IOWME, WFNMC and ICTMA), on major international events related to mathematics education and on other topics of general interest to the community of educational researchers, curriculum designers, educational policy makers, teachers of mathematics, mathematicians, mathematic educators and others interested in mathematical education around the world. The editor will be Jaime Carvalho e Silva of the Department of Mathematics of the Faculty of Sciences and Technology at the University of Coimbra (FCTUC), in Portugal. He is a member of the ICMI Executive Committee. He can be contacted at icmi-news-editor@mathunion.org.

To subscribe, visit http://www.mathunion.org/ICMI/Mailinglist.

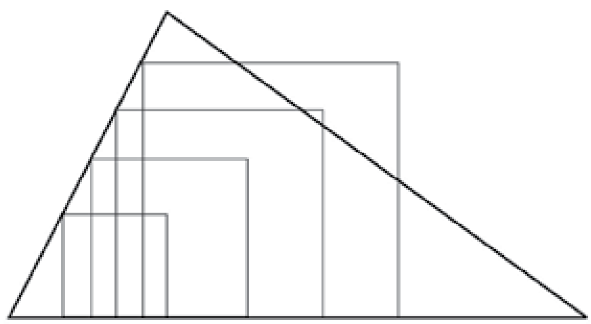
What I Learned from… Shutting Up and Listening

By David Kung

"Can you always inscribe a square in a triangle?"

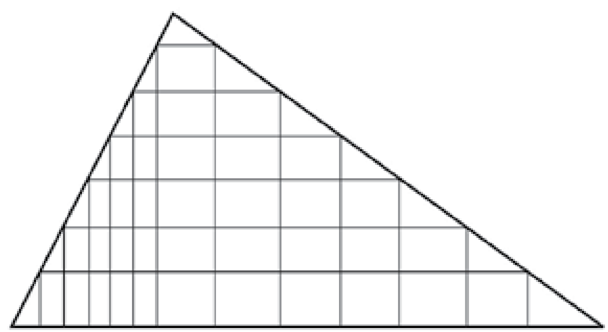
It seemed like such a simple problem to start out my proofs course. I had adapted the problem from Schoenfeld's work on problem solving and planned to spend about 45 minutes letting them muddle through the poor wording and implicit quantifier to come up with the two usual solutions. Two groups dutifully produced those solutions, both based on the Intermediate Value Theorem.

Alberto's group looked at small squares that have three vertices on the triangle and argued that you could expand the squares until the fourth corner met the triangle:



(Their picture brought up an important point: do the "free" corners of the squares all lie on a straight line?)

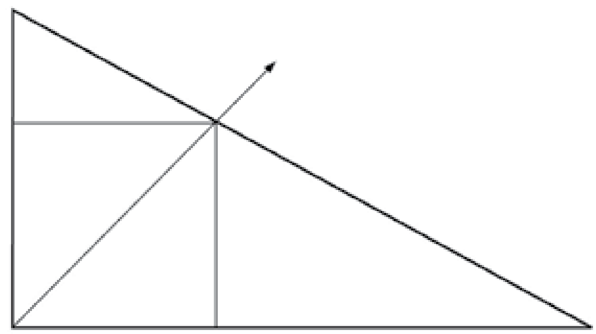
Beryl's group looked at a family of inscribed rectangles and argued (again using the IVT) that the family included a square:



When pushed to be more precise, Beryl's crew produced a nice graph of the height vs. width of the rectangles, which necessarily crossed the $y = x$ line representing the squares.

What I heard from the other students as I wandered among their groups was so interesting that I ditched my previous plans and ended up spending three hours (seriously!) listening to their ideas and having them discuss, debate, and refine them. While they were working in groups I would listen in and ask questions, but when it came to the discussions, I mostly shut up and listened from the back row.

