Not Business As Usual

Mathematics departments are not taking care of business. Nearly 20 percent fewer mathematics bachelor's degrees were awarded in 1998 than in 1985. How can it be that at a time when higher-quality research is occurring at more and more institutions, interest in mathematics among undergraduates is decreasing?

It should be the department's responsibility to attract undergraduate students to the study of mathematics and to retain them. Departments have failed to accept this responsibility. They have placed an overemphasis on the creation of new mathematics instead of new mathematicians. Faculty fully understand the yardstick by which they are measured. It is not teaching, it is not outreach, it is not mentoring; it is research.

I value the excitement of carrying out a research project, the joy of discovery, the thrill when a proof comes together. Research is vital. Research brings with it the understanding of complex phenomena, it gives us insight into structures, it displays connections that were invisible. But our undergraduates simply never see this aspect of our work. Too often we view research as an esoteric activity, the end result of which is a presentation at a research conference or a publication in a journal. We need to share the excitement with our students and make the grand ideas visible in our undergraduate curriculum.

Departments have failed to understand how critical it is for our undergraduates to obtain a sound and working knowledge of mathematics and how important it is for departments to produce such students. Having more mathematics majors in the work force is beneficial for mathematics. With an increase in the number of mathematics majors, more students will think about advanced degrees. Departments nationwide have difficulty finding qualified U.S. students to enroll in their graduate mathematics programs. Many departments depend on a large cadre of foreign students to keep their graduate programs running. Although the NSF VIGRE program is intended to encourage departments to pay attention to the education of U.S. students, critics have complained about VIGRE funds being restricted to U.S. citizens and permanent residents! Graduate programs want the best students, somehow implying that these students do not exist in the U.S. It makes no sense to ignore the mathematical education of our undergraduates and then to complain about the lack of mathematical preparation of U.S. applicants for graduate school.

The focus on research and the corresponding lack of attention to undergraduate mathematics majors have also served to decrease the number of minorities going into mathematics. Traditionally underrepresented minority groups such as Mexican Americans, Native Americans, and African Americans have been excluded from our profession, and even now these minority groups are almost invisible in our graduate programs. The internationalization of our mathematics departments over the last twenty years has resulted in very few from these minority groups being hired into faculty positions at our research universities. Since minorities are not part of the mathematical enterprise, minority concerns are not given voice in departmental matters. With so many other pressing concerns in a department, diversity issues are relegated to rhetoric. One doesn't need to have minority faculty in order to reach out to the minority students. However, minority faculty tend to be more concerned about diversity issues. It is just human nature.

I am not saying that our universities should exclude mathematicians trained abroad. I am saying that by depending heavily on this group to fill graduate school and faculty ranks, U.S. colleges and universities have managed to get by without giving proper attention to their undergraduates. Just getting by is a dangerous strategy, since American universities and American research efforts depend on U.S. tax dollars for their funding. Our attitudes toward undergraduates must change for the health of our subject, of our universities, and of our nation.

I would like to close with some recommendations for mathematics departments.

1. Departments should diversify their activities and their hiring. Research and scholarship; effective teaching; outreach to the local community; and recruitment of undergraduate mathematics majors, with special emphasis on integrating these students into the scientific life of the department, the university, and the nation, should be part of the portfolio of a department. Departments should hire and promote faculty who will be helpful in this endeavor.

2. Departments should substantially increase the number of undergraduate mathematics majors. Departments should establish collaborations with those mathematicians who have developed ideas and programs for increasing the number of mathematics majors.

3. Departments should recognize that the bachelor's degree in mathematics is marketable. Departments need to work with employers to ensure that mathematics majors are recruited by more firms.

4. Departments that have graduate programs should look upon their incoming graduate students as a national investment. Every effort should be made to insure that this investment pays off.

5. Departments should recognize that they are part of a neighborhood and that outreach to that neighborhood should be part of their portfolio. There should be faculty in a department that can achieve this goal.

6. Funding agencies like the National Science Foundation should require that all proposals include departmental documentation for the items listed above. The NSF is already asking this from Principal Investigators. An individual's efforts should reflect the activities of the department.

