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The Mathematical Association of America
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Mathematics in the Technical Work Force

Susan Forman and Lynn Arthur Steen

Conventional wisdom about mathematics education has often focused on "three T*s*": texts, tests, and teachers. Current political priorities have added two more T*s*: tracking and technical education. Although these latter are somewhat less visible, especially to mathematicians, they are no less important for the quality of mathematics education.

The campaign for advanced technical education is a centerpiece of the Clinton administration's educational program. The economic rationale for this priority is clearly spelled out in Robert Reich's *The Work of Nations*. The political rationale is centered in concern for an internationally competitive workforce. The personal rationale can be seen in the long lists of college graduates (and Ph.D. recipients) who cannot find work suited to their education.

To improve the transition from school to work, Labor Secretary Reich and Education Secretary Richard Riley advocate greater emphasis on programs in grades 10-14 that prepare students for technical careers in fields such as

Please see ***Technical Work Force*** *on page 9*

Reflections on the Joy of Teaching

Alan Tucker

Remarks on receiving the MAA's 1993 National Award for Distinguished Teaching, Cincinnati, Ohio, January 1994.

I am very honored to be a recipient of the MAA's 1993 National Award for Distinguished University/College Teaching of Mathematics. Teaching collegiate mathematics has always been so satisfying for me that I have felt obligated to those around me in my academic life—my students and fellow faculty—to pay them back in some way for making my life so enjoyable. While teaching day in, day out can lose some of its joy and excitement, one critical aspect of good teaching, I believe, is keeping the excitement constantly alive. If teachers show that they feel good about teaching, their students will feel good about learning, and this in turn enhances the pleasure of teaching.

At the same time that I am excited about being a mathematics teacher, I am fairly humble about the fact that 95% of the work in the educational process is done by the students; I am just their coach. I want very much to help them learn, but it is very hard to get into their heads to know the right things to say and the right times to say them. Thus, I characterize my job as *teaching students to show me how to help them learn*. To emphasize my role as coach and where the real responsibility lies, I often compare developing the mind to developing muscles. If I take a person into a room full of exercise equipment and I talk about how these machines can develop the body, my lecture, no matter how polished, will not build anybody's muscles. Mathematical learning involves growing many new synapses (and related biological changes) in the

Please see ***Reflections*** *on page 8*

★ The MAA Gopher is here! See page 18.

★ Individual Subscriptions now available for *Math Horizons*. See page 23.

FOCUS

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Editorial

Do We Need Education Reform?

Do we need education reform? Is our education system currently in a "crisis"? Several of the articles in this issue of *FOCUS* address these questions in one way or another.

To be honest, I do not know the answers. Certainly, things are not perfect—but then, they never are (or were). Moreover, those of us in the education business should always evaluate what we do, how we do it, and how successful we are. That much is part and parcel of being a professional, not just in education but in any walk of life. There are always ways to improve, and we need to be constantly looking for those ways. But is our education system in need of radical reform, the kind of major overhaul that many are calling for?

Most of us who have made mathematics the focus of our professional lives have been educated in the system that many now say is in need of complete change. If it was so bad, how come so many of us are doing what we do today?

One obvious difference—and maybe it is the principal difference—is the environment in which children grow up. We went through the educational process at a time when the written word was still the principal medium for broadcasting information. We were adapted to the concentration and time commitment necessary to obtain information from books. We learned at an early age that "technical" reading is not a passive activity, rather it requires considerable involvement. The same thing is not true today. Audio-visual communication is, for many, the norm. Attention spans are shorter, and there is a greater expectation of "gloss". Whether you think this is a good thing or a bad thing is beside the point; it is the way things are, and that is the environment in which we, as educators, must work.

The question is, do these changes in environment and expectation require just a modification to the education system we currently have, or is there need for radical reform? If the latter, how can we be sure we do not throw out the baby along with the bath water? As I said at the beginning, I do not know the answers, and I am wary of those that claim they do. But not knowing the answers will not make the questions go away, nor will the issues become less acute.

—Keith Devlin

The above are the opinions of the FOCUS *editor, and do not necessarily represent the official view of the MAA.*

CD-ROM Textbooks and Calculus

Roland E. Larson

Textbook publishing appears to be on the brink of a revolution—one that is likely to change the way we think about classroom instruction. The *static* printed textbook may be giving way to a new *dynamic* format: CD-ROM.

Up to now, college publishers have made only a few ventures into this new format. The reason is clear: the cost of producing a major textbook can easily transform this "cutting edge of technology" into the "bleeding edge of technology."

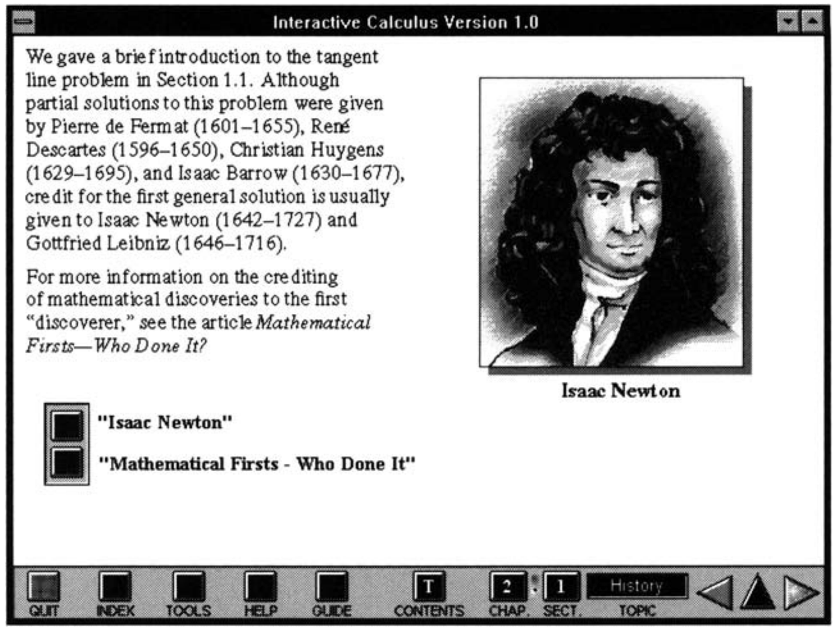
Now, however, the call for educational reform has increased the likelihood that CD-ROM textbooks could be commercially successful. With that possibility, we can expect the appearance of several new CD-ROM products.

This article, the first of two, explores the advantages of a CD-ROM calculus textbook.

In terms of currently affordable technology, the disadvantage of a CD-ROM textbook is that it is simply not as convenient as a printed textbook. Even most portable computers weigh more than printed calculus textbooks! Users of a CD-ROM textbook are restricted as to *where* they can use the text—reading in bed, for instance, is probably not a realistic option. Users are subject to computer or battery failure, and screen resolution is not as good as typeset resolution. In fact, if a CD-ROM calculus textbook is simply an electronic page turner, then the inconvenience of relying on a computer makes the printed version the better choice.

The advantages of a CD-ROM calculus textbook are its *storage capacity* and its potential for *interactivity*, *use of multimedia*, and *nonlinear organization*. The remainder of this and the next article will consider each of these four advantages.

Storage Capacity: An immediate advantage of a CD-ROM textbook is its enormous capacity for storing data. A single CD can contain many thousands of pages of text and art. In CD form, a calculus textbook can easily include historical



references, current journal articles, solutions to exercises, and alternative approaches.

By itself, the storage capacity of a CD is not a compelling reason to change from the comfort of print. In fact, initially the calculus reform movement talked about developing a "lean" course. (My second article on multimedia and nonlinearity explains how a CD-ROM calculus text can be both lean and voluptuous.) Much more compelling are a CD-ROM's capacity for interactivity, use of multimedia, and nonlinear organization.

Interactivity: Computer software is interactive if its responses depend on user input. An automatic teller machine is interactive because the amount it dispenses depends on the account holder's selection.

An *interactive* calculus textbook is one that is capable of responding to user input. At the low end, an interactive calculus textbook could consist of a single instruc-

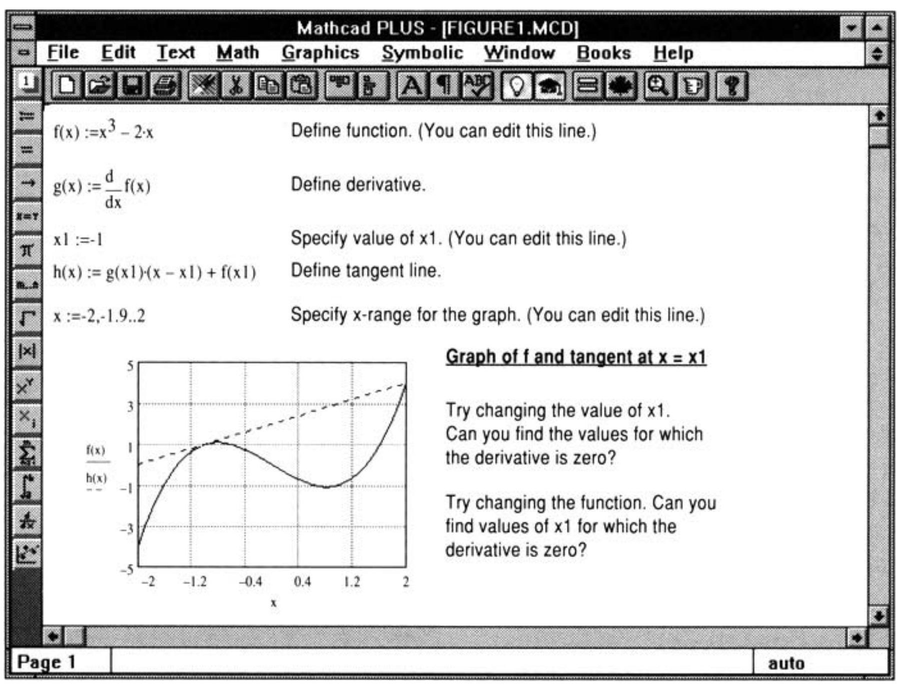


Figure 1 *This interactive exploration was written with* Mathcad. *In the initial screen the user is asked to estimate graphically the x-values at which the derivative of* $f(x) = x^3 - 2x$ *is zero. Each time the user edits the value of* $x1$*, the graph updates to reflect the new input. After exploring this function, the user can edit the function f to obtain an entirely new exploration.*

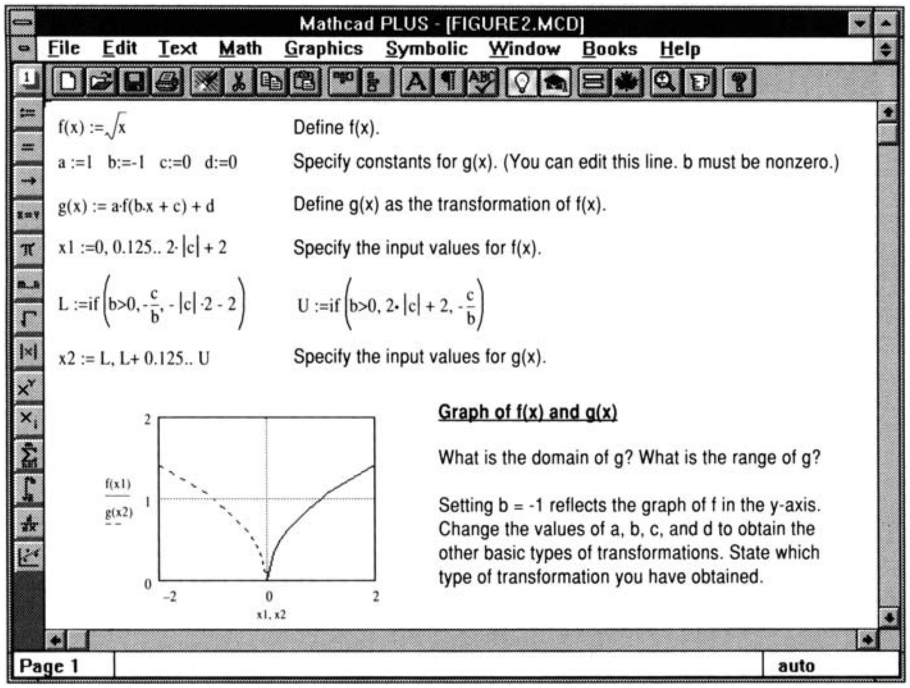


Figure 2 *In this exploration, the user is invited to "play" with the values of* a, b, c, *and* d. *As each of these constants is changed, the graph immediately updates. The goal of the exploration is for the user to discover how each constant affects the graph of the function f.*

tion on a word processor—"discover calculus for yourself." In this case the computer's interaction consists of keeping a record of the user's voyage. At the high end, the computer could play the role of an all-knowing tutor who would guide the user on his or her voyage. Each step up the interactive ladder involves more time and money for the developer of the text.

The *Mathcad* screen shown in Figure 1 is an example of *interactivity*. The user is able to edit the definition of *f*, the choice of $x1$, and the x-range of the graph. After each change, the entire screen updates to reflect the new input. Similar versions of this exploration can be written with symbolic languages such as *Derive*, *Maple*, and *Mathematica*.

This "exploration" invites the user to find x-values graphically at which the derivative is zero. Because the tangent line is redrawn with each new choice of $x1$, the user can discover that the appropriate values are close to ± 0.816. This exploration can also be used to confirm that the exact (or analytic) values are $\pm\sqrt{2/3}$.

The learning opportunities provided by interactive explorations like those shown in Figures 1 and 2 are very different from those provided by a printed textbook. For an author, the challenge in writing such explorations is to move out of the storytelling mode and into the "discovery" mode, as shown in Figure 2.

In this exploration, the user is asked to change the values of the constants a, b, c, and d. Each time the user edits one or more of these values, the graph updates to reflect the new input. A storytelling mode would explain how these four constants are related to horizontal shifts, vertical shifts, and reflections. A discovery mode allows students to deduce their own conclusions.

In practice, students seem to be more successful in courses that strike a balance between the storytelling mode and the discovery mode. If a CD-ROM calculus textbook is used as an alternative to a printed textbook, interactivity should form only part of the picture. Much of the CD-ROM textbook should be comprised of "noninteractive" material, such as definitions, examples, and theorems.

Interactivity has consequences that reach beyond the environment of a single student studying calculus. In a traditional classroom, an interactive CD-ROM textbook can be used as a lecturing device. In a nontraditional classroom or a math lab, an interactive textbook provides a perfect vehicle for group activities. In a tutorial center, an interactive textbook is capable of providing unlimited extra practice.

