Commentary

In My Opinion

Face to Face: Teachers and Mathematicians

Fame rarely visits the mathematician. While the names Beethoven, Rembrandt, and Einstein are household words, only those most interested in our field recognize the names of Cauchy or Weierstrass. We have no Hall of Fame, no Nobel Prize, and when a team does well in the International Mathematical Olympiad, the press hardly blinks.

Why is the work of the mathematician so hidden from public view? Part of the reason is that it is difficult to explain most advances in mathematics to people with only general knowledge. But we can go a bit deeper. It's not just the results of mathematics that the public has trouble relating to. It's also the act of creating mathematics. This is partly because, of all the arts, mathematics is perhaps the best at concealing itself. Mathematical thought is ripest when all traces of the struggle to achieve insight have been obliterated, when the result appears as if it has sprung full grown from its creator's head. It is difficult to recognize the product as the result of an intellectual struggle.

This is one of the most significant obstacles faced by the students of mathematics, who are striving to assimilate results created by others. They must unfold the carefully wrapped package that is a mathematical idea.

The classical work of Poincaré, Hadamard, Polya, Hardy, and others provides us with examples of mathematicians who were also gifted at revealing their art to the public. But there is no particular reason why someone whose talent lies in obtaining mathematical results should also have a talent for illuminating their results or taking others through the process by which they were obtained. For these are not mathematical processes. They do not partake, for example, of the ineluctable nature of mathematical truth. Different people acquire an understanding of mathematics in different ways.

Happily, mathematicians are not always called upon to make their work accessible outside the profession. However, there is one activity which most mathematicians engage in almost daily and which involves helping others acquire an understanding of mathematics. This is the activity of teaching. If it is to be more than the delivery of cut-and-dried results, teaching must involve the stimulation of a creative process in the learner. To be a good teacher, one must examine one's own thought processes and how they relate to those of the students. This sometimes involves a recapitulation of the creative process. We must recognize that a knowledge of mathematics does not automatically imply the ability to convey that knowledge to others. This is the task of the teacher, and it requires an effort separate and distinct from that of thinking mathematically.

Too often the good mathematician turns out not to be the good teacher. Neither is the good teacher always the good mathematician. Oddly, the two often work in close proximity, but back to back. Can we turn them around? Only if each community recognizes that it has something to learn from the other.

For example, mathematicians can sometimes learn about teaching from people in their own education departments. Now it is certainly not true that anyone on the faculty of a school of education will know how to teach: those faculties suffer from publish-or-perish as much as others, and the good teacher of teachers sometimes will not get tenure. But there are many people in schools of education who understand well and have thought deeply about how to communicate with students.

Another place to look for knowledge about teaching is the local high school or elementary school. Teachers on the precollege level are not used to talking about what they do; they're rarely asked. But good teachers possess deep wisdom about what it means to know mathematics and how to recognize whether the student has heard what you intended to say.

Better still than simply taking a lesson would be seeking—or constructing—situations in which mathematicians, teacher educators, and teachers can sit together and learn from each other. There has been much talk recently about the participation of mathematicians in education, and there have been some rather heavy-handed attempts by mathematicians to dictate curriculum and even methodology. More success would come from a more open approach, one through which mathematicians and educators might learn from each other, working together to explore aspects of mathematics that emerge in the classroom.

For we are not talking just about fame here. And we are not talking just about classrooms. We are talking about the role of the mathematician in society. We can let this role be assigned by our institutional structures and unconscious prejudices, or we can choose it carefully and consciously.

I hope we follow the latter course.

—Mark Saul
Associate Editor

Letters to the Editor

Interdisciplinary Mathematics

I hope that the December 1999 issue of the *Notices* is evidence that the mathematical world is at long last seriously recognizing the importance of research and development of "interdisciplinary mathematics"! I have been involved with this since my experience working at Lincoln Laboratory in 1959 and have seen at least some of my work become of utility in control theory, mechanics, and physics. For the past five years I have been trying to integrate some of the mathematics I know with developments in computer science.