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Letters to the Editor

The Lena Image

I was disappointed that Chan et al. chose to use the Lena image in their excellent article about image processing in the January 2003 issue. For those who don't know, the picture is the face of Lena Sjööblom, *Playboy*'s 1972 Miss November, and has become a standard test for image processing algorithms since A. Sawchuk and others scanned it at the University of Southern California (USC) in 1973. (See the article by Jamie Hutchinson in the May/June 2001 issue of the IEEE PCS newsletter, `http://www.ieeepcs.org/may_june01.pdf`, for more details.) The use of the image is a kind of joke: in the full picture she is wearing only the hat. It's easy to understand why not everyone finds the joke funny. It also reinforces the perception (reality?) that science is some kind of boys' club, an idea that mathematicians in particular have been trying hard to get away from.

—Christopher Woodward
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Response to Woodward

We are sorry that our inadvertent use of the Lena image has caused negative reactions from some readers. We certainly did not mean it, and we will try our best to refrain from using it again.

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Leonhard Euler's Blindness

As both an ophthalmologist and mathematics student, I was fascinated by the article "The World of Blind Mathematicians" in the November 2002 issue. These men are truly remarkable. I would like to add some comments regarding Leonhard Euler's blindness. Although it is not possible to make specific diagnoses so many years later, certain conclusions can be drawn. We are indebted here to René Bernoulli for his comprehensive review of all the existing medical reports, documents, and portraits ("Leonhard Eulers Augenkrankheiten", in *Leonhard Euler 1707–1783: Beiträge zu Leben und Werk*, J. J. Burckhardt, E. A. Fellmann, and W. Habicht, eds., Birkhäuser, 1983, pp. 471–488).

First, the notion that eyestrain causes blindness or leads to serious organic disease is simply an old wives' tale. Although Euler himself made this association, Bernoulli comments correctly that this "legend" is "certainly false." Precisely what did happen to his right eye is not known with certainty: little information is available. It is likely that Euler had a recurrent process in this eye which was inflammatory or infectious in nature. Uveitis, for example, would be a possibility. It is clear that by 1753 there had been significant loss of vision in this eye and that it eventually became phthisical. Phthisis is the end stage of many different catastrophic conditions in which the eye is totally blind and shrunken and its anatomy is completely disorganized. Thus we know that his right eye became totally blind, but the etiology remains speculative.

In terms of the left eye, there is evidence that he had problems as early as 1740. He seems to have had a relapsing inflammatory process. Then in 1766 Euler experienced a sudden, dramatic loss of vision in this eye. His description suggests a vascular event such as a retinal vein occlusion, although numerous other causes of sudden vision loss are considerations as well. He did not, however, become totally blind: he could still distinguish large characters, for example. It is likely that he experienced additional insults to this eye subsequent to this event as well. In 1771 he underwent cataract surgery in this eye. The cataract was very advanced, and one can infer from the operative report that the eye had suffered an attack of iritis in the past. Nonetheless, the surgery was uncomplicated and proved successful. Although his vision returned to some extent after this surgery, it was ultimately lost again at some point. The details are unclear.

Contrary to what is often repeated, we know that Euler did in fact retain a very small amount of vision in the left eye to the end of his life. Nevertheless, he was profoundly impaired: he was certainly functionally blind and would be considered legally blind today.

One can only stand in awe of an Euler even without knowing of his disability. Apparently some giants can see farther even without the advantage of sight.

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Computer Models

In his review of Wolfram's *A New Kind of Science* [February 2003], Lawrence Gray discusses many issues of interest to specialists in the study of cellular automata, but he neglects a more central issue of interest to all mathematicians: that is, the issue of the role of computers in mathematics. In recent years computer models have seen increased use in the sciences, especially in those disciplines where traditional mathematical models based on differential equations have been unsuccessful. (In particular, I am thinking of the computer models used by Robert Axelrod in the study of the social sciences. See `http://www-personal.umich.edu/~axe/homepage.html`.) But computer models and traditional mathematical models are difficult to reconcile. On the one hand, it is difficult to prove general facts about most computer models; they rarely yield to the methods of mathematical analysis. And on the other hand, specific solutions to differential equations are often difficult to calculate, although general properties of solutions may be quite easy to prove.