The screen shown in Figure 3 is taken from an interactive calculus textbook. It is the first of a group of five screens that explore the concept of a tangent line. The first three "pop-up" screens walk the user through

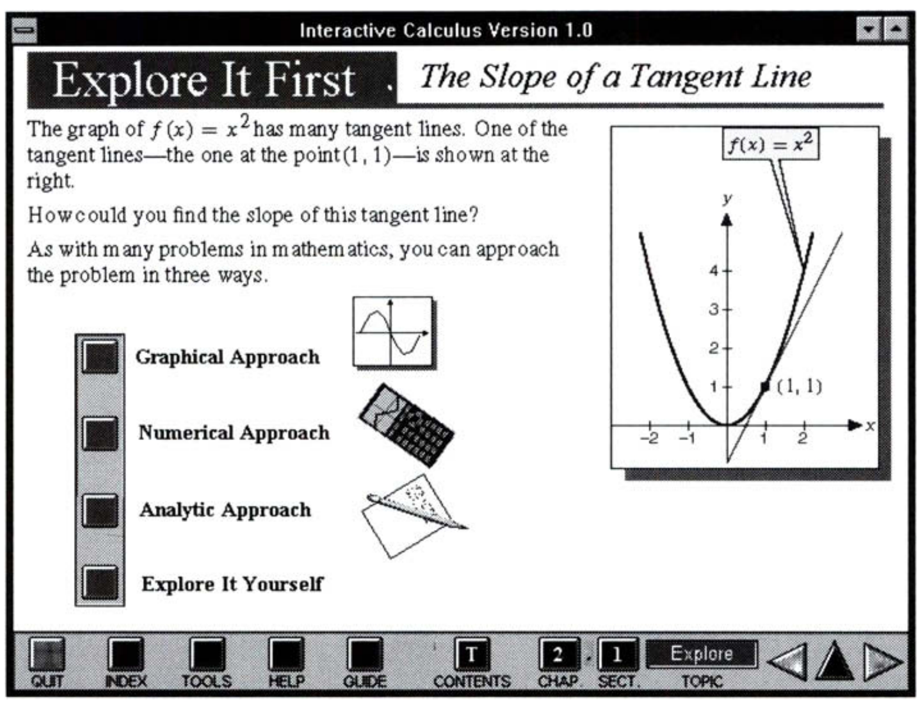


Figure 3 *The screen design for an interactive textbook needs to be very different from the page design of a printed textbook. For instance, this screen is the first of a group of five screens that explore the concept of tangent lines. Rather than having a lot of information on a single screen, the design calls for "morsels" of information on several screens. This type of design allows an interactive textbook to be used as a classroom lecturing device, and it also provides "rewards" for individual users. Each time the user moves on to a new screen, he or she is rewarded with new visual stimulation.*

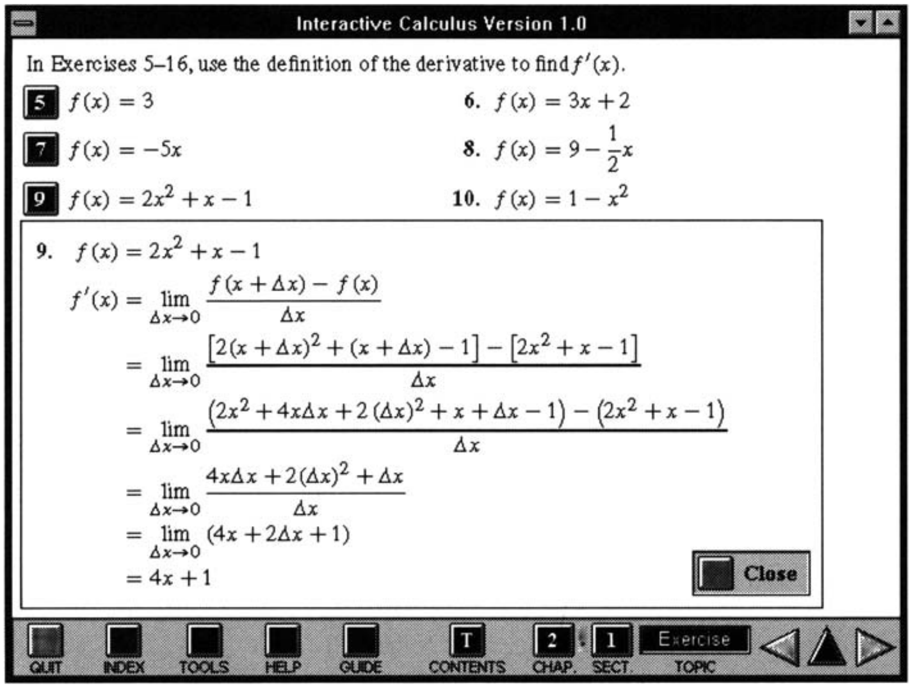


Figure 4 *Because of its vast ability to store data, a CD-ROM calculus textbook can provide many more examples for users. Including the worked-out solutions of the odd-numbered exercises of a typical printed calculus textbook would require several hundred pages of text. With a CD-ROM textbook, prose, art, explorations, animations, videos, examples, exercises, and worked-out solutions can all be stored on the same disc.*

various approaches to finding the slope of the tangent line. The last screen asks the user to try using one or more of the approaches to find the slope of the tangent line at a different point on the graph of $f(x) = x^2$.

Screen design and interface are important considerations for developers of interactive textbooks. For instance, using large type with an open format is not only more engaging for individual users, it also allows the textbook to double as a classroom lecturing device.

Figures 4 and 5 illustrate two ways that interactivity can be incorporated into the exercise sets of an interactive calculus textbook. At the push of a button, worked-out solutions can provide additional examples for the user, as shown in Figure 4, or problem-solving tools can be provided, as shown in Figure 5.

Rockley L. Miller, editor of *Multimedia & Videodisc Monitor*, lists the following learning benefits of interactive textbooks.

- *Reduced Learning Time* Several studies have found that interactive technologies reduce learning time. Although most of these studies have concerned remedial or technical subjects, one could expect similar results in calculus and other "mainstream" courses.
- *Privacy* When used in a one-on-one learning environment, an interactive book allows students the opportunity to "ask" questions without risking embarrassment.
- *Increased Retention* Preliminary studies are indicating that interactive learning situations have resulted in increased retention. This appears to be occurring because interactivity can provide immediate feedback to the user.
- *Increased Motivation* The dynamic interaction between user and computer has been shown to focus a user's attention. Users tend to respond more to the active setting of a CD-ROM textbook than the passive setting of a printed textbook.

In a May 1993 article in *Newsweek* titled "An Interactive Life," Barbara Kantrowitz and Joshua Cooper Ramo discuss the promises that interactivity hold for communication, entertainment, and education. They claim that the products that are beginning to appear are just the "first generation." What can we expect within the next decade? The answer appears to be: no one knows. It seems clear, however, that we can expect change.

The second article in this series will focus on two other advantages of a CD-ROM calculus textbook—*use of multimedia* and *nonlinear organization.*

Roland E. Larson is a professor of mathematics at Penn State University at Erie. The fifth edition of his calculus text, Calculus, *with D. C. Heath and Company, is available in printed and CD-ROM versions.*

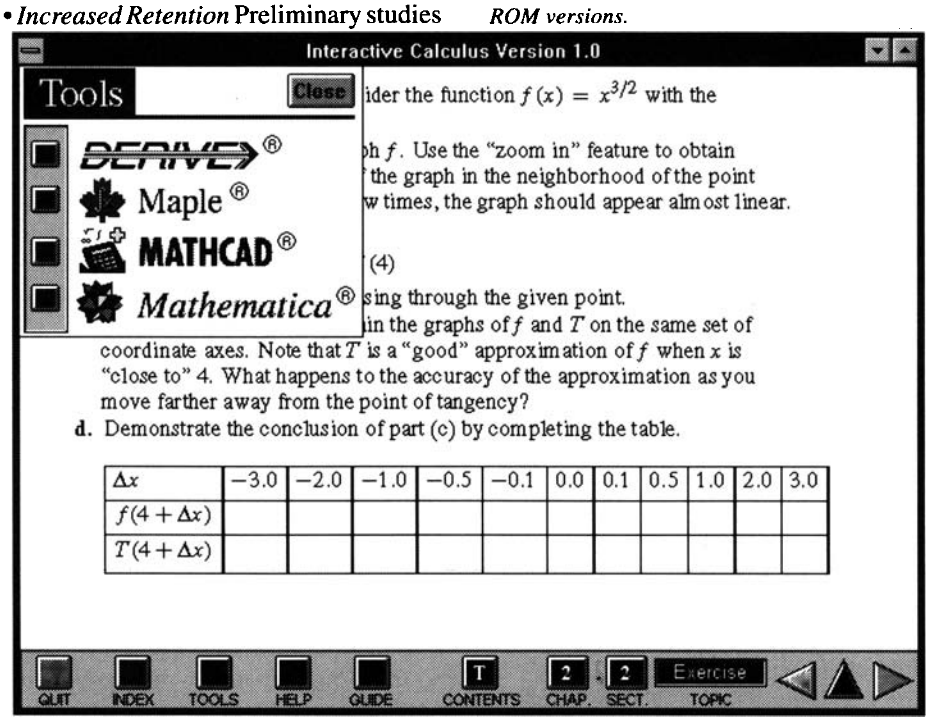


Figure 5 *An interactive calculus text can be programmed to interface with a variety of existing products. For instance, the tools button of this interactive textbook allows users to open a symbolic language window and use the language to solve the exercises provided in the textbook. Similar interfaces can be programmed to include word processors, graphing calculator simulators, curve-fitting software, testing software, and spreadsheets.*

Student Attitudes in First-Semester Calculus

David Bressoud

One of the large lecture sections[1] *of first-semester calculus at Penn State was surveyed to determine student attitudes toward calculus and the learning of calculus. This is a summary of the picture that emerged. The student described here is not entirely typical: only half of the students were in class that day. 91% of those who answered this survey reported that they regularly attend class. This is therefore a picture of the conscientious student who comes regularly to class. It says nothing about the student who does not come to class. I have chosen to name this conscientious student Chris.*

Chris is a science or engineering major in the first semester of the freshman year and is, by definition, a good student who did well in high school. Chris has always liked math,[2] feels confident about the ability to handle it,[3] and believes that it will play an important role in the chosen major.[4] Especially appealing is the precision found in mathematics and the sense of satisfaction that comes from getting an exact solution to a problem.[5] Chris took an Advanced Placement calculus course in high school last year,[6] but entered Penn State feeling insecure about the ability to use calculus. Expecting that it will provide an important foundation for later courses, Chris began this class looking for a better understanding of the topics that were studied the previous year.[7]

Having had an AP calculus class the year before, Chris has found all of the topics covered in first-semester calculus, and some of those in second-semester calculus, are familiar. Nevertheless, Chris comes to all or almost all of the lectures.[8] The professor spends the first half of the period talking about the theory involved in the topic at hand, and then moves into examples of problems that are based on this theory.[9] The material is projected onto a screen with the use of transparencies, many of which are prepared beforehand. Being conscientious, Chris strives to write down everything that is projected. Because the concentration is focused on getting everything written down, there is little time to listen or try to make sense of what is being said.[10] Chris will not ask questions;[11] the large lecture is simply too intimidating.[12] Not all of the other students are working as hard. Many in the back are talking, and some are sleeping.[13]

Later that same day,[14] it is time to study calculus. This means doing the homework problems.[15] Chris is conscientious, doing every problem that is assigned,[16] but feeling frustrated by the even numbered problems for which there are no answers in the back of the book.[17] The homework problems are worked alone, but sometimes Chris will discuss the most difficult ones with friends who are taking, or have taken, this course.[18] When doing the homework, Chris initially relies on what is remembered from last year. The next recourse is usually the notes from that day which are used to find examples of similar problems. Such examples are often helpful, but the notes from the theory part of the day's lecture make little or no sense.[19] The third recourse is the book, which is searched for worked-out examples.[20] Chris will spend about an hour working on the assigned problems that relate to that day's lecture.[21]

Once a week, there is a lab session that uses graphing calculators. To Chris, this is a mechanical exercise that is required, but seems to bear no relationship to the rest of the course.[22] It would be much more helpful to go over the homework problems.[23]

There are two midterm examinations given on Wednesday evenings. Serious study begins the weekend before the exam.[24] This means putting in two to three hours a night until the day of the test[25] redoing homework problems, working the practice exams, going over notes, and sometimes looking through the textbook.[26] The theory that was explained at the beginning of the lectures is unimportant because it never appears on the exams.[27] There is a good deal of frustration after the test because the exam questions are not quite like the homework questions,[28] and it does not seem that the instructor has tested what Chris has studied. The fact that the exams are multiple choice with no partial credit and that each exam counts for such a major portion of the grade reinforces a sense that the purpose of the exam is to trap and fail as many students as possible.[29]

Chris is becoming increasingly cynical about the importance of calculus. There has been no sign that it is actually useful for anything.[30] Maybe calculus really is just a "weedout course."[31] Having arrived at Penn State with the hope of beginning to understand calculus, Chris thinks it has now become more confusing than ever. There seemed to be more emphasis on concepts and understanding in high school than is being found at the university.[32]

M. Kathleen Heid and Barbara Edwards suggested many of the questions that went into this survey. A list of the questions and a more detailed summary of the responses can be obtained by anonymous ftp under pub/bressoud/survey.dvi *at* math.psu.edu.

Notes

[1]Initial enrollment was 350 students.

[2]On a scale of 1–10, 87% of respondents rated how much they like math as 7 or higher, 63% rated it as 8 or higher.

[3]58% of respondents felt that they could discover some mathematics on their own. Only 33% were certain that they could not.

[4]Among the most common responses to "How is calculus used?" were engineering, physics, science, and higher mathematics.

[5]This was the most common response to the question "What do you like about calculus?" Typical answers were "I like calculus because, as in all math, it has definitive answers," and "I like calculus because it is like a puzzle. If you know how to play or figure it out, you win." In a related vein, many students like the algorithmic nature of mathematics: "I like how it is very methodical and tedious."

[6]89% of respondents had taken calculus previously; of these, 53% took Advanced Placement calculus in high school.

[7]The most commonly given answer to the question "What do you expect to get out of class?" was "better understanding of calculus."

[8]As stated above, 91% of respondents come regularly to class. Many of these emphasized that they have never missed a class.

[9]This summary of what happens in the classroom is based on the respondents' descriptions.

[10]95% of the respondents said that they take notes in class; 43% said that they listen, pay attention, watch, or try to understand. A typical response was the student who said, "The prof gives notes and does a few examples. Most students pay attention and try to take notes, but he moves quickly. I usually end up behind and start doodling."

[11]85% of the students never ask questions in class.

[12]"Very rarely [ask questions in class]. The atmosphere is not conducive to interaction between lecturer and student. It's just too big."

[13]These were common responses to "What do other students do?"

[14]55% of the students will do the homework relevant to a given lecture either before or on the same day as the lecture. An additional 24% will do the homework problems within one week of the lecture.

[15]90% said that when they study they do homework or practice exam problems; 22% go over their notes; 17% go over the book.

[16]66% of respondents do all of the assigned problems. Homework is not collected or graded.

[17]A common complaint is expressed in this comment: "On the syllabus, there are quite a bit of even problems assigned. This is pointless, especially when the answers to such problems are posted one week later. You need to know if you're doing the homework right *as you do it*, *not* one week later. Either assign more odd problems or give us the answers to the even problems sooner."

[18]56% study alone, although many of these will sometimes get help from or help others. An additional 27% will sometimes study alone and sometimes study with others.