I would like to make a modest suggestion. In my interactions over the years with scientists and engineers, I have noticed their difficulty in obtaining information about the frontiers of mathematical research in a condensed and intuitive form which might be useful in their work. Might something of this nature be made available on a Web site?

One way to do this that has occurred to me might be to piggy-back on the grant applications which most of us write throughout our career. As part of this algorithm, one usually writes a description of past work and how it relates to others'. An edited version of this material (of course emphasizing its "interdisciplinary" aspects), together with an adequate bibliography, might be collected and made available on the Web under the auspices of the AMS or NSF or both, thus serving as a first approximation to the document that I have in mind.

—Robert Hermann
Brookline, MA

(Received November 22, 1999)

Chaos Theory: Present and Future

We were quite surprised by the opinion column of Steven Krantz (*Notices*, October 1998), "See No Evil, Hear No Evil, Speak No Evil", in which Krantz in particular claimed that "there is not one example of any scientific problem that has been solved (not just *described*) using [chaos theory]." Indeed, there are plenty of popular "near-science" publications where authors sometimes adduce highly dubious and speculative conclusions that seemingly follow from the mathematical theory of chaotic phenomena. In the history of science this frequently happens: One can mention cybernetics, singularity theory, and synergetics, where similar inferences have been posted. See also the letter by David Ruelle entitled "Achievements of Chaos Theory", *Notices*, March 1999.

In our opinion, the main problem raised by Krantz concerns the social attitudes in a mathematical society. The example with a theater is very beautiful, but it is necessary to note that among dramatic and theater critics there are authorities whose opinions are much more important than those of an ordinary audience. Moreover, the theater directors sometimes direct their performances *despite* the critics: they are artists and have their own attitudes.

How many mathematicians have proclaimed a new paradigm and a new world picture? At the same time, mathematicians who deal with physical problems know quite well that methods of chaos theory have been successfully applied in many fields of physics. In order to illustrate the obvious progress, one can mention a variety of examples. Among these are the justification of the Boltzman ergodic conjecture for certain classes of systems, the discovery of Anosov systems, time series analysis, etc. Moreover, on the basis of deterministic chaos theory it is possible now to describe such physical phenomena as self-organization and pattern formation, to quantify the fractality, and so on. Why should this area not be developed by mathematicians?

—Alexander Loskutov
Serge Rybalko
Moscow State University

(Received December 7, 1999)

FYI Item "BMS Report on Institutes"

As a member of the panel commissioned by the Board on Mathematical Sciences of the National Research Council, I write to correct several inaccuracies in the "For your information" note by Allyn Jackson entitled "BMS Report on Institutes" in the December 1999 issue of the *Notices*. First of all, the panel was told from the start that its task was to be totally independent of the re-competition process for existing NSF-supported mathematical institutes. Second, I recall no support whatsoever from panel members for an Oberwolfach-style U.S. conference center. Third, the panel strongly urged the preservation of funds for principal investigator grants. Finally, the panel's recommendation of consideration of two new sorts of institutes was made with the explicit caveat that such institutes should be funded with new funds and not drain scarce resources from existing NSF research programs. Indeed, the report states in its Executive Summary and repeats in its Recap and Closing Comments the following statement, italicized both times for additional emphasis: "[T]he committee strongly believes that it would not be in the best interest of either the mathematical sciences community or society as a whole to transfer funding from existing mathematical sciences individual (principal investigator) research grant programs to funding for existing or additional mathematical sciences institutes."

—Eric M. Friedlander
Northwestern University

(Received December 10, 1999)

Federal Funding for Basic Research

In her opinion column "Opinion and Responsibility" (*Notices*, December 1999), Mary Beth Ruskai raises an important point. It appears that my essay "The Immigration Law of 1990 and Its Effects" (*Notices*, August 1999) did not adequately address whether overall federal funding for basic research was or was not declining during the 1990s. The substance of this question is too important to be left hanging: news of healthy or of declining budgets can color perceptions on a wide range of issues and should not be made in error. Accordingly, I have researched the question in more detail than I was able to do during the preparation of the original essay.