Is it possible to reformulate science so that all models are computer models? Wolfram suggests that the answer is "yes" and provides many examples to support his claim. But it is unclear how computer models such as Wolfram's correspond to traditional mathematical models of the same phenomena. Indeed, given the contrast between ease of calculation and ease of proof, it is an open question whether or not the capabilities of computer models and of more traditional models are, in principle or in practice, equivalent. Because computer models will almost certainly play a significant role in twenty-first century science, it is important that we, as a community of mathematicians, begin to try to answer these questions.

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Mathematics Education

The way we teach it, mathematics would have long gone the way of Greek and Latin if it weren't for the fact that a great number of students are required, much to our financial benefit and very much against their will, to take math courses on the widespread, if questionable, assumption that math courses are the best way to separate the wheat from the chaff.

And how do we teach mathematics, from first grade on to college calculus? To see, one need only look at the textbooks on the market: by show and tell and drill and memorize and… pass/fail the exam and forget it.

The result, as John Holt wrote over thirty years ago in *How Children Fail*, is that students are "answer oriented instead of question oriented," and the consequences are here for all to see, e.g., in the *Trends in International Mathematics and Science Study* (`http://nces.ed.gov/timss`).

It is thus unfortunate that the *Notices* devoted yet more space to Steven Zucker's view that "there is wide agreement over the following statement: The fundamental problem with today's college students is that most arrive thinking that college is a simple continuation of high school" ("Telling the Truth", Opinion, March 2003) when he already said much the same thing in an article in the August 1996 issue ("Teaching at the University Level"). I, for one, am not in agreement.

The real reason that so many students fail in mathematics is that we have turned it into something that is what instant coffee is to espresso. For instance, already in first grade we look at "abstract" numbers such as 2 rather than numerators *cum* denominators such as $2\heartsuit$, thereby preventing our students from distinguishing the *addition* $2\heartsuit + 3\heartsuit = \heartsuit\heartsuit + \heartsuit\heartsuit\heartsuit = \heartsuit\heartsuit\heartsuit\heartsuit\heartsuit = 5\heartsuit$ from the *combination* $2\heartsuit + 3\blacklozenge$, where + should be read "and". Students who have seen that if, say, $1\heartsuit = 5*$ and $1\blacklozenge = 4*$, then $2\heartsuit + 3\blacklozenge = 2(5*) + 3(4*) = 22*$ have no problem dealing with $2/7 + 3/7$ and $2/5 + 3/7$ appropriately. But then, one should not begin with 3/4 but with 3/4 of $\heartsuit$ as "3 things, 4 of which can be exchanged for $1\heartsuit$," as with the 25-cent coin. And then, when, much later, we present the few survivors with vector spaces, it is unfortunate that we never gave them a chance to play with combinations of $\heartsuit$ and $\blacklozenge$. We may have had a few more students, both taking the course and passing it.

What is needed is rethinking the *logic* of mathematical exposition. For instance, do signed numbers really come *after* rational numbers? Is the Bolzano-Cauchy-Weierstrass theory of limits truly more appropriate to first-year calculus than polynomial approximations? Does it really simplify the approach to vector spaces not to deal with the dual from the start? etc. And why not appeal to the students' common sense? Students may then realize that things mathematical are the way they are, not because some teacher or some book says so, but because that is the only way they can make sense.

But then, it has always been easier to blame the victims as Steven Zucker does.

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Response to Schremmer

First, I am in some agreement with Alain Schremmer. There are serious problems that arise from the present state of primary and secondary education in mathematics. If we could fix K–12 education, that would be great. Since we can't, or rather until we can, it behooves us to determine *what we can do* with and for the "victims". Feeling sorry for them is not very practical, nor is simply blaming the system. We are obliged to deal with the high school graduates as they come to us. It is a mistake to equate guiding the victims' recovery with blaming the victims.

Moreover, students have always had to adjust to the higher aspirations and responsibilities of education in college. It's harder for them if they don't even know what these are.

—*Steven Zucker*
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