[19]Some of the comments were "I try to use [the notes] to figure out homework, but a lot of the notes seem like useless information," "I rarely read the notes, unless I have a problem with one of the homework problems," and "I always take notes! I read them but they make no sense."

[20]"[I use the text] when my notes fail to make sense. The text doesn't provide too much help either, it's written so technically that it's almost like reading a foreign language," and "You must filter out what is important and what is just to confuse you."

[21]55% of the students normally spend two to four hours a week studying calculus. Half of the remainder spend less than two hours, half over four hours. Students who have not had calculus before will spend about twice as much time.

[22]Asked to describe a typical lab session, 66% of the respondents said things such as, "I do the lab, then I leave." 29% were more negative: "We get worksheets that make no sense and put down answers that we don't understand."

[23]There was no question on the survey that addressed this issue, but it was one of the most common complaints.

[24]48% start studying at least five days before the exam, another 26% start the weekend before the exam.

[25]Before an exam, students average an extra nine hours of studying.

[26]As reported above, 90% said that when they study they do homework or practice exam problems; 22% go over their notes; 17% go over the book. Few students distinguished between "studying" and "studying for a test."

[27]"I try to take notes and pay attention, but it is very hard to [do] so because the material is not always necessary to do well on the test."

[28]Several students complained that the tests bore no relationship to the homework and seemed to be based on memorized tricks rather than on understanding.

[29]These were common complaints about the course.

[30]The second most common response to the question "What don't you like [about calculus]?" was it is not useful for anything. The most common response was to describe one or more specific topics such as volumes of solids of revolution.

[31]A term used by several students.

[32]When asked to describe the difference between high school and university mathematics, 32 respondents talked about the quality of explanations, the emphasis on concepts, the familiarity of the instructor with the material, and the requirement of more thought and deeper understanding. 81% felt they got more of this in high school; 19% said that they got more of it in college.

David Bressoud recently left Penn State for Macalester College in St. Paul, Minnesota, not out of discontent, but attraction to a student-centered environment.

Reflections from page 1

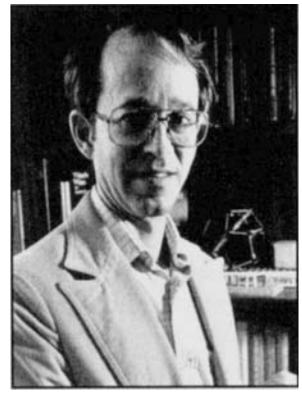
brain, and strenuous mental exercise is the only way that growth will occur. Coaching can include some standard lecturing, but such lectures are meant to provoke questions that show me where students have problems. I often remind myself of the Chinese proverb, "I tell you, you forget. I show you, you remember. I involve you, you understand."

One way of trying to stay excited about being a mathematics teacher is by reminding myself constantly of how hard it is to learn. There are two miracles that I will never understand, given the very imperfect creatures we humans are: one, that large, complex, human organizations function at all (I am constantly amazed when the lights are on every morning when I come into work!); the other miracle is that semester after semester, most students in my classes are learning lots of completely new ideas. As I age, I appreciate more and more how hard it is to learn new things. Perhaps teachers focus too much on what students have not learned, not adequately celebrating how much they have learned. Several times each semester, I stop during class and ask my students to look back at how much their knowledge has advanced since entering college or since eighth grade.

It annoys me when a student, upon solving a problem that had stumped him or her, says to me, "That was dumb of me not to see how to do it." In reality, such students usually figured out for themselves, with a little help from me, some problem that required reasoning skills they were just starting to acquire. The student should have said, "I think I'm developing a good understanding of how to solve these problems." Another instance is the term "dumb question." If a student has not been following a presentation and asks a "dumb question," it usually means that he or she is now trying hard to follow the class discussion while realizing the need to know some important fact that did not register as being important earlier. Even if the student's mind was wandering earlier or the student dozed off briefly (tired from being up late with a part-time job and a computer project, students cannot be expected to be alert constantly), the student tried to do the right thing in asking the question, and probably most other students would benefit from hearing that basic point reiterated. An occasional, truly lazy question is a small price to pay for having a classroom environment in which asking questions is recognized by students and instructor as a welcome and essential contribution to the learning process.

I should add another miracle to my list of miracles: the power of mathematics. Working in mathematics, we take for granted how amazingly dependable mathematical truths are. Compare mathematics to biology or economics. While biology has accumulated vast knowledge about the principles of how organisms work at the macro and molecular levels, if one performs some subtle biochemical test on the contents of some flask today and then does it tomorrow or in another lab, there is a good chance that the results will differ. The same applies to a fiscal stimulus imposed on two different countries or companies. But in mathematics, when students at my institution or another institution ten years from now integrate $sin(5x)$ from 0 to π, they will always get the same answer. Layer upon layer of techniques and concepts in mathematics are predicated on this consistency and reproducibility. Facility in such complex, multi-layered reasoning is great preparation for performing effectively in any sort of career, whether mathematically-based or not.

My appreciation for teaching is a family affair. My grandfather taught math before becoming a Methodist minister, and my father, A. W. Tucker, an eminent mathematician at Princeton, always spoke of himself as a teacher. He said that his university paid him to teach and gave him free time to do research. He had always wanted to be a teacher, originally a high school math teacher like his father, but he did not want to stop studying after a B.S. or an M.S. and ended up on a path leading to university teaching. At home, he talked constantly about his students and his joys in watching them grow and enter satisfying careers. When he was chair of Princeton's math department in the 1950s, he never had a reduction in his two-courses-per-semester teaching load—if anything suffered, it was his research. Further, as chair, my father appointed himself as the course coordinator teacher in



freshman calculus one semester each year, because, as he told me, "Teaching calculus is the most important thing the department does, and so as chair I felt I should be leading that effort." When I was young, I knew I wanted to be a math professor like my father so I could have the immense satisfaction that I saw him get from this profession.

I believe my father passed on to me a sense he got from his father that teachers had a special responsibility to look out for their students' interests (a bit like ministers towards their parishioners). One of my father's stories conveyed that message in stark terms. While a graduate student at Princeton, my father taught a section of analytic geometry. The professor in charge taught a specially chosen class of talented students. He expected all sections of the course to move at the fast pace of his special section. My father felt that pace was too fast for his own class and he asked the professor for a meeting to discuss the syllabus. The professor began the meeting by insisting that my father agree in advance to adhere to the syllabus they would decide on. My father refused, and the professor went to the mathematics chair, demanding that my father be dismissed for insubordination. Fortunately, a fellow TA sought help from another professor (S. Lefschetz, who respected people who stood up to intimidating professors), and my father was transferred to another course. I asked my father where he got the courage to stand up to the professor, risking his career. He told me he had no choice, the welfare of his students was his first priority as long as he was their instructor.

Alan Tucker is at the State University of New York at Stony Brook.

Technical Work Force from page 1

telecommunications, manufacturing, and agriculture. As educators have developed standards for mathematics and other subjects, so now industry associations are developing occupational standards in "skills clusters" to provide a portable national credential that will fit the workplace better than the traditional high school or college diploma.

At the school level, many of these occupational training programs fall under the general title of "tech-prep"; at the college level—most often at two-year colleges—the moniker of a new NSF program, Advanced Technical Education (ATE), provides a convenient descriptor. Many of these programs combine the last two years in high school with the first two years of post-secondary education into "2+2" programs.

In a recent study titled *Preparing for the Workplace*, the National Research Council reports that only one in five adults has a four-year college degree. "The other 80%" enter the world of work either directly out of high school, or after completing some non-baccalaureate form of post-secondary education in institutions ranging from community colleges to proprietary vocational institutes, from employer-sponsored training programs to community-based organizations. Overall, 50% of recent high school graduates take post-secondary education in contexts that are not leading to a four-year bachelor's degree.

No matter the institution or the program, mathematics plays a critical role in all such technical education programs: virtually every course of study requires mathematical preparation, often of a type that is quite different from the traditional "school-to-college" preparation that leads from algebra to calculus. That's where the other "T" comes in: the growth of school-to-work programs, valuable as they may be to many students, may well lead to a new and potentially invidious form of tracking.

The historical form of tracking that NCTM argued against in their *Standards* relegated large numbers of students, disproportionately minorities, to dead-end courses in which students received little challenge and even less education. The new career-based tracking will be more seductive—who can resist the allure of high-tech occupational preparation—but equally capable of perpetuating socio-economic class distinctions. Decisions made in early high school years—especially decisions about mathematics courses—can program students into a tech-prep or college-prep curriculum with little opportunity for switching. Yet students' dispositions for change between ages 15 and 20 virtually guarantee that no inflexible system of early tracking can be personally or educationally sound.

ATE programs employ distinctive examples in which mathematics is often embedded in occupational contexts rather than being presented within a traditional disciplinary framework. That such programs differ from the traditional pre-college track does not necessarily make them worse, weaker, or "watered down." But the presence of two parallel and quite different tracks, possibly beginning in grades 9 and 10, may prematurely foreclose future options at a time when neither students, parents, nor teachers can reliably predict a student's educational trajectory.

This poses a special challenge to the mathematical community: how to support the clear national need for tech-prep and ATE programs without undermining students' options for a traditional four-year bachelor's degree program. Educators also should be concerned that some students who are on the fast track for traditional college programs—sometimes under parental or peer pressure that may not reflect their true interests or abilities—may finish high school ignorant of options for post-secondary technical or vocational preparation that may suit them better than traditional college programs.

One resolution of this dilemma would be a common mathematics program that could serve equally well as preparation for college and as preparation for skilled work. All students could benefit from the broadening effects of such a high school preparation, yet there are currently few good models of curricula that serve both masters. The challenge of a common program opens up questions on many fronts:

- What would it take to convince high school and college teachers of mathematics that there is a common good in such a common curriculum?
- How can mathematicians contribute their understandings about the practice of mathematics to the tech-prep and ATE movements, and learn from these movements insights that may benefit their teaching and research?
- Can one develop performance expectations for high school mathematics that successfully reflect the goals of both the school-to-work movement and the school-to-college traditions?
- At what grade should a common curriculum give way to tracks that lead in distinctly different directions?

Mathematicians who think about curricular issues typically focus primarily on the "academic track" that leads to scientific, engineering, and mathematics courses at the university level. Those who develop curricula for the technical and vocational programs rarely work with mathematicians or mathematics educators to ensure consistency with the expectations and standards of mathematics education. Despite the current schism between these two communities, the increasing political pressure for educational alternatives such as tech-prep and ATE provide mathematicians with a marvelous opportunity to demonstrate the universal applicability of their discipline—to show that it is good for something other than preparing more university professors.

It is far too early to say with assurance how the many challenges of school-to-work programs will play out in the real world of education and politics. We can be certain, however, that they will occupy an increasing share of attention and resources, perhaps even becoming the dominant curriculum in the schools. Mathematicians have much to contribute to this discussion; we ignore it at our peril. Now is the time to get involved, to learn what the issues really are, and to use the many resources of our discipline to work with other constituencies to frame an effective response to this clear national need.

The authors are at the Mathematical Sciences Education Board, of which Steen is the Director.

Civilized Mathematics

Dan Alexander

While attending Kenneth Ribet's marvelous lecture on the gap in Andrew Wiles' proof of Fermat's Last Theorem at the recent Cincinnati meetings, I was struck with how civilized the discussions about Wiles' accomplishments have been. None of the principals in the recent developments leading up to Wiles' work have used the gap as opportunity to toot their own horns at the expense of Wiles. Indeed, although Ribet's talk directly addressed the gap in Wiles' proof, I was left with the clear impression that he was genuinely rooting for Wiles to close it.

Things don't always work in such a civilized manner. One need only look back a few years to the controversy which exploded in the pages of the *Mathematical Intelligencer* over who deserved credit for the discovery of the Mandelbrot set in the late 1970s. Perhaps an even better reminder that it is human beings who make mathematics is a dispute that broke out in France at the end of 1917 just as the First World War was entering its final year.

This dispute involved two of France's best mathematicians, Pierre Fatou and Gaston Julia, and at issue was the priority for several fundamental developments in the study of the iteration of complex rational functions (which, incidentally, provided the foundation for the discovery of the Mandelbrot set some 60 years later).

At the time of the dispute, Fatou was almost 40 years old. He worked at the Paris Observatory as an astronomer, having originally taken a position there because academic jobs in Paris had been scarce when he entered the job market after receiving his dissertation in 1906. For the first few years of his employment at the observatory, he evidently had insufficient time to pursue mathematics. This was unfortunate, since Fatou's early mathematical work revealed him to be a mathematician of great potential. Not only did his doctorate contain the important measure-theoretic result known as Fatou's Lemma, but he had also published a result in 1906 regarding the iteration of complex rational functions which represented a major breakthrough in that field of study. Nevertheless, Fatou published relatively few mathematical works until 1917, when he again took up the study of iteration.

Julia was 24 at the end of 1917, much younger than Fatou. He had been a prodigy in his youth and by 1917 had already established a strong mathematical reputation. Julia was also a war hero. In 1915, during a furious German attack, he exhibited uncommon bravery and was awarded the French Legion of Honor. The price of Julia's valor was extreme: he suffered a terrible wound to his face and was left with a disfigured nose which he customarily covered with a patch. According to his medal citation, his wounds left him almost blinded and unable to speak, yet he issued a written directive that he was not to be taken from the battlefield until after the German attack was repulsed. Julia's standing as a mathematician is indicated by the fact that, during the recuperation from his wounds, he was visited from time to time by two members of the French Academy of Sciences, Émile Picard and George Humbert.

As far as the public record is concerned, the dispute between Fatou and Julia was waged exclusively by Julia. At the center of this dispute was the most prestigious of the Academy's mathematical prizes, the *Grand Prix des Sciences mathématiques*. It was announced in 1915 that the 1918 *Grand Prix* would be given to the best paper the Academy received regarding the iteration of functions. The Academy suggested as well that the entrants confine themselves to the study of rational functions of one complex variable, which both Fatou and Julia did.

As was the custom, preliminary results were announced in the public record of the Academy's weekly sessions, the *Comptes rendus hebdomadaires des Séances de l'Académie des Sciences*. The first to do so was Pierre Fatou, who, on December 17, 1917, announced several fundamental results regarding the iteration of rational complex functions. This announcement apparently raised the ire of Julia, because two weeks later Julia announced that prior to the appearance of Fatou's note, he had established identical results. He offered proof of the matter in the form of the following letter, which appeared in the *Compte rendu* of December 31, 1917:

> I read with interest the note of Fatou published in the *Compte rendu* of December 17, 1917. The essential results which it contained, I had previously entered in a series of four sealed letters which I have deposited with the Secretary of the [Academy] and which were registered with numbers 8401, 8431, 8438, 8466, dated, respectively, June 4, 1917, August 17, 1917, September 17, 1917 [and] December 10, 1917. The academy can judge, upon opening these letters, whether they contain the results given by Fatou... The Academy can assess, at the same time, whose methods and whose results ought to be given priority.