Chantelle's group decided to solve the problem on a special class of triangles, namely right triangles. Their picture looked something like this:



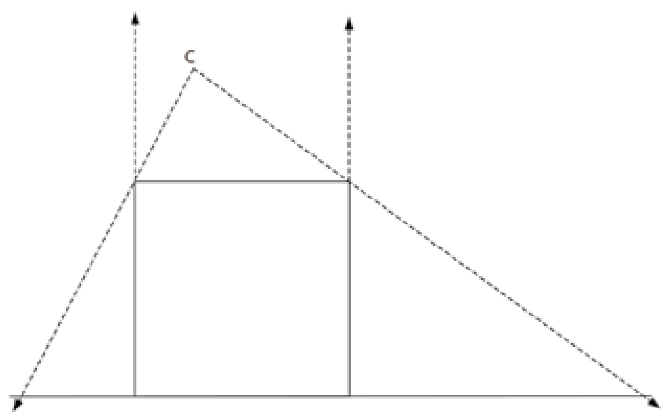
It made for a great discussion between Beryl and Chantelle's groups when I pointed out the similarities between this picture and Beryl's graph of the height vs. width of the family of rectangles.

The most interesting part of the discussion came from Debby's group. In the initial exploration of the problem, she steered her group in a unique direction. "Let's start with the square!" My reaction came in two parts:

Internal: "That's absurd! You can't start with the square!"

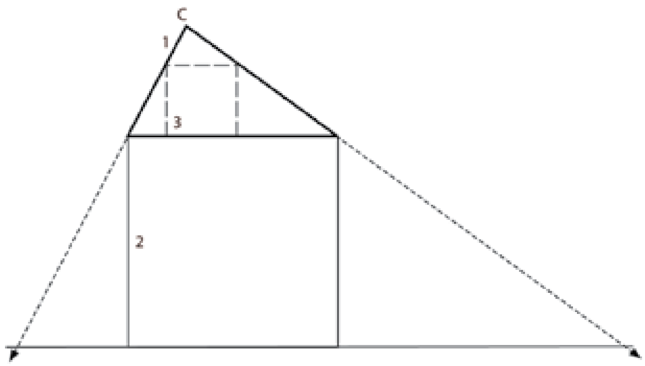
External: "That's interesting. If you start with the square, what happens?"

After receiving some feedback from the rest of the class (who thankfully avoided thoughts similar to my internal ones) they refined their idea to the following. You can get "any" triangle by placing a vertex C between the extensions of the two vertical sides of the square, connecting C with the two upper corners of the square, and extending the lines until they meet the extension of the bottom of the square.



This led to places I never dreamed this problem would touch on. The class, with me hiding in the back row to avoid getting in their way, quickly realized you couldn't really get "any" triangle, but rather one similar to any triangle (equivalence classes anyone?) They also argued back and forth about the wisdom of starting with the square: how do you begin a proof of $\forall x \exists y \; R(x,y)$? This last conversation was punctuated by Ernesto's brilliant observation:

Start with the triangle (1), draw a square below it (2), use Debby's group's idea, and then rescale the whole picture to get the square inside the triangle (3) instead of below it!



This solution is so much better than what I had in mind! It's constructive in the sense that it doesn't rely on the IVT. It makes it very clear that you need to start on the longer side (picture what happens when you put the square adjacent to an obtuse angle in the triangle). Students who were skeptical of the other methods seemed to understand this method very quickly. And in the end, they even agreed that the argument does have to start with the triangle (even if their solution didn't).

What did I learn from this day? Two things that I carry with me into every class I teach.

First, I need to spend more time listening and less time talking. Of course I know more mathematics than my students do, but that doesn't mean that talking at them all the time is the best way for them to learn. At the end of this episode, those students all understood the problem and the solution — and they had started grappling with some of the harder material we would face later in the semester. Perhaps most importantly, they felt a sense of ownership over this solution that would not have developed if I had presented a solution to them. Their open ended, meandering conversation wouldn't have happened if I had been at the front of the room directing things. I needed to step aside and let them think things through.

Second, I need to provide students more opportunities to explore rich problems like this — problems that have multiple solution strategies and subtly contain the content I'm aiming for. This gives them the freedom to argue out their ideas (both good and bad) and experience first-hand the excitement and intrigue of learning new mathematics.

