The Demise of the Young Scholars Program

Allyn Jackson

Starting in 1988, the Young Scholars Program at the National Science Foundation funded summer programs for high school students showing special talent in mathematics and science. The legendary program run by Arnold Ross at Ohio State University, which draws some of the top mathematical talent in the nation, received funding through Young Scholars for many years. Among the other well-regarded and long-running mathematics programs funded by Young Scholars are PROMYS (Program in Mathematics for Young Scientists) at Boston University, run by Glenn Stevens, and one at Hampshire College, run by David Kelly. In 1996 the NSF ended funding for Young Scholars, leaving these and other programs scrambling for funding and, in some cases, closing down altogether. The NSF itself acknowledges that Young Scholars has been very successful. So why did it cut off funding? The reason appears to be a potent mix of politics and legal troubles, together with the governmental fact of life that dollars flow more easily toward new ideas, even when the old ones have proven their worth.

Examples of Young Scholars Successes

The NSF funded summer programs for many years through SSTP (Summer Science Training Program), which was part of the post-Sputnik push to improve science and mathematics education. Funding faltered during the Reagan administration's attempt to wipe out the NSF's education directorate, but by 1988 worries about the "pipeline" for scientists and engineers led to the resurrection of SSTP in the form of Young Scholars. At the time of its demise Young Scholars was funding 114 summer programs that reached around 5,000 students annually. Funding totaled about $10 million a year, or 5% of the budget of the NSF's Division of Elementary, Secondary, and Informal Education. Generally the programs ran several weeks, brought in 20–60 students, and were directed by scientists and mathematicians. The size of a typical grant was $25,000–$50,000 per year. Some of the cost of the programs was covered by student tuition, and there was usually substantial cost sharing on the part of the sponsoring institutions. About 15% of the Young Scholars programs were in mathematics. A look at the three Young Scholars programs mentioned above gives a sense of what these programs aimed for and accomplished.

Among the Young Scholars programs in mathematics, the Ross program at Ohio State was probably the best known, partly because of its age—it started in 1957 and has run every year since then—and also because it has drawn students of such tremendous talent and has inspired many to pursue careers in mathematics. The distinctions of the alumni of the program include positions in some of the top mathematics departments, Sloan Fellowships, various prizes (including a Steele Prize and a Cole Prize), and at least one MacArthur Fellowship. The heart of the Ross program is a collection of problem sets that students are given to work on each day. The problems, many of them in number theory, encourage students to do extensive explorations and to draw conclusions from what they find. The problems are very different from what the students usually encounter in high school. For example, the sets include a list of statements headed with the instruction "Prove or Disprove and Salvage If Possible", with no hints provided as to whether the statements are true or false. Each day the students put intense effort into solving as much of the problem sets as they can, and each day their solutions are read by undergraduate counselors, many of whom are program alumni. There are also lectures by mathematics faculty, including Ross himself, who last summer at the age of ninety was still giving daily number theory lectures for first-year participants. These lectures lag behind the problem sets, revisiting and reinforcing ideas that the students have already explored for themselves in the problems. There are also courses on combinatorics and other subjects. [1]

Allyn Jackson is senior writer and deputy editor of the Notices. *Her e-mail address is* axj@ams.org.

As an alumnus of the Ross program, Glenn Stevens used it as his model when he and his Boston University colleague David Fried started PROMYS in 1989. The students who come to the program are already good problem solvers, Stevens notes. PROMYS gets them to move from seeing the "answer out there" as the ultimate goal to seeing answers to particular problems as forming patterns. "Ross's problem list is ideal for this," Stevens says. In fact, he tells the students that the most important problems are the numerical ones: observing the data gleaned from these problems allows the students to formulate and test hypotheses to explain their observations. With the undergraduate counselors and faculty members around, there are plenty of people for the students to talk to. Indeed, Daniel Shapiro, one of the co-directors of the Ross program, says that the "real reason" for the success of the program is the counselors, who live together with the students in the dorms. This provides an atmosphere in which the students are steeped in mathematics all day long and for many days on end: the Ross program runs eight weeks, and PROMYS runs six weeks.

David Kelly's program, Hampshire College Summer Studies in Mathematics, has a goal similar to that of PROMYS and the Ross program, which is, as Kelly puts it, to get the students to see themselves as "active creators of mathematics rather than passive learners." Kelly's program is different in that it is centered not on problem sets but on workshops designed to encourage the students to come up with their own definitions, conjectures, and theorems. The entire staff live in the dormitories and join students for meals and recreational activities, as well as the seven hours of class each day. The second half of the program includes courses on topics that students are unlikely to see in high school, such as real and complex dynamics, four-dimensional geometry, game theory, and probability. At the end of the six weeks the students "hate to leave," Kelly notes. With that much enthusiasm coming from the students, Kelly's love of the program has not dimmed after twenty-five years of running it. "This is one of the most gratifying teaching experiences you can imagine," he says.