The Academy heeded Julia's request and immediately following Julia's letter was a response titled "On a Communication of Gaston Julia," written by Humbert. He reported that in response to "questions raised [by Julia] concerning a question of priority," he had opened Julia's sealed letters and discovered that "the assertions of Julia are founded" since the letters indeed contained "all the results for which he has claimed priority."

In the folk history of mathematics this incident has grown to epic proportions, and it is sometimes said that Julia publicly accused Fatou of stealing his results. Although Julia made no such claims in his letter, he did refer to the similarity of Fatou's approach as a "curious coincidence." And although it would be an exaggeration to term this note a personal attack on Fatou, Julia did take a rather superior tone in observing, perhaps with some justification, that his approach was both more precise and more general.

Surely discouraged by the Academy's verdict, Fatou never formally entered the contest, and the fact that he had published results regarding the iteration of complex functions in 1906—when Julia was only 13—must have eaten at him.

I do not mean to suggest that the Academy displayed any favoritism towards Julia. Despite the fact that there is little substantive difference between the initial results of Fatou and Julia, it is important to keep in mind—and difficult to disagree with—a characterization of Julia's work from the Academy's announcement that it had awarded Julia the *Grand Prix*: "Julia's memoir is marked by a mathematical spirit of the highest order."

Nonetheless, it is interesting to speculate whether patriotic sentiments or personal contacts would have had any influence on the prize deliberations had Fatou decided to enter his paper. After all, Julia was a war hero—while Fatou did not go to battle—and was visited during his recovery from his wounds by both Humbert and Picard, both members of the Academy, the latter an ardent nationalist.

Dan Alexander is an assistant professor of mathematics at Drake University in Iowa. He specializes in the history of mathematics. His book, A History of Complex Dynamics from Schröder to Fatou and Julia, *has just been published by Vieweg Publishing, in their* Aspects of Mathematics *series.*

Most Successful Year Yet for Greater MAA Fund

The Greater MAA Fund concluded 1993 with its best record in the Fund's twelve years.

A total of 1,168 donors contributed $73,173. These numbers represent a 31% increase in number of donors, and a 55% increase in gift totals from 1992 figures.

The fund will assist such MAA projects as Electronic Services, student activities, and *Math Horizons*.

Thanks and appreciation to everyone who helped make 1993 a banner year for the Fund!

Involving Undergraduates in the Profession

Joseph A. Gallian and John Greever

Historically, scientists have involved undergraduates in their research and in their profession much more deeply than mathematicians. Recently, however, there has been a major effort by many mathematicians to increase the role that undergraduates play in the professional community. Examples abound: the MAA Student Chapters; *Math Horizons*; REU programs; the Mills program; a mathematical and computer sciences division in the Council on Undergraduate Research (CUR); the AWM Alice Schafer Prize. Moreover, the NSA, IDA, AT&T, Bellcore, and the NSF Regional Geometry Centers have expanded or created undergraduate research programs in the past few years. Pi Mu Epsilon and the MAA have provided travel support and sponsored paper sessions and activities for undergraduates at the annual summer meetings in recent years. Both PME and the MAA award prizes for the best presentation at the student paper sessions.

Perhaps one good way to gauge this change in the mathematics culture is to compare the annual joint AMS–MAA winter meeting in 1989 with the 1994 meeting in Cincinnati. The 1989 meeting did not have a single organized activity for undergraduates and it is doubtful if more than a handful of undergraduates attended. Moreover, committees of the professional organizations spent little or no time discussing ways to engage undergraduates in research or the professional community at the 1989 meeting. In contrast, at the 1994 meeting:

- the AMS sponsored a special session on research by undergraduates in which 38 students gave fifteen-minute presentations of papers written by 69 authors;
- the MAA Subcommittee on Undergraduate Research in Mathematics and the Mathematical and Computer Sciences Division of CUR cosponsored a poster session on research by undergraduates that featured the works of 19 students;
- the MAA Subcommittee on Undergraduate Research in Mathematics formulated proposals for the provision of publication outlets for undergraduate students;
- the MAA Committee on Student Chapters sponsored the Student Workshop and the Student Lecture followed by a "make your own sundae" social;
- the MAA Committee on Student Chapters sponsored a paper session for faculty on topics pertaining to activities for undergraduates;
- the AMS and the MAA held a social for first-time attendees;
- the MAA Committee on Student Chapters sponsored a hospitality/information center;
- both the Mills program and the Study in Budapest program had informational tables;
- the MAA offered a minicourse on organizing an undergraduate research program which had 43 participants from 25 states;
- an MAA committee passed a motion to establish a joint AMS–MAA $1000 prize for research by an undergraduate;
- an AMS committee discussed ways to increase undergraduate research.

So, in just a few years we went from where the annual meetings had little significance regarding the involvement of undergraduates in our profession to where this involvement is now one focal point of the meetings. Most gratifying, undergraduates now make a rich contribution to the meetings.

We wish to express our appreciation to those who made these changes possible and encouraged even greater participation by undergraduates in the life of our community.

Joseph Gallian is at the University of Minnesota–Duluth; John Greever is at Harvey Mudd College in Claremont, California. Both are highly active in nationwide initiatives to involve undergraduate students in research activities.

Personal Opinion

Can Students Solve Math Problems?

Leonard Gillman

In this article I will comment on the report *Can Students Do Mathematical Problem Solving? Results from the 1992 Mathematics Assessment*, by John A. Dossey, Ina V. S. Mullis, and Chancey O. Jones, National Center for Education Statistics, U.S. Department of Education, 1993, 226 pp. Copies of the report can be obtained from Education Information Branch, Office of Educational Research, Department of Education, 555 New Jersey Ave, Washington, DC 20208-5641; (800) 424-1616.

The report is required reading for all who take mathematical education seriously. The tests under discussion were administered to 250,000 students in grades 4, 8, and 12, from 10,000 schools in 41 states. They were designed with extreme care, and graded in painstaking detail. The results are analyzed by region (Northeast, Southeast, Central, West), state, ethnic background, sex, societal environment (advantaged urban, disadvantaged urban, extreme rural, other), and type of school (public, private). The comparisons are what one would guess, with one exception: there was no significant difference in performance between the girls and the boys, a fact mysteriously not included in the list of major findings.

I expected the mathematical performance overall to be dismal, but was not prepared for the actual numbers. "Jill's Class Trip" asks how many weeks Jill must work to earn $45 for the trip if every week she earns $2 on each of three days, $3 on each of three other days, and nothing on Sunday. This is a problem in simple arithmetic, but the solution requires more than one step. Only 22% in Grade 4 and 59% in Grade 8 answered it correctly.

The outstanding feature of this year's tests is the inclusion of questions requiring extended responses in which students explain their reasoning either directly (perhaps by a diagram) or by examples. (The usual multiple-choice and short-answer formats are there, too.) The report quotes three extended-response questions in each grade level, along with examples of students' answers, detailed comments on them, and models for possible solutions. These questions were graded on a scale of 0 (Blank), 1 (Incorrect), 2 (Minimal), 3 (Partial), 4 (Satisfactory), 5 (Extended). Of the students in Grade 12—currently sitting in your freshman calculus class—only 9% earned 4 or 5. (In Grade 8 it was 8%; in Grade 4, 16%.)

In any enterprise as vast as this one, there are bound to be some rough spots, though I found none that affect the results in any significant way; however, I think it will be useful to point them out.

A short-answer problem for Grade 8 asks for two numbers that make the sentence $54 < 3 \times \square$ true. Only 49% gave an acceptable response. Apparently, students are trained to solve first, think later—and half were unable to solve. The suggested solution is 19, 20. Why not 54, 55—requiring no computation? Or 1000, 2000?

An extended-response problem for Grade 12 asks why the square of a number ending in 5 must end in 25. Only 2% earned 4 or 5 on this one. The problem penalizes students who do know how to expand $(10n+5)^2$ yet slip, writing $100n^2 + 25$, apparently solving the problem and thus lessening the incentive to go back and check. The analysis in the report shows that at most 2% of the students could have been affected in this way; but the principle should be kept in mind.

The following extended-response problem is from Grade 12: Under a proposed income tax, you pay nothing on income up to $10,000, then 6% on any excess over $10,000. The effective tax rate is the percent of total income that you pay in tax. Can this be 5 percent? Can it be 6 percent?

Only 3% of the students earned a score of 4 or 5—2% earning 4 for answering the first question correctly and 1% earning 5 for answering both correctly.

I think this abysmal performance is due in part to the plodding way students are taught to handle equations. Such simple tactics as doing the steps in a different order can brighten things up considerably. **Table 1, Column 1** shows the suggested solution to the first question. My own principle is to clear clutter as soon as possible. Express income in units of $1,000, thereby sidestepping a welter of zeros. Clear decimal clutter right away instead of carrying it doggedly to the very end. The result, shown in **Column 2**, saves time, inhibits copying errors, and is light in spirit, assimilable almost at a glance, and very easy to check.

Table 2, Column 1 shows the suggested solution to the second question. The rule seems to be to remove parentheses first off, willy nilly. This requires a calculation, and can complicate the algebra rather than simplify it. Ironically, in this case it gives the solution sooner than the writers realized—since any number minus 600 is less than the number itself. The third line is unneeded and unwanted. (Perhaps the contradiction in the second line was hard

Table 1

Yes, the effective tax rate can be 5 percent

Given solution	Proposed alternative
Let x be the income in dollars.	Let x be the income in units of $10,000.
$0.06(x-10{,}000) = 0.05x$	$0.06(x-10) = 0.05x$
$0.06x - 600 = 0.05x$	$6(x-10) = 5x$
$0.01x = 600$	$6x - 60 = 5x$
$x = 60{,}000$	$x = 60$

to spot amid the clutter.) But the whole matter of parentheses succumbs to the principle of clearing clutter: first cancel the 0.06, as shown in **Column 2**.

The authors feel that the concept of limit somehow plays a role in the solution, but I don't see that limits have anything to do with it.

The instructions explicitly invite using words or diagrams. Here are some words: Can the effective tax rate be 6%? Of course not! The tax rate of 6% is the tax divided by part of the income. The effective rate is the same tax divided by the total income—so must be smaller. (Thus, the second question, which gave the students so much trouble, actually requires only trivial arithmetic.)

Not all high school seniors have studied coordinate geometry; but let's try a diagram. Line **a** in **Figure 1** shows the tax for incomes above 10. (For readability, we use different horizontal and vertical scales.) The slope of this line—"rise over run"—is equal to tax divided by x – 10. That's the tax rate, 6%.

Can the effective tax rate be 5%? Let **b** be a line from the origin that moves up to the right. If its slope is 5%, which is less than 6%, then **b** is less steep than **a** and will intersect it at some point **P**. The coordinates of **P** represent an income x and the tax on it. The slope of **b**—tax divided by x—is the effective tax rate. This shows that the effective tax rate can be 5%.

We don't expect today's students to come up with this proof, but the report would do well to point it out. It uses no computation. The only special fact about the number 5 is that it lies between 0 and 6; hence, the proof shows with no additional effort that the effective tax rate can be any positive number less than 6%. Moreover, this conclusion is derived from a diagram consisting of not much more than two straight lines. The reader can now see something of the spirit and power of mathematics, as well as its elegance, beauty, and charm.

Leonard Gillman is at the University of Texas at Austin, and is a former president of the MAA.

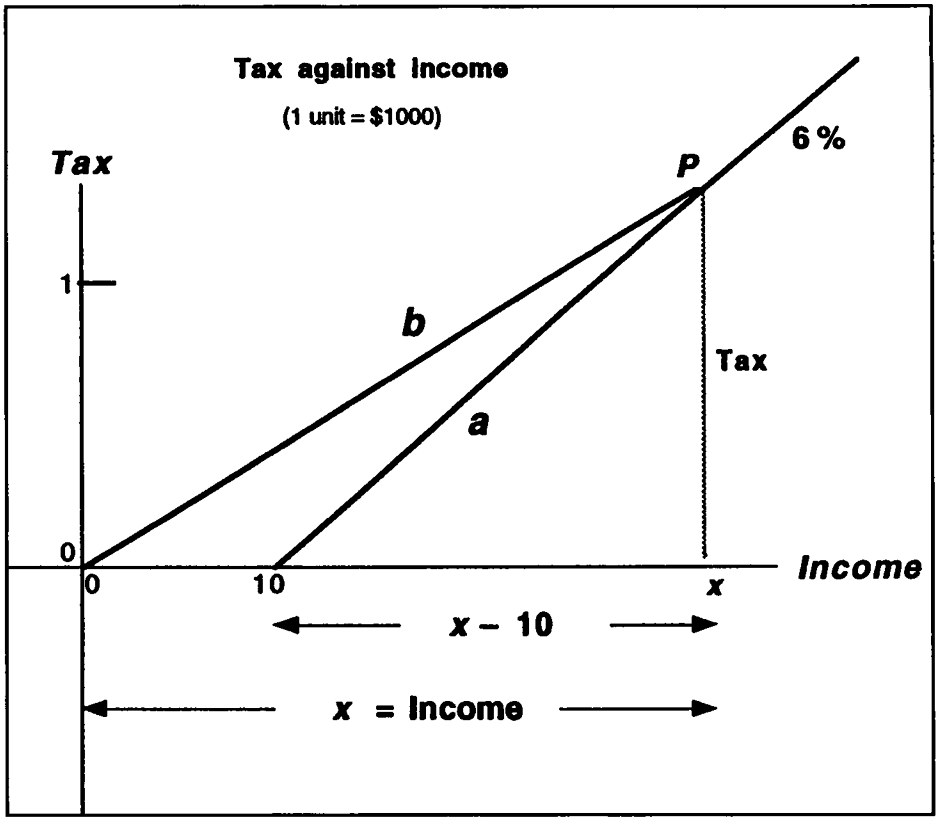


Table 2

No, the effective tax rate cannot be 6 percent.

Given solution	Proposed alternative
Let x be the income in dollars.	Let x be the income in units of $10,000.
$0.06(x - 10{,}000) = 0.06x$	$0.06(x - 10) = 0.06x$
$0.06x - 600 = 0.06x$	$x - 10 = x$
$0 = -600$	
—a contradiction.	—a contradiction.

MAA Contributed Papers in San Francisco

The Mathematical Association of America and the American Mathematical Society will hold their annual joint meetings from Wednesday, January 4, 1995 through Saturday, January 7, 1995 in San Francisco, California. The complete meetings program will appear in the October 1994 issues of FOCUS and the AMS *Notices*. This preliminary announcement is designed to alert participants about the MAA's contributed papers sessions and their deadlines.

Please note that the days scheduled for these sessions remain tentative. The organizers listed below solicit contributed papers pertinent to their sessions; proposals should be directed to the organizer whose name is followed by an asterisk (*). For additional instructions, see the Submissions Procedures box on page 16.

Sessions generally must limit presentations to ten minutes, but selected participants may extend their contributions up to 20 minutes. Each session room contains an overhead projector and screen; blackboards will not be available. You may request one additional overhead projector, a 35mm slide projector, or a 1/2 inch or 3/4 inch VHS VCR with one color monitor. Persons needing additional equipment should contact, as soon as possible, but prior to October 27, 1994: Donovan H. Van Osdol, Department of Mathematics, University of New Hampshire, Durham, NH 03824, e-mail: dvanosdo@math.maa.org.