Dave Kung was the 2006 sectional teaching award winner from the MA/VA/DC section of the MAA. He currently resides at Fudan University in bustling Shanghai, enjoying a sabbatical from St. Mary's College of Maryland. He's spending the year improving his Mandarin and co-writing an upcoming book entitled What Could They Possibly Be Thinking: Understanding Your College Math Students. *He can be reached at* dtkung@smcm.edu.

The 2008 IAS/Park City Mathematics Institute: Analytic and Algebraic Geometry

By William H. Barker

Each summer since 1994, the Institute for Advanced Study in Princeton, NJ has sponsored a unique mathematics event in Park City, Utah: the IAS/Park City Mathematics Institute. For three weeks mathematics researchers, scholars, and students at the post-secondary level, as well as mathematics educators at the secondary level, gather for research and study in Park City, a setting of breathtaking mountain scenery and outdoor opportunities.

In 2007, PCMI participants marched in the Park City July 4 parade.

The PCMI group gets ready to march.

This year's PCMI Summer Session will be held from July 6 to July 26, 2008, with a research theme of *Analytic and Algebraic Geometry: Common Problems – Different Methods* and an education theme of *Knowledge for Teaching Mathematics*.

The fundamental, driving goal of the IAS/Park City Mathematics Institute (PCMI) is to provide a consistent and persuasive model for career-long development for all mathematics professionals. Through its summer institute, PCMI offers parallel but interconnecting programs for a variety of components of the mathematics community. Cross-program interaction — a central goal of the summer institute — is accomplished through both structured and unstructured activities. The premise on which PCMI was founded — and which continues as its central cornerstone — is that interaction between research and education strengthens all aspects of the mathematical enterprise.

The themes of PCMI are developed in five separate but connected programs:

- *Research Program*, for mathematics researchers,
- *Undergraduate Faculty Program*, for undergraduate college faculty,
- *Secondary School Teachers Program*, for secondary school teachers,
- *Graduate Summer School*, for graduate students,
- *Undergraduate Program*, for undergraduate students.

At the Summer Session these groups meet simultaneously, each following an individual program of research and study. However, considerable interaction takes place between the groups due to the fundamental structure of PCMI: lectures and courses in each Summer Session program are open to all participants and, in addition to the activities specific to each group, there are daily events of general interest designed for the full Institute. Further opportunities for informal and social interaction are also available, ranging from organized Cross Program activities to informal conversations over meals. Cross-program mentoring is also encouraged and nurtured to further enhance the sense of community among participants. The rich mathematical experience combined with interaction among groups with different backgrounds and professional concerns results in greatly increased understanding and awareness of the issues confronting contemporary mathematics and mathematics education.

Each of these programs will be attractive and appropriate for many members of the MAA. However, the Undergraduate Faculty Program (UFP), with its focus on collegiate mathematicians with a strong interest in undergraduate education, is of relevance to a particularly large portion of the MAA. Co-sponsored by NSF's Chautauqua Program, the UFP offers opportunities for broad professional growth and engagement with the excitement of mathematics by working with peers on new approaches to teaching, tackling research questions, and interacting with the broader mathematical community.

One of the popular "pizza and problem solving" sessions run by Andy Bernoff of Harvey Mudd College. This event happens several times at each PCMI institute, and regularly attracts close to 200 participants.

This year's UFP instructor/coordinator will be Thomas Garrity, the William R. Kenan Jr. Professor of Mathematics at Williams College. His program description is as follows:

Algebraic Geometry in the Undergraduate Curriculum

Algebraic geometry is one of the richest areas in all of mathematics and also has the somewhat legitimate reputation for being one of the most difficult. Still, undergraduates can learn and do research in algebraic geometry. For faculty, knowing even a little algebraic geometry can lead to insights in teaching from calculus to the highest level courses. The 2008 Undergraduate Faculty Program intends for its participants to:

1. *Develop a sufficient understanding to be able to teach an undergraduate course in algebraic geometry.*

2. *Work on research type problems in algebraic geometry.*

3. *See how ideas from algebraic geometric are used in other courses and fields.*

4. *Survey current work in algebraic and analytic geometry, thus allowing meaningful interaction with the other PCMI programs.*

In essence, algebraic geometry studies the zero loci of polynomials, linking algebra and geometry. Without much effort, topology and analysis also arise naturally. In fact, algebraic geometry likely lurks in the background of most areas of mathematics. Used in class, algebraic geometry can highlight connections between traditionally segregated areas of undergraduate mathematics. The UFP sessions will give participants the needed tools to make these connections.

