Forum

The Forum section publishes short articles on issues that are of interest to the mathematical community. Articles should be between 1000 and 2500 words long. Readers are invited to submit articles for possible inclusion in Forum to:

Notices Forum Editor
American Mathematical Society
P.O. Box 6248
Providence, RI 02940

or electronically to notices@math.ams.org

Some Thoughts on the Funding of Mathematics

William Yslas Vélez
The University of Arizona

I have just finished a one-year stint as program officer for the Algebra and Number Theory program in the Division of Mathematical Sciences at the National Science Foundation. It was certainly an interesting year, one which I would definitely repeat. I cannot say that it was enjoyable (the workload was tremendous), but I can say that it was challenging. Based on this experience I would like to bring to the mathematics community three issues:

1. Why and how should this country fund mathematical research?
2. In determining which graduate students receive funding as part of an NSF grant, should U.S. citizens and permanent residents be given preference?
3. What are the responsibilities of an academic department to the citizens of this country?

The Funding of Mathematical Research

I arrived at the NSF in August 1992, just as the division was in the midst of deliberations on the issue of "flat-rate" funding. You will recall that the flat-rate scheme was to consist of essentially two funding levels, one at around twenty thousand and the other at around thirty thousand. This scheme was rejected by "the mathematical community". The reason for the quotation marks is that I am not 100 percent sure who exactly turned it down. My impressions were that the majority of the community was behind this idea. In any case, the end result of this situation was that the program officers were left with little advice as to how to fund mathematical research. (The reader might consult the article which appeared in the July/August 1993 issue of the *Notices of the AMS* for remarks by Fred Wan on this issue.) In fact, after my experience in this position, I personally have to admit that I am not sure how best to fund mathematical research. I know what tradition tells me, that I should provide 2/9 summer salary, graduate student support, and $2000–$3000 for other activities, plus some computing expenses, if they are warranted. The problem that keeps coming up is this question of summer salary. Should summer salary be provided, and how much should be provided?

This last year I processed around 130 proposals and recommended around forty proposals for funding. When I think back to the proposals that went unfunded, I remember many proposals that represented the efforts of hard-working and talented individuals. However, the cutoff level for funding is so high these days that these talented individuals were not funded. But these unfunded mathematicians have not stopped working, and they are carrying out very active and important research programs. How should the NSF fund mathematics?

Several issues need to be addressed. Should the NSF fund a small elite group of mathematicians, or should the NSF attempt to find a greater variety of mathematical scientists? How should these mathematicians be funded? How does society benefit from funding mathematical research?

Suppose that a researcher does not get funded. What is such a person to do? One choice is simply not to do research during the summer and to go work in the garden. If the researcher is a junior faculty member, this is not a strategy that will bring tenure. One common choice is to teach summer school where possible. So, the unfunded person will teach 5–8 weeks during the summer and do research the rest of the time. The unfunded and funded researchers both work hard all year, except that one of them has to teach for 5–8 weeks. In practice, what an NSF grant buys is 5–8 weeks of summer work at a cost of $20,000–$40,000!

If teaching is not an option for the researcher, but summer salary is still a necessity, then another possibility is to hustle some consulting work in either business or the

defense industry. In this option, the researcher probably does not produce publishable mathematical work, and research in mathematics is slowed down. Do society and the profession suffer from this scenario? No, quite the contrary! If more working mathematicians addressed the issues that arose in business or the defense industry, then these industries would see how powerful mathematicians are and that would open new job opportunities for our students.

Now that we understand what funding buys, we turn to the question of who gets funded. It appears that in determining who it is that receives a research grant, creativity seems to be the primary difference between those who are funded and those who are not. It appears that the most creative researchers are the ones that need the most funding. Why is that? Granted, it is these individuals who make the most spectacular breakthroughs, but why do they *need* this funding in order to carry out the research program? This is an important issue. The budgets that are attached to the proposals are almost completely divorced from the proposal itself, and, except for tradition, there is no rationale for requesting the summer salary. However, here are some of the reasons that I have heard while at the foundation.