Experiences with Modeling in Elementary Differential Equations

Thursday afternoon and Saturday morning

Professor Robert Borrelli *
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Courtney Coleman
Harvey Mudd College

Modeling is playing an increasingly important role in elementary differential equations courses mostly because of the ready availability of inexpensive ordinary differential equations solver platforms. These platforms open the door for students to consider an incredibly rich variety of applications and models which more closely fit the needs of client disciplines. Papers are invited on how modeling has been integrated into the teaching of differential equations, whether by case studies, cooperative projects with industry, or a laboratory experience.

Making Statistics Come Alive

Thursday afternoon and Saturday afternoon

Professor Robert W. Hayden *
20 River Street
Plymouth State College
Ashland, NH 03217-9702
phone: (603) 968-9914
e-mail: hayden@oz.plymouth.edu
Mary R. Parker
Austin Community College, Texas

The MAA has a joint committee with the American Statistical Association. One of its goals is to support mathematicians teaching statistics, and this session is part of that effort. We invite papers related to statistics in any undergraduate course. Possible areas include specific curriculum topics and examples, the use of real data, student projects, writing, computers, innovative approaches to grading, using student feedback to improve teaching, and curriculum organization issues.

The First Two Years

Thursday morning and Saturday morning

Professor William Davis *
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e-mail: davis@math.ohio-state.edu
Donald B. Small
U.S. Military Academy

As various reform efforts are implemented, the character of courses in the first two years of college mathematics is changed. Certain aspects of differential equations, linear algebra, and discrete mathematics have been incorporated into most of the calculus courses, and the several variables offerings thus look quite different than they used to. This session will look at various efforts toward building a coherent mathematical sciences program for the first two years of college.

Chaos and Dynamics

Wednesday afternoon and Friday afternoon

Professor Denny Gulick *
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e-mail: dng@math.umd.edu
Jon Scott
Montgomery College

To commemorate the 20th anniversary of the scientific terms "chaos" and "fractals," a special session on chaotic dynamics and dynamic geometry is being offered. The session invites papers on topics related to either chaotic dynamics or fractal geometry. The papers need to have an expository flavor.

Teaching with Original Sources

Thursday afternoon and Friday afternoon

Professor David Pengelley *
Mathematical Sciences Department
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FAX: (505) 646-6218
e-mail: davidp@nmsu.edu
Reinhard Laubenbacher
New Mexico State University

Teaching with original sources is becoming increasingly widespread. This session is a forum for exchanging experiences using original sources from all time periods in teaching at any level. Papers are invited which address the incorporation of specific sources in a particular instructional setting.

Dynamic Geometry

Thursday morning and Saturday morning

Professor James R. King *
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University of Washington
Seattle, WA 98195
phone: (206) 543-1915
FAX: (206) 543-0397
Doris Schattschneider
Moravian College

The availability of "dynamic" geometry software such as *CABRI Geométre* and *Geometer's Sketchpad* has opened the door to many changes in the teaching of geometry. This session invites papers that present instructive examples of the use of dynamic geometry software in the classroom or for research, and also invites papers that discuss the implications of dynamic geometry software for what mathematics we teach and how we teach it. Note: if you will need computer equipment for your presentation, please include with your submission a clear statement of your needs.

Laboratory Approaches to Teaching Mathematics

Wednesday morning and Thursday evening

Dr. Jon Wilkin *
6725 North 27th Street
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Alexandria, VA 22213-1204
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FAX: (703) 450-2536
e-mail: nvwilkj@vccscent.bitnet
Marilyn Mays
North Lake College

The use of laboratory techniques and approaches in teaching mathematics is gradually permeating all undergraduate mathematics courses. This session will present papers that deal with laboratory approaches to teaching mathematics courses other than the calculus. We are interested in papers which present courses which have laboratory experimentation and/or exercises as their primary mode of teaching and learning. Presentations may include methodology, equipment used, and sample laboratory exercises, as well as a discussion of the merits of the particular approach.

Innovations in Teaching Linear Algebra

Wednesday afternoon, Thursday evening, and Friday afternoon

Professor Donald R. LaTorre *
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Clemson University
Clemson, SC 29634-1907
phone: (803) 656-3437
FAX: (803) 656-5230
e-mail: latorrd@clemson.clemson.edu
Steven J. Leon (ATLAST)
University of Massachusetts at Dartmouth
David C. Lay (LACSG)
University of Maryland

The teaching of linear algebra is undergoing substantial change. This session invites papers on personal experiences with innovations in teaching linear algebra, including: (1) the creative use of computer algebra systems, supercalculators, or computer software; (2) experiences with the NSF-funded ATLAST summer workshops; (3) experiences with the core curriculum recommended by the Linear Algebra Curriculum Study Group (LACSG); (4) "gems" of exposition in linear algebra; and (5) other innovative teaching or curriculum initiatives in undergraduate linear algebra.

Recruitment and Retention of Female Faculty

Thursday morning and Friday morning

Professor Marcelle Bessman *
Frostburg State University
644 Geneva Place
Tampa, FL 33606
phone: (813) 253-6584
e-mail: jtaylor@madonna.coedu.usf.edu
Sr. Miriam Cooney
University of Notre Dame
Gerald Porter
University of Pennsylvania

Women are obtaining doctoral degrees in mathematics in increasing numbers. Mathematics departments are seeking qualified women faculty. This session, sponsored by the MAA Committee on Participation of Women, seeks papers on strategies that are being used, or could be used, to recruit and retain female faculty. Papers should take approximately twenty minutes to present.

New Directions in Student Assessment

Wednesday morning and Thursday evening

Professor Rose Hamm *
Honors Program
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FAX: (803) 953-7135
e-mail: hammr@ashley.cofc.edu
Richard Vandervelde
Hope College

Assessing students' performances with respect to critical thinking, mathematical communications skills and the use of technology demands assessment techniques dramatically different from those many institutions and instructors have traditionally relied upon. We invite contributed talks from persons regarding new (and old) evaluation techniques which are effective in this new environment.

Preparing Teachers to Implement Change (3 models)

Wednesday afternoon and Friday morning

Dr. Bettye Clark *
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FAX: (404) 880-8250
Robert Bix
University of Michigan-Flint
M. Kathleen Heid
Pennsylvania State University

Sponsored by the Committee on the Mathematical Preparation of Teachers (COMET), this session solicits papers describing model programs, creative partnerships, research, and position papers on how colleges and universities are changing attitudes and curricula in the mathematics and mathematics education departments to implement change in teaching mathematics in all collegiate mathematics and mathematics education courses.

Research in Undergraduate Mathematics Education

Friday evening and Saturday afternoon

Professor Daniel L. Goroff *
Department of Mathematics
Harvard University
Cambridge, MA 02138
phone: (617) 495-4869
FAX: (617) 495-3739
e-mail: goroff@math.harvard.edu
Joan Ferrini-Mundy
University of New Hampshire

We solicit research papers which address questions about teaching and learning of undergraduate mathematics. We are especially interested in including reports from completed research studies. Areas of particular interest are: visualization, the role of technology in learning undergraduate mathematics, student learning in reformed curricular settings, student learning of advanced undergraduate mathematical topics, and the preparation of teachers.

Mathematical Sciences, Technology, and Economic Competitiveness

Friday morning and Saturday afternoon

Dr. S. Brent Morris *
5088 Lake Circle West
Columbia, MD 21044-1442
phone: (301) 688-0332
FAX: (301) 688-0289
but call voice phone before sending FAX
e-mail: sbmorri@sirius.alpha.ncsc.mil
Patrick Dale McCray
Searle & Co.

A 1991 National Research Council report, *Mathematical Sciences, Technology, and Economic Competitiveness*, emphasized the central importance of mathematics to modern industry. This session invites papers that describe case studies of mathematics in use in industry. A case study should explain what mathematical problems were involved, what solutions were generated, and how the solutions were implemented. It should also describe project sponsorship—how the company defined, approved, and managed the project, the working relations between the members of the project team, and the reasons for success or failure.

Student Chapters Session

The MAA Student Chapters Session serves as a forum for the exchange of ideas among advisors to individual chapters and Section coordinators. Each fifteen-minute talk in this Special Session will focus on one or several activities implemented by a campus chapter or by a Section, or on activities supported by the Exxon grants. If you are interested in presenting a paper on your Student Chapter activities, please submit the title and an abstract of the proposed talk, including your name, affiliation, address, telephone number, e-mail address, and whether you are a chapter advisor or a Section coordinator. Send to Karen Schroeder, Mathematical Sciences Department, Bentley College, 175 Forest Street, Waltham MA 02154-4705; phone (617) 891-2267; FAX (617) 891-2457; e-mail kschroed@bentley.edu; so as to arrive by September 16, 1994.

Correction

The Young Mathematicians' Network article (February 1994, page 23) incorrectly stated that Charles Yeomans was an assistant professor at the University of Kentucky. We regret the error.

Submission Procedures for Contributed Papers

After you have selected a session to which you wish to contribute a paper, forward the following directly to the organizer (indicated with an (*)):

- **the name(s) and address(es) of the author(s); and**
- **a one-page summary of your paper.**

The summary should enable the organizer(s) to evaluate the appropriateness of your paper for the selected session. Consequently, you should include as much detailed information as possible within the one-page limitation.

Your summary must reach the designated organizer by Friday, September 2, 1994.

The organizer will acknowledge receipt of all paper summaries. If the organizer accepts your paper, you will receive a standardized abstract form. Use this form to prepare a brief abstract. Please return the completed form to the organizer by Friday, September 16, 1994. Abstracts received after the deadline will not be published in the *1995 Joint Annual Meetings Abstracts Journal*. This abstracts journal will be available in the meetings registration area during the conference in San Francisco.

DO NOT FORWARD COMPLETED ABSTRACTS TO THE MAA OR TO THE AMS. THEY ARE TO BE SENT TO THE SESSION ORGANIZER.

If you wish to obtain an abstract form in advance, please contact: The Executive Department, MAA, 1529 Eighteenth Street, NW, Washington, DC 20036; e-mail: maahq@maa.org.

1994 Summer Geometry Workshop

Experiencing Geometry presented by David Henderson

Geometry and the Visual World presented by Maria Terrell

June 20-25, 1994 at Cornell University, Ithaca, New York

As curricular reform includes more informal, intuitive, and applied geometry, college faculty need opportunities to explore new options for college geometry courses.

Henderson's *Experiencing Geometry* is revolutionary in its approach to teaching. His approach provides a rare opportunity to experience using materials designed to encourage both student and instructor to construct their own understanding of basic concepts in plane and spherical geometry.

Terrell's *Geometry and the Visual World* uses linear perspective and geometrical optics to motivate geometric models in Euclidean and projective geometry. Topics include the historical development of geometrical optics, linear perspective and projective geometry from Euclid to Desargues, a hands-on approach to applied geometry, and a crash course in analytic projective geometry.

Room, board, and a modest stipend will be provided by an NSF grant. Workshop is limited to 25 participants. For further information, contact David Henderson (dwh2@cornell.edu) or Maria Terrell (maria@math.cornell.edu), Department of Mathematics, Cornell University, Ithaca, NY 14853-7901.

The Mathematics Archives

The Mathematics Archives, making use of information provided by mathematicians in the Division of Undergraduate Education at the National Science Foundation, has established "gopher links" to the abstracts on the National Science Foundation gopher of funded proposals in mathematics and statistics education. Using a gopher client, one can locate these abstracts by accessing the Mathematics Archives at archives.math.utk.edu (port 70) and choosing the menu items:

Teaching Materials and Other Information

NSF Awards in Mathematics Education Abstracts.

The abstracts are arranged first by program and then by the institution of the principal investigator.

The MAA Gopher is Here!

We are pleased to announce that the first phase of MAA's Electronic Services, the MAA Gopher, will be available for testing by MAA members, as of June 15. On the MAA Gopher, you will find information about the MAA and its structure, how to become a member, the MAA Publications Catalog (including ordering information) a complete calendar of meetings and workshops, and section and student chapter news. In addition, a pilot for Celebrating Progress in Collegiate Mathematics, an electronic database of programs and projects in undergraduate mathematics, is available for your perusal.

You can access the MAA Gopher several different ways:

- **If your computer runs a gopher client, or you can log into a computer with a gopher client, you can access the MAA gopher server by typing "gopher gopher.maa.org".**
- **The MAA gopher server is also listed in the appropriate menus under "Other Gopher and Information Servers" at the University of Minnesota master gopher server, and may be accessed that way as well.**
- **You can also connect to MAA on the World Wide Web at URL "http://www.maa.org/".**

The MAA Gopher is in a test stage. We are in the process of refining, improving, and expanding the gopher. This is the time for you to send us your opinions and comments so that we can make the gopher a useful service for you. You will find a Suggestion Box on the MAA Gopher. Please use it.

Art and Mathematics Conference

The third annual interdisciplinary conference relating art and mathematics will be held June 25-29, 1994 at SUNY in Albany, New York. For information, contact: Nat Friedman, Department of Mathematics, SUNY, Albany, NY 12222; (518) 442-4621; FAX: (518) 442-4731; e-mail: artmath@math.albany.edu.

Women in Mathematics and Computer Science

October 21, 1994

Kean College of New Jersey

This one-day conference will bring together mathematics and computer science professors and high school teachers concerned with increasing the number of women students in these disciplines. Practitioners from industry and academia will address the problems and explore various intervention techniques. The conference will feature a keynote address by Prof. Patricia Kenschaft of Montclair State College, followed by a panel discussion, lunch, and breakout groups. If you are interested in leading a breakout group or would like further information, contact Prof. Barry J. Arnow, Chairperson, Mathematics and Computer Science Department, Kean College of New Jersey, Union, NJ 07083; (908) 527-2104; e-mail: barnow@turbo.kean.edu.

The MAA Gopher is Here!

See the top of this page!

New Mathematical Sciences Curriculum Initiative at the NSF: AMS and MAA Team Up to Offer Workshop to Spark Discussion and Focus Ideas

Allyn Jackson

The National Science Foundation (NSF) has launched a major new initiative that should be of interest to every mathematical sciences department in the country. The initiative, entitled *Mathematical Sciences and Their Applications Throughout the Curriculum*, will fund large-scale interdisciplinary educational projects at the undergraduate level. The basic goal of the program is to increase students' understanding of mathematics and their ability to apply mathematics in other disciplines. This initiative differs from the NSF's calculus reform efforts in that projects funded under this initiative should aim at comprehensive, coordinated change involving more than one course (most likely several courses) and should have strong participation by faculty from other disciplines. The NSF is insisting upon serious dissemination plans to insure nationwide impact so that the projects will have influence far beyond the confines of the institutions receiving the grants.

The NSF expects to fund a few projects at the level of about $1 million per year for three to five years. Formal proposals are due in February 1995; proposals for $50,000 planning grants are due June 6, 1994. Instructions about how to obtain program announcements and additional information are at the end of this article.