UFP participants have traditionally taken part in many of the other PCMI programs. For example, some UFP participants like to attend the Graduate Summer School courses or lectures in the Research Program. Some also work actively with the Secondary School Teachers program, particularly concerning pedagogical, curricular, or articulation issues. A large number are attracted to the Undergraduate Program, both for the interesting mathematics in the courses and for the kind of research experiences for undergraduates that are often available.

This summer's UFP instructor/coordinator, Tom Garrity was an undergraduate at the University of Texas at Austin, a graduate student at Brown University, and a post-doctoral instructor at Rice University. He joined the faculty of Williams College in 1989, serving as the William R. Kenan Jr. Professor of Mathematics, department chair, and the director of the Williams College Project for Effective Teaching. With research interests in algebraic geometry, differential geometry and number theory, Tom is the author of *All the Mathematics You Missed [But Need to Know for Graduate School]* and appears with Colin Adams in the DVD *The Great π/e Debate: Which is the better number?* Among his honors is the 2004 Haimo Award for Distinguished Teaching by the Mathematical Association of America.

For more information and application instructions for the Undergraduate Faculty Program, consult the UFP web page at http://pcmi.ias.edu/current/program_undergradfaculty.php. Reviewing of applications begins January 20, 2008, and financial support is available for participants in all the programs. For more general information on all aspects of the 2008 Summer Session consult the PCMI web page: http://pcmi.ias.edu/.

Bill Barker is Isaac Henry Wing Professor of Mathematics at Bowdoin College in Brunswick, ME, and a member of the PCMI Steering Committee.

Calculus Placement that Really Works!

By Todd Retchless, Randy Boucher, and Donald Outing

Bored students, overwhelmed students, and instructors struggling to make their classroom work: these are some of the difficulties faced by colleges and universities attempting to develop curriculum for students who have taken calculus in high school. As the number of students entering college with calculus experience has increased, so has the difficulty of identifying which students should receive credit for single variable calculus and be enrolled directly into more advanced courses. As a result, many instructors are faced with the difficult task of designing lesson plans that will reach an audience with vastly different calculus backgrounds. While the Advanced Placement (AP) Calculus Exam score gives us some indication of a student's preparation, by itself it is an inadequate indicator of future success. So how can we best assess a student's high school calculus foundation and in turn leverage this at the university level?

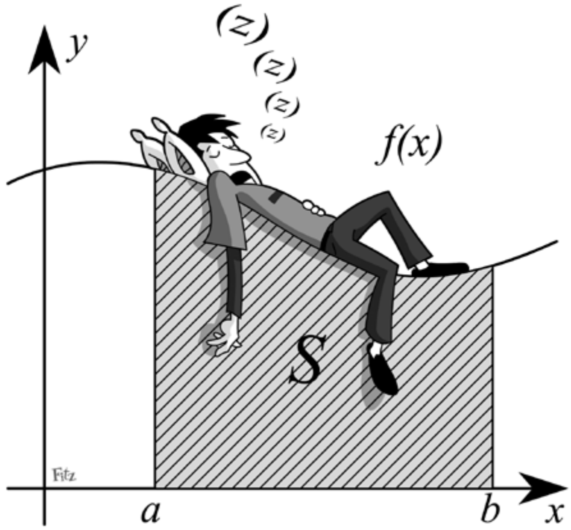


Illustration by Brad Fitzpatrick

Over the past three years, the Mathematics Department at the United States Military Academy (USMA) has developed a course placement process for an advanced math program that cuts through this uncertainty. By considering students' performance on two USMA administered single-variable calculus validation exams, as well as any AP Calculus Exam Scores on file, we are able to enroll our best qualified first year students into a mathematics curriculum rich in multi-variable calculus and differential equations.