POVERTY: "My university does not pay me enough, and, if I do not have these funds, I would have to teach or find some other way of making money." My thoughts: This vaguely reminds me of a welfare system for university faculty.

CHILDREN: "My children are now attending private schools, and I sure need the money." My thoughts: So the children of the most creative researchers need to have their education subsidized by the taxpayers.

PRIDE: "I don't mind getting partial summer funding if everyone else is. But if anyone is getting full funding, I certainly should get it because I am the best mathematician working in this area." My thoughts: How many times did I hear that one!

TENURE: "This award will help me to get tenure." My thoughts: NSF program officers should not play such an important role here.

FELLOWSHIP: "Based on my reputation and my past work, I deserve an award. I can't be bothered with providing you with documentation to support these claims." My thoughts: Are NSF awards either fellowships or research grants? I have seen several 2–4-page proposals that stated essentially this. The proposer felt that he was leading the pack and the NSF should simply hand over the money.

I may have been a bit frivolous, but the issue of who to fund and the correct way to fund mathematical research is a very serious one, and it is one that the mathematical community should confront before someone else sets the agenda for us.

The Funding of Graduate Students on NSF Research Grants

An issue that I chose to address while I was at the NSF was the question of foreign graduate students. Fifteen or twenty years ago, foreign graduate students made up a small percentage of the graduate students in the sciences. Recently, we have seen this figure rise, and it appears that now the majority of doctoral mathematics degrees are being awarded to foreign students. One of the factors that has caused this increase in the foreign-student population is the lack of interest among U.S. citizens to study higher-level mathematics. Even though fewer of these students chose to study graduate-level mathematics, this did not mean that graduate production decreased dramatically. Departments had slots to fill, and it was unthinkable that these slots would go unfilled, so foreign students began arriving. Perhaps it would have been better to have slowed down Ph.D. production. The profession would be healthier for it, and the mathematical community should consider this option seriously, even now.

The issue that concerned me in dealing with foreign students was the funding of their studies in this country. Were the percentage of foreign graduate students in the teens, there would be no need to be concerned about this. However, now that this figure is around 50 percent, it needs to be addressed. In particular I was confronted by this problem as I looked at grant proposals that arrived to my program. I had to determine whether or not to support the graduate students that the investigator requested. My thought on this issue was as follows. The program that I managed supported the best mathematicians around. A student who has the opportunity to work under one of these individuals already has an advantage in the academic world. This advantage is further amplified when that student is given a research fellowship or is supported by someone's grant. The opportunity for uninterrupted study is critical to a student and allows the student to write an even better thesis.

A student that is supported under an NSF grant is being given preferential treatment. As such, it appears to me that the children of those taxpayers who are supporting this research should be given preferential treatment. Further, when considering which students get funding under NSF grants, priority should be given to students who are U.S. citizens or permanent residents.

STOP! We've all heard it before. Many of the readers are already thinking that the result of such a priority will be a decrease in the quality of the graduate students. I would like to make two points regarding this concern. First of all, if academia expects to see a decrease in the quality of the graduate students, they can certainly ensure that outcome. I am sure that everyone told Jaime Escalante at Garfield High School that he couldn't possibly hope to teach calculus to a bunch of poor Hispanics from East Los Angeles. But someone, or some community, with a vision can bring about the unexpected. The second point that I want to make concerns the international marketplace. Suppose that we opened up every position in this country to anyone in the world. Would we expect that an American would get the position, based only on qualifications? I think not; yet that is exactly how we treat the graduate students. Maybe we ought to apply the same criteria to research grants. Instead of just funding investigators in this country, maybe the NSF should support simply the best science. Then how many of the investigators in this country

would be funded? But we don't do that because the "N" in NSF means national, and the funds for research are supposed to have a positive impact on science and science education in this country.

Earlier I alluded to the question as to what it is that society gets out of funding mathematics. The standard answer is that support of pure research pays off in the long run, and society and the Congress sort of believe this and provide funds for this research. What is hardly ever mentioned is the short-term benefit of this funding, and that is that our children will have the opportunity to learn from brilliant researchers and, with this education, these same children will be able to participate in these exciting careers. I think that parents live with this hope and support education because of this. However, our graduate programs are no longer aimed at our children. This is a dangerous state of affairs, and if the public and the Congress became truly aware of this situation, we might find it hard to convince them to continue their support of our research endeavors.