In order to inform the mathematical sciences community about this initiative, the AMS and the MAA teamed up to organize a workshop entitled *Changing Collegiate Education: Mathematical Sciences and their Uses in Other Disciplines*. Held March 27-28, 1994 in Washington, DC, the workshop brought together about 130 participants who listened to presentations about how such large-scale projects can be organized, and asked questions about the initiative. What follows is a report about the conference.

What the NSF is Looking For

The new initiative is a cooperative effort of NSF's Course and Curriculum Development (CCD) Program, which is part of the Division of Undergraduate Education (DUE) of Directorate for Education and Human Resources, and the NSF's Division of Mathematical Sciences. An outgrowth of the NSF calculus reform program, CCD funds projects in all disciplines to improve undergraduate science and engineering courses. The new initiative is an attempt to build on these improvements through coordinated, comprehensive reform of a large number of courses that use the mathematical sciences. CCD has launched an analogous initiative in chemistry that is further along than the mathematical sciences initiative: Out of 120 proposals for planning grants for the chemistry initiative, CCD recently made fourteen awards.

Robert F. Watson, director of DUE, noted that the initiative is *not* a replacement for calculus reform projects, but rather is a natural sequel. One of the motivations behind the initiative is the common complaint that students do not possess enough mathematical and quantitative skills to handle problems in the disciplines in which they study. Watson noted that the NSF may be least interested in mathematics majors as part of this initiative—the aim is to reach out to other areas. The initiative should not just strengthen a few departments or a few institutions, he noted, but rather should engender widespread change. The "end product" should be students who can utilize mathematical and quantitative skills in whatever they do and who can function effectively in our increasingly technological society. Watson emphasized that proposals must be multi-disciplinary and must involve partnerships among faculty in different disciplines. One or two faculty focusing on a small number of courses is not sufficient. There must be a larger interdisciplinary group looking at several different courses or sequences of courses. The focus should be on improving student learning through new courses, new activities in existing courses, new teaching methods, new software, etc.

Watson also noted that strong support from ""beyond the departmental level"—meaning from deans and provosts—is likely to be a key factor. In response to a question from the audience, Watson said that he did not mean that one must have a dean as a co-principal investigator, but rather that launching a large-scale project such as this would naturally need the support of higher administration. In addition, the NSF wants to support projects that do not die out when the NSF funding dries up; unless the institution makes a commitment to the project from the beginning, the project's future can be uncertain. Matching funds from the institution are not required, but, as Watson put it, "it never hurts."

James H. Lightbourne, an NSF program director working on the initiative, said that the NSF hopes to build on successes with earlier reform efforts, such as with calculus, but that it wants to bring on board more faculty, both from the mathematical sciences and from other disciplines. Planning grant proposals will be limited to five double-spaced pages, he noted; within that space, proposers must set forth a vision of the project, tell which courses will be involved, and describe the interdisciplinary team. He stressed that planning grant proposals should make it clear that interdisciplinary communication has already begun; confining planning within the mathematics department in the hope that other departments will join in later is probably not a winning strategy. Other faculty may join in as the project evolves, but there must be significant cross-departmental communication and collaboration from the outset.

Another NSF program officer working on the initiative, William Haver, noted that although the calculus reform effort has been successful in many ways, it has not really reached a large percentage of students nationwide. The NSF is hoping that, through this initiative, a small number of institutions can attack the larger problems of linking the mathematical sciences and other disciplines to improve mathematical sciences instruction and bring about pervasive changes that reach large numbers of students.

One participant from the audience wondered why the NSF was making so few grants of such a large size instead of seeding grassroots efforts through a large number of smaller grants. Haver acknowledged that the mix of large and small grants is a serious question for the NSF; he also noted that DUE will continue to fund smaller projects through its other programs. In addition, Haver pointed out that the initiative will focus on projects that will be useful to institutions all over the nation. Therefore, institutions not receiving these grants could indirectly benefit from the intiative. Tina Straley, another NSF program officer working on the initiative, noted that there is no restriction on the type of institution that can apply for the initiative grants, and coalitions of institutions are especially encouraged. Haver also stressed that the NSF remains committed to supporting calculus renewal efforts. In addition, it is expected that the new initiative will strengthen calculus renewal efforts by supporting some projects which will build upon the success of the calculus program and link the newly developed curricula and approaches to other courses.

Large-scale Projects Require New Thinking

Denice Denton is on the electrical engineering and the chemistry faculties at the University of Wisconsin at Madison. She was part of a group who submitted a successful planning grant proposal to CCD for the chemistry initiative. In addition, she has been involved in a couple of large-scale curricular reform projects. Denton said that flexibility is crucial in such projects. There will be a natural ebb and flow—some faculty will join the project early on and later drop out; some will observe at first and join only later. One must be flexible enough to allow the project to evolve and change.

Also, she noted that although $1 million sounds like a lot of money, it really isn't: given the high overhead rates at some institutions one might be left with around half that amount. She suggested talking to the grants and contracts office at one's university to get a more realistic picture of what one will have to spend. In addition, if n institutions are involved in the project, and the money is divided by n, the funds are stretched yet further. Denton also suggested getting institutional funding commitments in writing.

One needs to get the word out on campus, not only to bring in those who want to participate, but also to get feedback to help guide the project. In preparation for their work on the chemistry initiative, Denton and her colleagues sent out a survey to other departments asking what they expected their students to get out of chemistry courses, what they liked, what they didn't like, etc. The survey form also described the NSF initiative and asked for those interested in participating to contact the project directors.

Getting students to contribute their ideas is another important factor.

As for writing up the proposal, Denton noted that many proposals come into DUE without references; she suggested writing these proposals like research proposals, with appropriate supporting references to the literature. She also stressed the importance of the dissemination and evaluation component. Ronald Douglas of the State University of New York at Stony Brook, one of the organizers of the workshop, echoed this point, saying that dissemination and evaluation cannot be add-ons but must be integral parts of the project. Very few mathematical sciences faculty have sufficient expertise in this area, he said, and most will need to bring in someone from outside of mathematics for this component of the project.

Harvey Keynes of the University of Minnesota stressed that, with large-scale projects like the ones the NSF hopes to fund, there has to be a clear mission in mind. "Reform" does not just mean a new textbook and new activities, he noted; it has more to do with looking at the goals of the courses and formulating ways of meeting those goals. In particular, the NSF initiative requires a substantial component for evaluation, and one's goals must be clear in order to evaluate whether or not they have been achieved.

Fostering Collaborations

Keynes mentioned the idea of collaborating with two-year colleges, which also came up in later discussions during the workshop. Many students start out at two-year colleges and transfer to four-year colleges or universities, so it makes sense for the two types of institutions to coordinate the mathematics students learn. One participant in the audience wondered how receptive two-year colleges would be to such collaboration. One of the speakers, Deborah Hughes Hallett of the University of Arizona, responded that, in her experience, it is often the two-year colleges that bring four-year institutions on board when it comes to curricular innovation.

On the subject of collaboration with other institutions, Hughes Hallett noted that her work with calculus reform involved a range of different institutions, from Harvard University to the University of Southern Mississippi to Haverford College. Although involving a wide range of institutions can slow down the process of getting started, she said, ultimately the different viewpoints are very helpful, because each institution brings its individual strength into the group. In addition, dissemination is easier because different kinds of institutions have already tried out the ideas.

Hughes Hallett noted that initiating collaborations with other fields is a difficult challenge for mathematics, and one that should be addressed even were it not for the NSF initiative. She had some practical advice for getting started: invite a colleague from another department to lunch. Large meetings with people from different disciplines are often much more difficult, because different groups tend to stake out their own "territories". What is needed, she said, is a good, friendly relationship, not a political alliance. Hughes Hallett also warned against deciding beforehand what to do and then asking other departments to join in. Talking, listening, and looking for common ground will insure that all sides have a vested interest in making the project work.

It almost goes without saying that proposals for the NSF initiative should include something about the impact of the projects on the achievement of groups traditionally underrepresented in science, mathematics, and engineering. Uri Treisman of the University of Texas at

Austin described some of his experience in working with underrepresented groups. He noted that it is important to try to build a sense of "community" centered on intellectual interests. In response to questions from the audience, he suggested that if one wanted to improve minority achievement in mathematics, one should "start small" with students who have strong backgrounds and are already interested in mathematics. Once one has "existence proofs", it is much easier to reach out to more students. In addition, he suggested getting mainstream, senior faculty involved in such programs, not just young faculty.

Building on Experience

Although this initiative is a first for the mathematical sciences community (at least at the undergraduate level), the community has built some experience in cross-disciplinary curricular projects. Two of the presentations at the workshop described successful ongoing projects. Frank Giordano and Fletcher Lamkin of the United States Military Academy at West Point described an interdisciplinary mathematical sciences curriculum they have developed, which brings in applications ranging from pollution along a river to predator-prey problems to flight strategies for aircraft range. Louis J. Gross of the University of Tennessee at Knoxville described a program he designed to enhance the quantitative skills of students in the life sciences.

Such programs can succeed if the departments involved see improved student learning and understanding as the primary goal. Gross said that he told his colleagues in biology that they are ultimately responsible for what life sciences students learn or do not learn, so biology faculty must also make changes in their own courses if they want to increase their students' quantitative skills. He suggested working with other departments to prioritize what quantitative skills they want to emphasize and to assist them in including a larger quantitative component in their courses.

Arnold Ostebee of St. Olaf College brought out some key curricular issues that proposers should consider. What are the most important things for students to retain six weeks, six months, or six years after the course? Are communication and oral skills important? What level and type of problem solving skills are needed? How do mathematics courses play into other courses the students are taking? In the area of mathematical content, he said that most successful curricular reform efforts don't ask, "What should we delete?" but rather start from ground zero and ask, "What do we put in?" Bringing in applications can be accomplished in many ways—from setting the entire course around a few specific applications to introducing them piecemeal. Which applications are the most important? How does one get students to appreciate the *mathematics* in the applications? What level of rigor should be expected in courses taken by non-mathematics majors?

Some Common Questions

A number of questions about the NSF initiative were posed during the workshop as the participants tried to get a handle on exactly what the initiative was about. Some of the commonly asked questions were:

Question: *Can the projects include calculus or precalculus?*

Answer: One thing to remember is that the NSF has formulated a vision for this initiative, but ultimately the shape it takes will be determined by the proposals the Foundation receives. The NSF is not ruling out any courses, but the focus must be on a number of courses, not just one or two. The CCD program funds projects for curricular development for individual courses, whereas the initiative is an attempt to stimulate curricular reform in a coordinated way across many courses.

Question: *What about non-science majors?*

Answer: Projects should focus on the areas that fall under the NSF's mandate: science and engingeering, including social science and economics. Reforming courses like "mathematics for humanities" majors could conceivably be worked into such a project, but again, if that is the sole focus, one would do better to make a proposal to the general CCD program that funds curricular reform for individual courses.

Question: *What about equipment?*

Answer: Support for equipment is not ruled out, but the projects must be "people-oriented" rather than centered on equipment.

Question: *What will be the composition of the review panel?*

Answer: The NSF intends to have about half mathematical scientists on the review panel. The composition of the other half will be determined by what kind of expertise is needed based on the different areas emphasized in the proposals.

For More Information

E-mail addresses for NSF staff working on this initiative are:

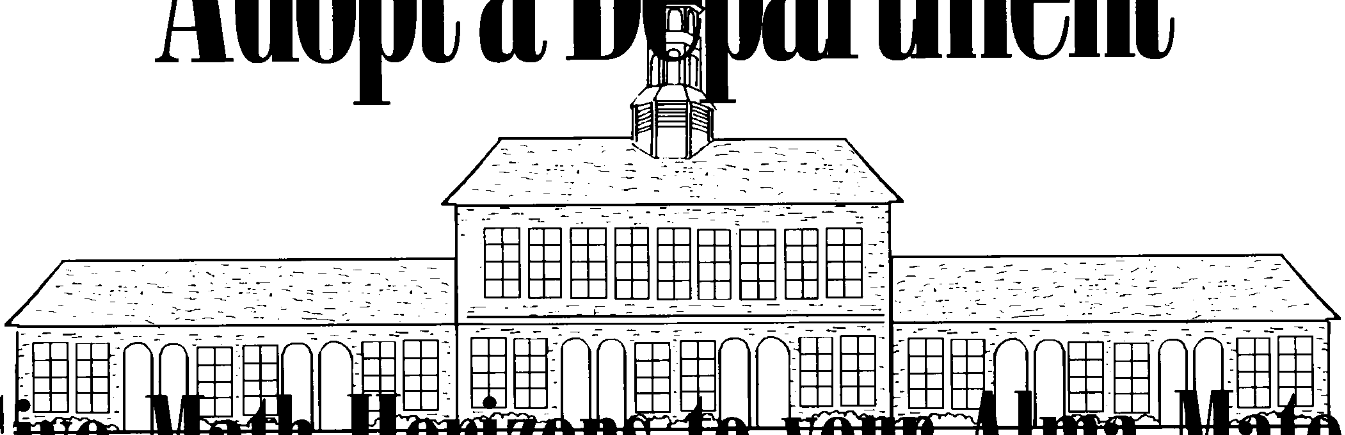
Lloyd Douglas, ldouglas@nsf.gov
Deborah Lockhart, dlockhar@nsf.gov
James Lightbourne, jhlightb@nsf.gov
Tina Straley, tstraley@nsf.gov
Elizabeth Teles, eteles@nsf.gov
Herbert Levitan, hlevitan@nsf.gov

These are Internet addresses; for Bitnet, replace @nsf.gov with @nsf. The telephone number is (703) 306-1669. The mailing address is:
Division of Undergraduate Education,
Directorate for Education and Human Resources
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

The program announcement may be found in *Funding Information in the Mathematical Sciences* in the current issue of the AMS *Notices*. Copies are also available through STIS, NSF's online information service. For information on how to use STIS, send e-mail to stis@nsf.gov (Internet) or stis@nsf (Bitnet); or telephone 703-306-0214.

Allyn Jackson is Associate Managing Editor, Notices of the AMS. *This article also appears in the current issue of the AMS Notices.*

Adopt a Department



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New from the MAA

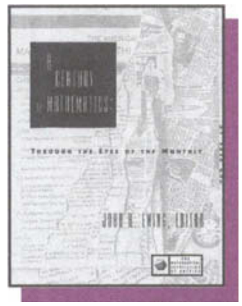
A Century of Mathematics

Through the Eyes of the *Monthly*

John Ewing, Editor

This is the story of American mathematics during the past century. It contains articles and excerpts from a century of the *Monthly*, giving the reader an opportunity to skim all one-hundred volumes without actually opening them. It samples mathematics year by year and decade by decade. Along the way, readers can glimpse the mathematical community at the turn of the century, and the divisions between the mathematical communities of teachers and researchers. Read about the struggle to prevent colleges from eliminating mathematics requirements in the 1920s, the controversy about Einstein and relativity, the debates about formalism in logic, the immigration of mathematicians from Europe, and the frantic effort to organize as the war began. At the end of the war, hear about new divisions between pure and applied mathematics, heroic efforts to deal with large numbers of new students in the universities, and the rise of federal funding for mathematics. In more recent times, see the advent of computers and computer science, the problems faced by women and minorities, and some of the triumphs of modern research.