In a conversation with about ten PROMYS students, it is clear that the program's goal of getting them to look at mathematics in a new light is amply realized (see sidebar on page 386). "When you do math in high school, you kind of get an idea of it as already done for you," said Peter Frazier, a student from Rhinebeck, New York. "But when you come to PROMYS, you get the idea that it's not really all cut and dried and there's new stuff always going on that you have to figure out." Another student, Radu Iòvita, pointed out that in high school the justification for learning mathematics is often that it is useful in another subject, such as chemistry or physics, but what they learn in PROMYS is mathematics that is interesting in its own right. "Here you find out that pure math is incredible, you can do all these incredibly weird things, and use your imagination to the full twist," he declared. It is "basically full liberty of imagination." Their only complaint? The program could be longer.

The Young Scholars programs have sometimes been criticized for catering to "elite" students. The argument is that these students are already highly talented and motivated and such programs simply add to their advantages. Some of the programs, especially the more rigorous and challenging ones like the PROMYS, Ross, and Kelly programs, have also been criticized for what is seen as inadequate representation of women and minorities. The Ross program has probably come in for the heaviest criticism of this type, in part because it does not advertise widely and relies mostly on a group of high school teachers to recommend the program to their students. PROMYS and the Hampshire program advertise more widely, but applications from women and minorities are not plentiful. The main criterion for admission to these programs is performance on a set of problems sent out with application materials. Any student doing well enough on the problems is admitted. According to Shapiro many students get discouraged by the difficulty of the problems and do not send any solutions back.

In all these programs, when an application from a female or minority student is received, the directors do all they can to bring the student into the program. Kelly has gone as far as to work with minority students during the school year to try to bring them up to speed for the demands of the program, because the program "won't be a service if they are not qualified." While the actual number of women students in Kelly's program has been small, about a dozen have gone on to advanced degrees in mathematics. Three are nearby in New England: Susan Landau of the University of Massachusetts, Marcia Groszek of Dartmouth College, and Ann Trenk of Wellesley College. The Ross, PROMYS, and Hampshire programs have met with success with the individual female and minority students who participate, but they get few applications from such students.

There are some Young Scholars programs in mathematics that target women, a prominent example being the one run by Harvey Keynes at the University of Minnesota. Some have a high minority enrollment, such as the program run by Max Warshauer at Southwest Texas State University. About 25% of the students in Donald Goldberg's

[1] *The article "A Conference Honoring Arnold Ross on His Ninetieth Birthday", by Daniel Shapiro, presents background and history about Ross and his program. The article appeared in the* Notices, *October 1996, pages 1151–1154.*

program at Occidental College were members of underrepresented minorities. Warshauer's program is continuing despite the loss of NSF funding, but Goldberg's has closed down. These programs provide two more examples of how the established, long-running programs have provided models that can be used successfully in other settings: Warshauer is a three-time participant in the Ross program, and Goldberg was in Kelly's program as a student and later as a counselor. The SUMMA (Strengthening Underrepresented Minority Mathematics Achievement) program at the Mathematical Association of America also helped to create more minority-focused Young Scholars programs by providing advice, technical assistance, and small grants to those who wished to get such programs off the ground. In fact, all but one of the new grants in Young Scholars in mathematics since 1992 were obtained with the assistance of SUMMA.

Legal Headaches at NSF

The NSF encouraged the directors of the Young Scholars programs to include women and minorities among their participants, but the numbers remained small. In 1992 Congress directed the NSF to create the Summer Science Camps (SSC), which were similar to the Young Scholars programs but were aimed exclusively at minority students. The guidelines were explicit: "Participants in the SSC must be underrepresented students." The NSF defined underrepresented minorities as including Native Americans (American Indians and Alaska Natives), Blacks, Native Pacific Islanders (Micronesians and Polynesians), and Hispanics. The SSC started out with a budget of $2 million, which grew to about $5 million by 1994, when it supported around eighty projects.

The SSC was short lived. In 1994 a white ninthgrader from Corpus Christi, Texas, sued the U.S. Government, with the NSF and Texas A&M University named as defendants in the suit, because she had applied to and been denied admission to a Summer Science Camp. The student had applied to Camp Planet Earth: Summer Environmental Science Camp, held at Texas A&M. According to a piece in the *Washington Times* that appeared on January 9, 1995, the student was told during an admission interview for the program that she was ineligible to attend because she is white.

The Center for Individual Rights (CIR) took on the girl's case, which was settled out of court on February 5, 1996. The CIR has become well known for its work on two high profile legal battles: Hopwood v. Texas, which successfully challenged affirmative action policies at the law school of the University of Texas, and California's Proposition 209, which amended the state's constitution to prohibit affirmative action. In the Summer Science Camp case, the settlement stipulated that the government had to ensure that "no person, on the grounds of race, color, age, sex, national origin, or disability shall be excluded from participation in, denied the benefits of, or be subjected to discrimination under any Summer Science Camps Program receiving financial assistance from the National Science Foundation." In addition, the NSF was to supply material about its programs so that the CIR could check that the NSF had complied with the settlement. (In an unusual twist, the same student has filed a second lawsuit after having been denied admission to another minority-oriented program at Texas A&M, this one funded by the National Institutes of Health and the Department of Agriculture. CIR has taken on this suit as well.)