Each year, the USMA enrolls approximately 400 students who have taken calculus in high school, with about 170 having AP Calculus Exam scores on file at USMA. During the summer prior to the first academic semester, students with calculus experience are administered an open-invitation single-variable calculus validation exam. The validation exam is 110 minutes long and tests student comprehension of single-variable calculus concepts (typically topics covered in college Calculus I and II) without the use of technology (i.e. graphing calculator). Upon completion of validation exam grading, approximately 180 to 190 students receive single-variable calculus validation credit based first on their validation exam score and second on their AP Calculus Exam score (when available). These students also receive advanced placement and are enrolled into a fall semester offering of multi-variable calculus.

Student performance is closely monitored by instructors during the first two weeks of the semester. This allows students to acclimate to the pace of the course and permits instructors to assess students' skills through classroom interaction and graded assignments. The culminating event of the placement process is the administration of a second single variable calculus exam (again without the use of technology) at the end of the second week. While similar in nature to the summer validation exam, there is a much higher performance expectation on this exam as students have had two weeks to prepare. At this point in the selection process 10 to 20 students will normally transfer out of the program, either by self nomination or by the suggestion of their instructor, resulting in a final enrollment of approximately 175 students (roughly 14% of each entering USMA class). It is important to note that nearly one-third of the students in the advanced program do not have any AP Calculus scores on file at the USMA.

Selecting the most qualified students — those who demonstrate strong fundamentals and the ability to learn at an increased rate — allows the development of a curriculum rich in advanced mathematical concepts. As a result, we have been able to create a two semester advanced mathematics program consisting of courses in multi-variable calculus and differential equations. This allows us to expose students in our program to topics not found in the core mathematics curriculum, such as advanced vector calculus, infinite series, and a full semester of differential equations. Additionally, our students participate in an interdisciplinary guest lecture program and a rigorous technical writing program designed to pique their interest in and prepare them for future study in math, science, or engineering. We take great pride in the fact that nearly 70% of participating students over the last three years chose to major in a math, science, or an engineering (MSE) discipline.

Although many hours are required to implement a placement process such as this, we believe the benefits are worth the cost. Through the administration of in-house validation exams, we are able to best identify students deserving of advanced placement who, for whatever reason, do not have AP Exam scores on file. Each year, students in this category account for nearly one-third of our total enrollment in the course and have historically performed at or above the course averages. We also believe that a thorough placement process allows us to include more rigor into mathematics instruction in the classroom. As a result, we have developed a process to more accurately assess a student's high school calculus education. The assessment permits us to correctly place entering freshmen into the appropriate academic level of instruction. Students are less bored, more involved, and properly challenged in the classroom. Students complete the course more confident in their advanced skills and better prepared for further study at the university level.

The authors teach at the Department of Mathematical Sciences at the United States Military Academy. Todd Retchless received his M.S in Applied Mathematics from the University of Maryland and is currently an Assistant Professor. Randy Boucher received his M.S. in Applied Mathematics from the University of Washington and is currently an Instructor. Donald Outing received his M.S and Ph.D. in Applied Mathematics from Rensselaer Polytechnic Institute and is currently an Academy Professor.

Employment Opportunities

KANSAS

Tabor College, Hillsboro
Professor of Mathematics
Tabor College invites applications for the position of Professor of Mathematics to start fall 2008. Ph.D. in mathematics preferred. Suitable teaching experience required. Responsibilities include teaching undergraduate courses in the mathematics major, and in the general education courses offered by the department, supervising senior projects, advising students majoring in mathematics, serving on appropriate committees, and other duties, as assigned. Candidates must understand and support the mission of the department of mathematics and computer science and the mission and goals of an evangelical, Anabaptist Christian college (refer to www.tabor.edu/about-tabor/employment/faculty#job2), and must be able to articulate a personal Christian commitment. Salary commensurate with experience and rank. The mathematics and computer science department offers majors in Mathematics, Computer Science and Computer Systems Administration and includes programs for pre-engineering and secondary teaching. To apply, send letter of interest, vita, and names of three professional references to lawrencer@tabor.edu. Review of applications will begin January 1, 2008; applications will be accepted until position is filled. Tabor College is an Equal Opportunity Employer operating under the auspices of the Mennonite Brethren churches of the United States. It complies with all applicable non-discrimination laws.