This is a book about mathematics—about teaching and research, applied and pure, elite universities and community colleges.



Browsing through its pages, readers see what has changed (the kinds of mathematics in fashion, for example) and what has stayed the same (our concern about teaching and our complaints about the deplorable state of our students).

This is a book about history—a sampling of history, meant to be savored rather than studied. For one-hundred years, the *Monthly* has contained articles by some of the greatest mathematicians in the world, as well as articles by students and faculty from small midwestern colleges where those great names were barely known. This book gives a glimpse of both worlds. It tells a story rather than the details of history.

This is the story of a century of mathematics in America.

335 pp., Hardbound, 1994

ISBN 0-88385-457-0

List: $ 39.50 MAA Member: $32.00

Catalog Number CENTMA

New from the MAA

Complex Numbers and Geometry

Liang-shin Hahn

This book demonstrates that complex numbers and geometry can be blended together beautifully, resulting in easy proofs and natural generalizations of many theorems in plane geometry—such as the Napoleon theorem, the Ptolemy-Euler theorem, the Simson theorem, and the Morley theorem.

Beginning with a construction of complex numbers, readers are taken on a guided tour that includes something for everyone, even those with advanced degrees in mathematics. Yet, the entire book is accessible to a talented high-school student.

The book is self-contained—no background in complex numbers is assumed—and can be covered at a leisurely pace in a one-semester course. Over 100 exercises are included. The book would be suitable as a text for a geometry course, or for a problem solving seminar, or as enrichment for the student who wants to know more.

200 pp., Paperbound, 1994

ISBN 0-88385-510-0

List: $25.50 MAA Member: $19.50

Catalog Number CNGE

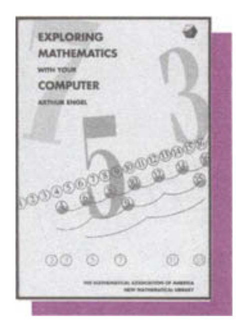
Exploring Mathematics With Your Computer

Arthur Engel

Today's personal computer gives its owner tremendous power which can be used for experimental investigations and simulations of unprecedented scope, leading to mini-research. This book is a first step into this exciting field.

This is a mathematics book, not a programming book, although it explains Pascal to beginners. It is aimed at high school students and undergraduates with a strong interest in mathematics, and teachers looking for fresh ideas. It is full of diverse mathematical ideas requiring little background. It includes a large number of challenging problems, many of which illustrate how numerical computation leads to conjectures which can then be proved by mathematical reasoning.

You will find 65 interesting and substantial mathematical topics in this book, and over 360 problems. Each topic is illustrated with examples and corresponding programs. The major goal of the book is to use the computer to collect data and formulate conjectures suggested by the data.



It is assumed that readers have a PC at their disposal.

264 pp., Paperbound, 1993

ISBN 0-88385-636-0

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Catalog Number NML-35

You need a Pascal compiler in order to use the 3.5" IBM-compatible disk packaged with this volume.

You're The Professor, What Next?

New from the MAA

Ideas and Resources for Preparing College Teachers

Bettye Anne Case, Editor

You're the Professor, What Next? is a valuable guide for doctoral mathematical sciences departments wishing to prepare their advanced graduate students and postdoctoral instructors for collegiate teaching and related academic responsibilities. The book also will be useful to faculty mentors of new assistant professors and as personal reading for many, especially inexperienced, members of mathematics faculties.

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362 pp., Paperbound, 1994

ISBN 0-88385-091-5

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See page 30

Prepublication Sale—Available June 1994

New from the MAA

A Radical Approach to Real Analysis

David M. Bressoud

This book is an undergraduate introduction to real analysis. It can be used as a textbook, as a resource for the instructor who prefers to teach a traditional course, or as a recourse for the student who has been through a traditional course yet still does not understand what real analysis is about and why it was created.

This course of analysis is radical; it returns to the roots of the subject, but it is not a history of analysis. It is designed to be a first encounter with real analysis, laying out its context and motivation in terms of the transition from power series to those that are less predictable, especially Fourier series.

The book begins with Fourier's introduction of trigonometric series and the problems they created for the mathematicians of the early nineteenth century. It follows Cauchy's attempts to establish a firm foundation for calculus, and considers his failures as well as his successes. It culminates with Dirichlet's proof of the validity of the Fourier series expansion and explores some of the counterintuitive results Riemann and Weierstrass were led to as a result of Dirichlet's proof.

To facilitate graphical and numerical investigations, *Mathematica* commands and programs have been included in the exercises. *Mathematica* is powerful and convenient, but any mathematical tool with graphing capabilities—including the graphing calculator—can be substituted.

336. pp., Paperbound, 1994

ISBN 0-88385-701-4

List: $29.00 MAA Member: $22.00

Catalog Number RAN

Game Theory and Strategy

New from the MAA

Philip D. Straffin, Jr.

This important addition to the New Mathematical Library series pays careful attention to applications of game theory in a wide variety of disciplines. The applications are treated in considerable depth. The book assumes only high school algebra, yet gently builds to mathematical thinking of some sophistication. ***Game Theory and Strategy*** might serve as an introduction to both axiomatic mathematical thinking and the fundamental process of mathematical modelling. It gives insight into both the nature of pure mathematics, and the way in which mathematics can be applied to real problems.

Since its creation by John von Neumann and Oskar Morgenstern in 1944, game theory has contributed new insights to business, politics, economics, social psychology, philosophy, and evolutionary biology. In this book, the fundamental ideas of game theory share the stage with applications of the theory. How might strategic business decisions depend on information about a rival company, and how much would such information be worth? When is it advantageous to vote for a candidate who is not your favorite? What can we learn about the problem of "free will" by imagining playing a game with an Omnipotent Being? Game theory gives insight into all of these questions.

200 pp., Paperbound, 1993

ISBN 0-88385-637-9

List: $27.50

MAA Member: $22.00

Catalog Number NML-36

Turn the page for more books from the MAA →

Mathematical Cranks

Underwood Dudley

Mathematical Cranks is about people who think that they have done something impossible, like trisecting the angle, squaring the circle, duplicating the cube, or proving Euclid's parallel postulate; people who think they have done something that they have not, like proving Fermat's Last Theorem, verifying Goldbach's Conjecture, or finding a simple proof of the Four Color Theorem; people who have eccentric views, from mild (thinking we should count by 12s instead of 10s) to bizarre (thinking that second-order differential equations will solve all problems of economics, politics, and philosophy); people who pray in matrices; people who find the American Revolution ruled by the number 57; people who have in common something to do with mathematics and something odd, peculiar, or bizarre.

This is a truly unique book, written with wit and style. Kenneth O. May calls the work of mathematical cranks part of folk mathematics that should not pass unrecorded.

300 pp., Paperbound, 1992

ISBN 0-88385-507-0

List: $27.50 MAA Member: $19.50

Catalog Number CRANKS

The Trisectors

Formerly entitled *Newly Revised*

A Budget of Trisections

Underwood Dudley

As a companion to ***Mathematical Cranks*** the MAA is happy to offer its readers Underwood Dudley's ***The Trisectors***. This book is also about mathematical cranks—angle trisectors.

It is impossible to trisect angles with straightedge and compass alone, but many people try and think they have succeeded. This book is about angle trisections and the people who attempt them. Its purposes are to collect many trisections in one place, inform about trisectors, amuse the reader, and, perhaps most importantly, to reduce the number of trisectors. ***The Trisectors*** includes detailed information about the personalities of trisectors and their constructions.

According to Dudley, "hardly any mathematical training is necessary to read this book. There is a little trigonometry here and there, but it may be safely skipped. There are hardly any equations. There are no exercises at the end of the sections, and there will be no final examination. The worst victim of mathematics anxiety can read this book with profit and dry palms. It is quite suitable to give as a present."

176 pp., Paperbound, 1994

ISBN 0-88385-514-3

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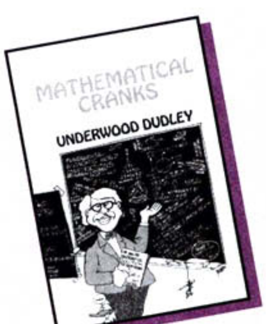
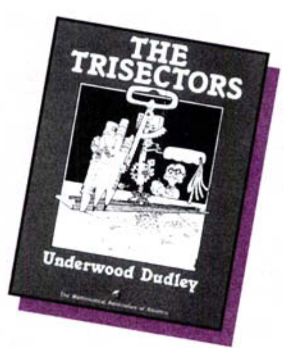
Catalog Number TRI





Buy both Dudley volumes and save:
List: $53.00 MAA Member: $37.00
Catalog Number CRTRI

Proofs Without Words

New from the MAA

Exercises in Visual Thinking

Roger B. Nelsen

Proofs without words are generally pictures or diagrams that help the reader see *why* a particular mathematical statement may be true, and *how* one could begin to go about proving it. While in some proofs without words an equation or two may appear to help guide that process, the emphasis is clearly on providing *visual* clues to stimulate mathematical thought.

Proofs without words have a long history. In this collection you will find modern renditions of proofs from ancient China, classical Greece, twelfth-century India—even one based on a published proof by a former president of the United States! However, most of the proofs are more recent creations, and many are taken from the pages of MAA journals.

The proofs in this collection are arranged by topic into six chapters: Geometry and Algebra; Trigonometry, Calculus and Analytic Geometry; Inequalities; Integer Sums; Sequences and Series; and Miscellaneous. Teachers will find that many of the proofs in this collection are well suited for classroom discussion and for helping students to think visually in mathematics.

The readers of this collection will find enjoyment in discovering or rediscovering some elegant visual demonstrations of certain mathematical ideas that teachers will want to share with their students. Readers may even be encouraged to create new "proofs without words."

160 pp., Paperbound, 1993

ISBN 0-88385-700-6

List: $27.50 MAA Member: $22.00

Catalog Number PWW

Memorabilia Mathematica

The Philomath's Quotation Book

Robert Edouard Moritz

When Robert Edouard Moritz compiled his book of quotations, ***Memorabilia Mathematica***, which appeared in 1914, he stated that his primary objective was to seek out the exact statement of and exact references for famous passages about mathematics. His sources ranged from the works of Plato to the writings of Hilbert and Whitehead. His second objective was to produce a volume that would be a source of pleasure, encouragement, and inspiration to both mathematicians and non-mathematicians alike.

The more than eleven-hundred fully annotated selections in this book, gathered from the works of three-hundred authors, cover a vast range of subjects pertaining to mathematics. Grouped in twenty-one chapters, they deal with such topics as the definitions and objects of mathematics; the teaching of mathematics; mathematics as a language or as a fine art; the relationship of mathematics to philosophy, to logic, or to science; the nature of mathematics, and the value of mathematics. Other sections contain passages referring to specific subjects in the field such as arithmetic, algebra, geometry, calculus, and modern mathematics.

To mathematicians the book will be a great source of pleasure, inspiration, and encouragement. To teachers of mathematics and writers about mathematics, it will remain of inestimable value as a source of quotations and ideas. To the layperson, it will be a revelation.

440 pp., Paperbound, 1993

ISBN 0-88385-321-3

List: $24.00 MAA Member: $19.00

Catalog Number MEMO

Out of the Mouths of Mathematicians

A Quotation Book for Philomaths

Rosemary Schmalz

Published as a companion volume to Robert Edouard Moritz's ***Memorabilia Mathematica***, Rosemary Schmalz's ***Out of the Mouths of Mathematicians*** picks up where Moritz left off. Her work will give you a sense of the "story" of twentieth century mathematics. You will encounter the mathematicians, their collaborations and disputes, the movement from abstraction to application, the emergence of new areas of research, the impact of computers on mathematics, the challenges in mathematics education, and more.

Out of the Mouths of Mathematicians: A Quotation Book for Philomaths is a compilation of 727 quotations from 292 contributors, almost all of whom are twentieth century mathematicians. Some of the subject categories include: The Development of Mathematics, Exhortations to Aspiring Mathematicians, Pure and Applied Mathematics, About Mathematicians (by name), Anecdotes and Miscellaneous Humor, Particular Disciplines in Mathematics, Moments of Mathematical Insight, Mathematics and the Arts,... and much more.

This book will be particularly useful to teachers of mathematics at all levels, to encourage, motivate, and amuse their students.

304 pp., Paperbound, 1993

ISBN 0-88385-509-7

List: $29.00 MAA Member: $23.00

Catalog Number OMMA

Package Price—Both Books
List: $48.00; Member: $38.00
Catalog Number: OMPH

The Words of Mathematics

New from the MAA

An Etymological Dictionary of Mathematical Terms Used in English

Steven Schwartzman

The Words of Mathematics explains the origins of over 1500 mathematical terms used in English. While other dictionaries of mathematics define technical terms, this book concentrates on where those terms came from and what their literal meanings are.

As in any dictionary, the entries themselves are arranged alphabetically. The words are drawn from arithmetic, algebra, geometry, trigonometry, calculus, number theory, topology, statistics, graph theory, logic, recreational mathematics, and other areas.

This dictionary is an indispensable reference for every library that serves teachers and students of mathematics. It is a natural source of information for courses in the history of mathematics and for mathematics courses intended for liberal arts students. At the individual level, whether you are a teacher or a student of mathematics, a lover of words, or hopefully both; whether you are a veteran mathematician or a novice, you will find material in this book appropriate to your level of language and mathematics.

ISBN 0-88385-511-9

262 pp., Paperbound, 1994

List: $27.00
MAA Member: $21.00

Catalog Number WORDS

Turn the page for more books from the MAA →

Cryptology

New from the MAA

Albrecht Beutelspacher

FR BRX XQFHUVWCQG WKLV? If you can't decipher this coded message, you must read this book!

How can messages be transmitted secretly? How can one guarantee that the message arrives safely in the right hands exactly as it was transmitted? Cryptology—the art and science of "secret writing"—provides ideal methods to solve these problems of data security.

Technology advances have stimulated interest in the study of cryptology. Of course, computers can break cryptosystems much more efficiently than humans can. Computers allow complex and sophisticated mathematical techniques which achieve a degree of security undreamt of by previous generations. Today the applications of cryptology range from the encryption of television programs sent via satellite, to user authentication of computers, to new forms of electronic payment systems using smart cards.

The first half of the book studies and analyzes classical cryptosystems. Here we find Caesar's cipher, the Spartan scytale, the Vigenère cipher, and more. The theory of cipher systems is presented, including a description of the best possible cipher, the one-time pad. An introduction to linear shift registers, which serve as building blocks for most presently used ciphers, is also given.

The second half of the book looks at the exciting new directions of public-key cryptology, which since its invention in 1976, has revolutionized data security. The author also looks at the famous RSA-algorithm, algorithms based on "discrete logarithms," the so-called zero-knowledge algorithms, and the smart cards that bring cryptographic services to the person-on-the-street.