It is a common complaint that American students do not want to study mathematics, and it is difficult to attract them to the study of mathematics. There is no question that efforts aimed at attracting this recalcitrant population would take away from research time. Given a choice between research and encouraging students to continue in their mathematical studies, which choice should the mathematics community make? The choice that is made is influenced by a pervasive attitude among mathematicians that there are very few students with the potential to be great research mathematicians. To some extent this is true. There are very few Hilberts around. There are very few individuals who are capable of writing that wondrous music that makes the rest of the mathematical community sing. Many of us have been captivated by the song, and we have spent most of our lives trying to understand it, rewriting the score, improvising on the main themes, all the while enjoying ourselves. What is oftentimes forgotten is that the individuals who write the best scores are many times either not capable or not interested in signing the songs. Is it any wonder that our youth have not been captivated by the song? In order to interest our youth in the study of mathematics, we need more diversity in the presentation. It doesn't take a Hilbert to make mathematics interesting.

I am not gloomy about the prospects of encouraging our youth to study more mathematics. It does take energy, and it does take up some of the resources of a department. However, it should be part of the social contract that we have with the community. It is in the best interest of this country, and of the mathematics community, to produce a mathematically literate work force. Some of these students grow up to become policy makers. The NSF has a responsibility to encourage American students to pursue careers in mathematics. It is in keeping with this responsibility that priority should be given to funding American graduate students on research grants. I encourage you to write and express your views to those who are making the decisions on these issues. I suggest that you write to the officials at the National Science Foundation, to your congress person, and in particular to Mr. George Brown, Representative from California and chairman of the Committee on Science, Space, and Technology.

We, as a community of scholars, benefit from the support of the country, and the children of this country should be given a chance to participate in these adventures.

The Coming Disaster in Science Education in America

John Saxon

(Editor's Note: John Saxon is the president of Saxon Publishers in Norman, Oklahoma. He is the author of a mathematics series that has been used in over 4,000 American schools.)

I believe that the present disaster in science education in America will be drastically exacerbated in the next decade because of recent actions of the National Council of Teachers of Mathematics (NCTM). These actions are capricious at best and approach total irresponsibility at worst. This organization has decided, with no advanced testing whatsoever, to replace preparation for calculus, physics, chemistry, and engineering with a watered-down mathematics curriculum that will emphasize the teaching of probability and statistics and will encourage the replacement of the development of paper-and-pencil skills with drills on calculators and computers. This drastic shift in emphasis will leave American students bereft of the detailed knowledge of the parts that permit the whole to be comprehended.

America is on the road to becoming a follower in technology and science rather than a leader. Our captains of industry tell us that they are at a disadvantage in worldwide competition because our labor pool is mathematically incompetent. This incompetence has been documented by recent tests which show that 82 percent of our 17-year-olds do not know what the word *area* means and also by international test results wherein American students scored near the bottom of the students in the nations tested. The engineering and physics departments of American universities have an overabundance of foreign-born students and teachers because most American university students do not know the mathematics necessary to be successful in engineering and physics.

To correct this situation, we need a no-frills national mathematics program that concentrates on precalculus fundamentals. We have to get our best students (30 percent) through advanced placement calculus in high school and get the next ability group (40 percent) prepared for calculus as college freshmen. The rest of the students should master the fundamentals of mathematics that are required to be productive members of our labor pool, enabling us to compete with Europe and the Asian nations. It can be done. Jaime Escalante, whose exploits were documented in the film *Stand and Deliver*, had 150 students in advanced placement calculus at Garfield High School in 1988–1989. This school is in the heavily Hispanic East Los Angeles area. If all of our schools had the same percentage of students in calculus, there would be no crisis in American scientific education.

Rather than implement a program to prepare students for engineering and the hard sciences, as well as for advanced