KENTUCKY

Berea College
Mathematics
and Computer Science Department
Berea College announces a full time, tenure-track position in the Mathematics and Computer Science Department, beginning September, 2008. Appointment will be at the assistant professor level. A Ph.D. in Computer Science and willingness to teach courses in mathematics or a Ph.D. in the mathematical sciences with a willingness to teach courses in computer science is required. A strong commitment to teaching is essential. Responsibilities center on mathematics and computer science teaching ranging from introductory to advanced undergraduate. Above all we are seeking candidates who can achieve excellence in teaching and who, in an undergraduate environment, will find ways to grow professionally. All faculty in the Department will be expected to interact with students on a one-on-one basis in the excitement and vitality of their growth through such activities as summer faculty/student research, independent studies, or senior capstone projects. The Department is supportive of all forms of scholarship. Applicants should send a cover letter, resume, transcripts of graduate and undergraduate work, a statement of personal teaching philosophy, and three letters of recommendation by January 21st to Professor James Blackburn-Lynch, Chair, Mathematics and Computer Science Department, CPO 2146, Berea College, Berea, KY 40404. More information about Berea College and the Mathematics and Computer Science Department is available at http://www.berea.edu/mcs/ Women and minority candidates are especially encouraged to apply.

Berea College, in light of its mission in the tradition of impartial love and social equality, welcomes all people of the earth to learn and work here.

OREGON

Southern Oregon University
Tenure-track Assistant Professor, Southern Oregon University, starting Fall 2008. One tenure-track position in Mathematics Education. Application review begins January 15, 2008 and continues until position is filled. Requirements: Doctorate in Mathematics Education or Ed. D. in Mathematics Education or Mathematics, excellent teaching record, strong commitment to teaching undergraduate mathematics, potential for professional activity including publication, speaking and grant writing. Applicants must be willing to work with regional K-12 teachers and teacher educators. See http://www.sou.edu/hrs for complete position description and salary. Send ALL of the following: vita, statement of teaching philosophy, description of professional goals, summary of teaching evaluations, all post-secondary transcripts, completed SOU Faculty Application, and three letters of recommendation to: Dr. Dusty E. Sabo, Department of Mathematics, SOU, Ashland, OR 97520. SOU is an Affirmative Action/Equal Opportunity Employer.

RHODE ISLAND

Roger Williams University
The Department of Mathematics in the Feinstein College of Arts and Sciences at Roger Williams University invites applications from candidates specializing in the area of Statistics for the position of Visiting Assistant Professor of Mathematics/Statistics.

Review of applications will begin January 15, 2008 and will continue until the position is filled.

For a full description of this position and how to apply, please go to: http://www.rwu.edu/depository/hr/jobs/faculty/fcas_visiting_asst_professor_math-stats.pdf.

SOUTH CAROLINA

Central Carolina Technical College
Mathematics Instructor (2 positions): #020901MA & #139217MA.
Responsible for teaching college credit algebra, statistics, trigonometry, geometry and calculus classes at main and off campus locations. Requires Master's Degree in mathematics or a Master's Degree with 18 graduate semester hours in mathematics. Post-secondary teaching experience with ability to teach all levels of college math and Master's Degree

in mathematics or Master's Degree with 18 graduate semester hours in mathematics preferred. Apply online at http://jobs.sc.com or visit www.cctech.edu.

Questions? Contact the **Personnel Office** by email: **personnel@cctech.edu**
or by mail:
Central Carolina Technical College
506 N. Guignard Drive
Sumter, SC 29150

WISCONSIN

Milwaukee School of Engineering
Mathematics Faculty Position
The Milwaukee School of Engineering invites applications for a full-time mathematics faculty position starting in the fall of 2008. The person selected should be able to teach any of the standard courses in an undergraduate mathematics curriculum and possible a course in graduate level engineering mathematics. MSOE offers degrees in engineering, engineering technology, technical communication, business, construction management and nursing. Candidates should possess an appropriate doctoral degree and related experience. Salary and rank will be commensurate with experience.