Although the mathematics covered is nontrivial, the book is fun to read, and the author presents the material clearly and simply. Many exercises and references accompany each chapter. The book will appeal to a wide audience including teachers, students, and the interested layperson.

Cryptology was originally published in German by Vieweg. This edition has been extensively revised.

176 pp., Paperbound, 1994

ISBN 0-88385-504-6

List: $26.00 MAA Member: $20.00

Catalog Number CRYPT

FREE BOOKS!! See page 30

...And the Winner Is...

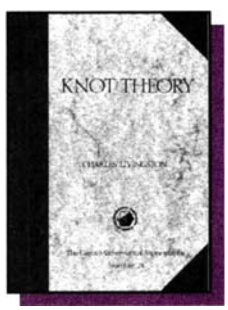
Knot Theory

Charles Livingston

Winner—Best New Book in Mathematics for 1993...Professional and Scholarly Publishing Division of the Association of American Publishers

Knot Theory, a lively exposition of the mathematics of knotting, will appeal to a diverse audience from the undergraduate seeking experience outside the traditional range of studies to mathematicians wanting a leisurely introduction to the subject. Graduate students beginning a program of advanced study will find a worthwhile overview, and the reader will need no training beyond linear algebra to understand the mathematics presented.

Over the last century, knot theory has progressed from a study based largely on intuition and conjecture into one of the most active areas of mathematical investigation. ***Knot Theory*** illustrates the foundations of knotting as well as the remarkable breadth of techniques it employs—combinatorial, algebraic, and geometric.



The development of knot theory has taken place within the context of the growth of topology. ***Knot Theory*** illuminates that context. The classification of surfaces, one of the major achievements in topology, is described, and then applied to prove the existence of prime decomposition of knots.

The interplay between topology and algebra, known as algebraic topology, arises early in the book, when tools from linear algebra and from basic group theory are introduced to study the properties of knots, including the unknotting number, the braid index, and the bridge number. Livingston guides you through a general survey of the topic, showing how to use the techniques of linear algebra to address some sophisticated problems, including one of mathematics' most beautiful topics, symmetry. The book closes with a discussion of high-dimensional knot theory and a presentation of some of the recent advances in the subject—the Conway, Jones, and Kauffman polynomials. A supplementary section presents the fundamental group, which is a centerpiece of algebraic topology.

An extensive collection of exercises is included. Some problems focus on details of the subject matter; others introduce new examples and topics illustrating both the wide range of knot theory and the present borders of our understanding of knotting. All are designed to offer the reader the experience and pleasure of working in this fascinating area.

264 pp., Hardbound, 1993

ISBN 0-88385-027-3

List: $31.50 MAA Member: $25.00

Catalog Number CAM-24

Research Issues in Undergraduate Mathematics Learning

Preliminary Analyses and Reports

James J. Kaput and Ed Dubinsky, Editors

New from the MAA

Research in undergraduate mathematics education is important for all college and university mathematicians. If our students are to be more successful in understanding mathematics, then college faculty need to understand how mathematics is learned. This knowledge can guide us in curriculum reform and in improving our own teaching. It can help us make mathematics accessible to all students and it can increase the number of graduate students in mathematics.

This volume of research in undergraduate mathematics education informs us about the nature of student learning in some of the most important topics in the undergraduate curriculum: sets, functions, calculus, statistics, abstract algebra, and problem solving. Paying careful attention to the trouble students have in learning mathematics will help us to work with students so they can deal with those difficulties.

A survey of the literature begins the volume. Becker and Pence have brought together an unusually complete list of references on research in collegiate mathematics. Their comments will guide those attempting to begin or to continue a program of research in student learning.

The sad fact that even good calculus students stumble over nonroutine problems is the theme of Selden, Selden, and Mason. Their conclusions point to significant shortcomings in the curriculum. This study of student difficulties is continued by Ferrini-Mundy and Graham who investigate a single student's interactions with the fundamental concepts of the calculus. Baxter studies a group of students to learn how they acquire the concept of set, while Cuoco does the same for the concept of function.

Cooperative learning does help the student. That is the conclusion of Bonsangue, who investigates how two carefully matched classes of students in a statistics course perform on exams. How students learn to write proofs in group theory is the subject considered by Hart. Rosamond breaks new ground by comparing how emotions vary in their effect on the problem solving ability of novices and experts.

All college faculty should read this book to find how they can help their students learn mathematics.

150 pp., Paperbound, 1994

ISBN 0-88385-090-7

List: $24.00

Catalog Number NTE-33

New from the MAA

In Eves' Circles

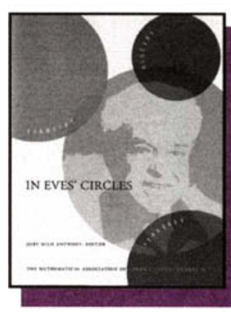
Joby Milo Anthony, Editor

A very special volume for all of Eves' thousands of admirers. If your interest is history of mathematics, geometry, or pedagogy, then this book is for you.

Howard Eves celebrated his eightieth birthday in 1991. To honor that occasion, the University of Central Florida sponsored a conference that focused on the lifelong interests of this prominent American mathematician, namely, the history of mathematics, the teaching of mathematics, and geometry. Eves is well-known for his contributions to all three areas.

The conference was unique. Conference participants included pre-college mathematics teachers, community college and university teachers, and research mathematicians. Papers were delivered in sessions devoted to the classroom teacher, to the history of mathematics, and to pedagogical and research interests in geometry. Many lectures combined these subjects. This book presents some of those lectures. Anyone involved with teaching or producing mathematics can find something in this volume that will be interesting to them.

Also included in this volume is a penetrating interview with Eves.



220 pp., 1994, Paperbound

ISBN-0-88385-088-5

List: $24.00

Catalog Number NTE-34

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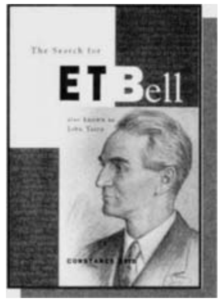
The Search for E.T. Bell

also known as John Taine

Constance Reid



Eric Temple Bell (1883–1960) was a distinguished mathematician and a best-selling popularizer of mathematics. His *Men of Mathematics*, still in print after almost sixty years, inspired scores of young readers to become mathematicians. Under the name "John Taine," he also published science fiction novels (among them *The Time Stream, Before the Dawn,* and *The Crystal Horde*) that served to broaden the subject matter of that genre during its early years.

In *The Search for E.T. Bell*, Constance Reid has given us a compelling account of this complicated, difficult man who never divulged to anyone, not even to his wife and son, the story of his early life and family background. Her book is thus more of a mystery than a traditional biography. It begins with the discovery of an unexpected inscription in an English churchyard and a series of cryptic notations in a boy's schoolbook. Then comes an inadvertent revelation, by Bell himself, in a respected mathematical journal.... You will have to read the book to learn the rest.

Originally agreeing to write only a profile of Bell, Mrs. Reid soon found herself involved in a full-length biography. The discoveries she made in the course of her five years of research will necessitate a fresh evaluation of his extensive mathematical work and his science fiction novels as well as the revision of almost every statement currently in print about his family background and early life.

Honorable Mention—Best New Book in Mathematics for 1993...Professional and Scholarly Publishing Division of the Association of American Publishers

Mrs. Reid is already well known as the author of acclaimed biographies of David Hilbert, Richard Courant, and Jerzy Neyman.

Includes a collection of over 75 photographs.

384 pp., Hardbound, 1993

ISBN 0-88385-508-9

List: $35.00 MAA Member: $28.00

Catalog Number BELL

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Louisiana Tech University Department of Mathematics and Statistics

Applications are invited for an anticipated tenure-track assistant professorship specializing in an area of mathematics closely related to computational analysis and modeling. Applicants must have a Ph.D. by the time of the appointment (9/94) and are expected to show strong potential for excellence in both teaching and research. A current resume and three letters of recommendation should be sent to:

R.J. Greechie, Head
Department of Mathematics and Statistics
Louisiana Tech University
Ruston, LA 71272

The screening of applicants will begin on June 1 and will continue until the position is filled. Louisiana Tech University is an Equal Opportunity/Affirmative Action Employer. We are interested in receiving applications from qualified women and minorities.

Long Island University Brooklyn Campus

Applications are invited for a tenure-track position at the Assistant Professor level beginning September 1, 1994. Requirements include a Ph.D. in pure mathematics (preferably in geometric topology) and a commitment to teaching with an interest in research.

Please furnish curriculum vitae and three letters of reference to Dr. S. Park, Personnel Committee, Department of Mathematics, Long Island University, University Plaza, Brooklyn, New York 11201. Long Island University is an AA/EO employer.

Oberlin College

A full-time, temporary position is available at Oberlin College for the academic year 1994-95. Teaching load is 5 courses. Qualifications include Ph.D. in hand or expected by Fall 1994, plus demonstrated interest and potential excellence in teaching. To be considered, send a letter of application, academic transcripts, curriculum vitae and at least 3 letters of reference to Michael Henle, Department of Mathematics, Oberlin College, Oberlin, OH 44074. Consideration of applicant files will begin April 18, 1994.

POSITION FILLED

Mathematics

The Department of Mathematics anticipates an opening for an assistant professor to teach the full range of mathematics courses from algebra through calculus. Ph.D. in appropriate discipline; experience and expertise in current classroom pedagogy and technology including graphics calculator, computer-assisted instruction, reform of calculus, etc. Resumes to: Dean Thomas M. Carroll, Human Resources, New York City Technical College (CUNY), 300 Jay Street, Namm 321, Brooklyn, NY 11201. AA/EOE/D

Cottey College of Missouri

Assistant Professor, full-time, tenure-track faculty starting fall 1994; three person department. Curriculum now includes algebra, trigonometry, statistics, calculus and differential equations; four sections per semester load. Ph.D. preferred ABD considered for initial appointment, but continuation requires doctorate. Teaching oriented, small, private (non-church related), two-year, residential, liberal arts college for women. 10:1 students/faculty ratio, students from 35-40 states, and 18-20 countries. 80 miles from Kansas City metropolitan area, 40-140 miles from Ozark recreation areas. Our mission is the development of intellect, leadership and self-esteem in young women. Send c.v. and letter expressing interest to Vice President for Academic Affairs, Cottey College, Nevada, Missouri 64772.

Interactive Mathematics Text Project Chooses Second Round of Developers

The MAA's Interactive Mathematics Text Project has announced the selection of eight interactive text developers. The developers were selected from the 138 participants in the IMTP workshops held during the summer of 1993. Each developer will receive an IBM Pentium computer, printer, and software to be used in the creation of an interactive text. In addition, each developer will be supported to attend an IMTP advanced workshop during this summer and the IMTP Developers' Conference to be held in October at the Institute for Academic Technology at The University of North Carolina at Chapel Hill.

The Interactive Mathematics Text Project has as its goal the improvement of mathematics learning through the use of computer-based interactive texts. The project is supported by the IBM Corporation, The National Science Foundation, Waterloo Maple, Wolfram Research, MathSoft, and Eduquest. Twelve IMTP workshops are scheduled for the summer of 1994. More information is available through the gopher: imtp.math.upenn.edu or by contacting the project director, Gerald J. Porter, gjporter@math.upenn.edu.

The individuals chosen, the topics of their proposed texts, and the software platforms they are using follows:

Charles Hofmann
LaSalle University
and
Roseanne Hofmann
Montgomery County Comm. College
Precalculus and Calculus, *MathKit for Windows*

William Slough
Eastern Illinois University
A Brief Calculus for Non-science Students, *Maple*

Ken Davis
Albion College
Discrete Mathematics, *Mathematica*

William Mueller
University of Arizona (currently at Northern Michigan University)
Mathematical Modeling, *Mathcad*

Caren Diefenderfer
Hollins College
Differential Equations, *Maple*

Margie Hale
Stetson University
Differential Equations with Modeling, *MathKit for Windows*

Kyle Siegrist
University of Alabama in Huntsville
Probability, *MathKit for Windows*

William McClung
Nebraska Wesleyan University
Number Theory, *Mathematica*

Calendar

National MAA Meetings

August 15-17, 1994 Sixty-ninth Annual Joint Summer Meeting, Minneapolis – MATHFEST 1994

January 4-7, 1995 Seventy-eighth Annual Meeting, San Francisco (Board of Governors, January 3, 1995)

Sectional MAA Meetings

ALLEGHENY MOUNTAIN, November 5, 1994, Montgomery County Community College, Blue Bell, PA

FLORIDA, March 5-6, 1995, Florida Institute of Technology, Melbourne, FL

NEW JERSEY, November 19, 1994, Georgian Court College, Lakewood, NJ

NORTH CENTRAL, October 28-29, 1994, Minot State University, Minot, ND

NORTHEASTERN, November 18-19, 1994, University of Hartford, Hartford, CT

NORTHERN CALIFORNIA, October 21-22, 1995, Cal Polytech State University, San Luis Obispo, CA

OHIO, October 28-29, 1994, University of Findlay, Findlay, OH

SEAWAY, November 4-5, 1994, Rochester Institute of Technology, Rochester, NY

SOUTHERN CALIFORNIA, October 21-22, 1995, Cal Polytech State University, San Luis Obispo, CA

TEXAS, March 30-April 1, 1995, Baylor University, Waco, TX

Other Meetings

October 13-15, 1994, Twenty-fourth Annual Conference of the International Society for Exploring Teaching Alternatives, Arizona State University, Tempe, AZ. For more information, contact: Gloria Balderrama, Society Registrar, Mathematics Department, Colorado State University, Fort Collins, CO 80523; (303)491-6452; FAX: (303) 491-2161; e-mail: gloria@math.colostate.edu.

Minneapolis MathFest Updates

Breakfast for MAA Visiting Mathematicians.

There will be a breakfast on Wednesday morning, August 17, 7:00 a.m. to 8:20 a.m., for past, present and potential future MAA Visiting Mathematicians. These are people who arrange to work at the MAA headquarters in Washington while on sabbatical, during retirement, etc. The past and present Visiting Mathematicians will tell about their Washington experiences and answer questions. Anyone interested in being included should contact the MAA Executive Director, Marcia P. Sward.

AWM Panel Discussion

Monday, August 15, 3:30-5:00 p.m. Celebrating women's achievements in algebra, analysis, combinatorics, and geometry: past, present, and future.

Panelists include: Jane Gilman (Rutgers University), Karen Saxe (Macalester College), Doris Schattschneider (Moravian College), Marie Vitulli (University of Oregon), and the Organizer and Moderator is Joan Hutchens (Macalester College).

NAM Special Invited Lecture

The National Association of Mathematicians (NAM) is pleased to announce a Special Invited Lecture which will take place in Minneapolis and at all future Mathfests. The lecture, scheduled on Tuesday, 1:00 p.m. to 1:50 p.m., will be given by David Blackwell (University of California, Berkeley), and is titled *Large deviations for martingales.*

MAA-Mu Alpha Theta Lecture

Monday, August 15, 1:40 p.m. Pamela J. Drummond (Kennesaw College), talk is entitled, G*enerating Enthusiasm while Achieving Equity in Mathematics.*

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