The Office of Management and Budget publishes historical tables of funding by agency and funding by function and subfunction. Of the agencies, funding to the NSF has been the statistic habitually employed in the mathematical community to gauge federal commitment to our discipline. Of the functions and subfunctions of federal outlays, Subfunction 251, "General science and basic research", most closely aligns with basic research as Ruskai defines it. Funding to the NSF occupies the lion's share of the appropriations gathered into this subfunction; funding for the Space Program, NIH, and many other federal technical programs do not appear there at all. In addition, the portion of NSF funding that is devoted to education does not appear in Function 250 at all, but rather in Function 500.

An examination of NSF funding and Subfunction 251 funding, both in constant dollars and as a fraction of the Gross Domestic Product, reveals surges in the 1960s and declines in the 1970s. Both accounts, as a fraction of GDP, have been holding their own through the 1980s and '90s: that for the NSF holding at about 75% of its post-Sputnik levels, and that for Subfunction 251 holding at about half. In constant dollars both accounts have had healthy growth during the past two decades. In fact, in constant dollars each account was at an all-time high in 1998, the last year the tables provided by the OMB are not qualified with the word "estimate". Those who wish to check the work should begin their navigations at `http://w3.access.gpo.gov/usbudget/` and at `http://www.bea.doc.gov/bea/dn/gdplev.htm`.

In all, the assertion in my essay of August 1999 holds, though for reasons not properly presented there. The evidence is little short of overwhelming that federal funding for basic research was not declining in the 1990s. The declines happened twenty years earlier.

—Damon Scott
Rochester, NY

(Received December 15, 1999)

Location of Joint Meetings

The selection of Washington, DC, for the winter meeting of the American Mathematical Society was ridiculous. Throughout the meeting there was ice on the streets, and the temperature was always below the freezing point. For those people in the Omni Shoreham Hotel, the walk to the Marriott Hotel was a real hazard. The map that showed the Marriott Hotel across from the Omni Shoreham was in error.

There is no reason to select a northern or borderline site for the winter meeting when some southern city would be better. To refresh your memory, here are a few locations of other winter meetings: 1987 in San Antonio, Texas; 1988 in Atlanta, Georgia; 1989 in Phoenix, Arizona; 1993 in San Antonio, Texas; 1996 in Orlando, Florida; 1997 in San Diego, California; 1999 in San Antonio, Texas.

Other southern cities are possible: namely, Miami, Florida; New Orleans, Louisiana; and Houston, Texas.

Please schedule future winter meetings of the AMS in the Deep South. If one wishes to visit Washington, DC, it should be in the spring or fall.

—A. W. Goodman
Tampa, Florida

(Received February 10, 2000)

Rota Students

In regard to the two unknown Ph.D. students of Rota mentioned on page 205 of the February *Notices*, I can give the following information about one of them, Robert L. McCabe.

He received his degree in mathematics from Boston University in 1971 with a dissertation entitled "On Distensions of Positive Operators". That has the sound of Rota. However, in the abstract of his dissertation a different adviser is listed. No doubt Rota helped him, but since Rota was not on the faculty of Boston Unuversity, another acted in this role. I believe that McCabe now teaches at the University of Massachusetts at Dartmouth, MA.

I cannot help with O. Murru.

—W. A. Beyer
Los Alamos National Laboratory

(Received February 22, 2000)

The *Notices* invites letters from readers about mathematics and mathematics-related topics. Electronic submissions are best. Acceptable letters are usually limited to something under one printed page, and shorter letters are preferred. Accepted letters undergo light copyediting before publication. See the masthead for electronic and postal addresses for submissions.