MSOE is located in the heart of downtown Milwaukee and has been recognized in several national publications for its "applications-oriented" approach. Faculty are judged primarily on excellence in teaching. MSOE graduates are in high demand as evidenced by our strong job placement rate.

The review of candidates will begin immediately and continue until the position is filled. To apply, please submit a detailed resume, evidence of teaching excellence and three professional references to: Dr. Karl David, Chair, Mathematics Department, Milwaukee School of Engineering, 1025 N. Broadway, Milwaukee, WI 53202-3109. The information can also be faxed to (414) 277-7462. Please visit us at www.msoe.edu.

Viterbo University
Mathematics
Assistant Professor, Tenure Track
The Mathematics Department at Viterbo University invites applications for a full-time tenure-track position, effective August 2008. Responsibilities include teaching courses such as the pre-Calculus sequence and the Calculus sequence, Statistics, "liberal arts" mathematics, mathematics for education majors, business mathematics, and upper-division courses in the major such as Linear Algebra, Differential Equations, Abstract Algebra, Geometry and Real Analysis. Student advising plus department and university service is expected. Qualifications include a Ph.D. in mathematics and teaching experience. Viterbo University is a Catholic, Franciscan, ecumenical liberal arts institution with an undergraduate enrollment of 1,980 located in southwest Wisconsin in the scenic upper Mississippi River Valley. Relocation assistance is available. Send letter of application, application form www.viterbo.edu/EmploymentApplication.aspx, curriculum vita, undergraduate and graduate transcripts, a statement of teaching philosophy, and three letters of recommendation to: Dr. Mary Hassinger, Dean, School of Letters and Science, Viterbo University, 900 Viterbo Drive, La Crosse, WI 54601. FAX: 608-796-3391 Email: mchassinger@viterbo.edu. Review begins January 21, 2008 and continues until position is filled. Viterbo University is an equal opportunity employer and encourages nominations and candidacy of historically underrepresented groups. www.Viterbo.edu.

ASU College of Liberal Arts & Sciences
ARIZONA STATE UNIVERSITY

DIRECTOR, SCHOOL OF MATHEMATICS AND STATISTICS

Arizona State University announces an international search to recruit a Founding Director for the proposed School of Mathematics and Statistics. Arizona State University (see http://www.asu.edu) is a dynamic, internationally recognized research university serving more than 60,000 students in the Phoenix metropolitan area, one of the fastest growing urban centers in the nation. The Department of Mathematics and Statistics at Arizona State University (see http://math.asu.edu) currently has about 50 tenured or tenure-track faculty members and offers a range of undergraduate and graduate programs including pure mathematics, computational and applied mathematics, mathematical biology, statistics, and mathematics education.

The Department has established strong interdisciplinary ties with University and community-based research and education initiatives. The Director of the School is expected to maintain and expand these by providing visionary leadership, overseeing growth in the faculty and research programs, and supervising the further development of the graduate and undergraduate programs.

Candidates must have an earned doctorate in mathematics, statistics, or a closely related field and a distinguished scholarly record appropriate for appointment as a full Professor. Desirable qualifications include documented leadership skills, previous administrative experience in a doctoral-granting department, experience with program development in research and education, evidence of excellent communication and organizational skills, and evidence of commitment to working with and supporting a diverse student and faculty population.

The position is available beginning 1 July 2008. Salary and start-up funding will be competitive and commensurate with qualifications. Review of applications will begin on 4 January 2008; if not filled, applications will be evaluated every two weeks thereafter until the search is closed. Applicants must submit electronically (in MS Word or PDF format) a cover letter and current curriculum vitae to Mr. Gabriel Escontrias (Gabriel.Escontrias@asu.edu). Inquiries and nominations should be directed to: Sid P. Bacon, Dean of Natural Sciences, College of Liberal Arts and Sciences, Arizona State University, PO Box 876505, Tempe, AZ 85287-6505; or email: spb@asu.edu. A background check is required for employment. Arizona State University is an affirmative action, equal opportunity employer committed to excellence through diversity.

The Mathematical Association of America
1529 Eighteenth St., NW
Washington, DC 20036

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