At the time of its demise, Young Scholars was funding 114 summer programs that reached around 5,000 students annually.

NSF officials cannot speak publicly about the lawsuit, but it is clear that the Foundation was badly shaken. The settlement dictated that the NSF adjust the admission criteria of the SSC projects to include nonminority participants; instead, NSF wiped out the program entirely. Some have speculated that the NSF—watching support for affirmative action erode in many quarters, particularly in the Republican-controlled Congress—was moving to head off future legal troubles. Around this same time the NSF also changed the names of some of its programs for minorities. For example, the Comprehensive Partnership for Minority Student Achievement Program was changed to Comprehensive Partnerships for Mathematics and Science Achievement. In addition, some of the wording in certain NSF program descriptions was amended to shift away from an exclusive focus on minorities. The official word from the NSF is that the SSC lawsuit had no impact on any other NSF programs. According to NSF general counsel Lawrence Rudolph, "The resolution of the SSC lawsuit was limited to that program, and any subsequent changes in other Foundation activities were solely for programmatic reasons."

In 1996 the NSF awarded a grant to Laila Denoya of State University of New York College at Fredonia to carry out an "accountability project" of the SSCs. Denoya, who was herself a director of an SSC, wanted to disseminate the models and ideas developed by the SSCs to provide a resource for people interested in starting up such programs. The result was an attractive epitaph for the SSCs: "Leaving a Legacy of Successes", a 207-page, four-color report printed on glossy paper and crammed with

A Sampling of Problems

The following problems were taken from problem sets designed by Arnold Ross and are in use in the Ross program and in PROMYS.

Numerical Problems: Some Food for Thought

1. How many square roots of -1 are there in $\mathbf{Z}_m$ for $m = 3, 5, 7, 9, 11, 13, 15, 17, 19, 65$? Any conjectures?
2. Construct a table of "logarithms" (indices) for $\mathbf{Z}_{29}$. Use this table to find all the solutions in $\mathbf{Z}_{29}$ of (a) $7x = 6$, (b) $x^2 = 3$, (c) $x^3 = 6$.
3. Write the polynomial $f(x) = x^5 + 3x^4 + x^3 - 2x^2 + 6x - 3$ in $\mathbf{Z}_7[x]$ in base $x - 3$.
4. What are the units in $\mathbf{Z}_5[x]$? in $\mathbf{Z}_9[x]$? in $\mathbf{Z}_{45}[x]$?

Prove or Disprove and Salvage If Possible

1. If $a|bc$ and $(a, b) = 1$, then $a|c$. True in $\mathbf{Z}$? in $\mathbf{Z}[i]$? in $\mathbf{Z}[\sqrt{-5}]$?
2. A polynomial of degree n with coefficients in $\mathbf{Z}_m$ has at most n distinct roots in $\mathbf{Z}_m$.
3. For a rational prime $p > 2$, u is a primitive root in $\mathbf{Z}_p \Leftrightarrow u^{\frac{p-1}{2}} = -1$.

Miscellaneous

1. Find all positive integers that are both square and triangular.
2. The sum $1 + \frac{1}{2} + \frac{1}{3} + \cdots + \frac{1}{n}$ for $n > 1$ is never an integer.
3. Is it possible to draw a regular pentagon in the plane all of whose vertices are lattice points?
4. Find all integer solutions of the Diophantine equation $y^2 = x^3 - 2$.

photographs and handsome graphics. Denoya sounds rueful about the closure of SSCs, saying that there was "no question" that they were very successful. She believes that the NSF is still dedicated to increasing minority participation in science and mathematics. "The commitment is 100 percent," she declares.

While the SSC lawsuit was progressing in 1995, the directors of some of the Young Scholars programs began getting signals from the NSF that the ground was shifting under Young Scholars as well. The NSF announced that there would be no competition that year, but that proposals would be accepted the following year. Don Goldberg at Occidental became concerned about this change, because it meant that in case there was no new competition in 1996 his program would end that year. He says he discussed this with NSF staff and was told that he would have to live with some uncertainty for a few months but that a new competition would take place. Still, Goldberg was worried not only about his own program but about the Young Scholars effort as a whole. In March 1996 he sent an e-mail message to many people, including other directors of Young Scholars programs. "I believe the Young Scholars Program is a valuable program that is in grave danger," he wrote. "If you agree, please express your views to people who can save it." Goldberg said in the e-mail that he planned to write to his senators and congressional representatives, as well as to top NSF officials, and urged others to do the same. Afterward he got the impression that the NSF did not appreciate the move to go above their heads to get the program restored: Goldberg said that a colleague told him, "I heard you're making trouble. A friend of mine at NSF said to back off." Later that year Goldberg's fears were confirmed when NSF announced it was closing down Young Scholars. Many directors of the programs were mystified, saying that the NSF never made clear to them its reasons for ending Young Scholars.

The AMS Committee on Education (COE) discussed the demise of Young Scholars at a meeting in 1996. In August of that year, COE chair Hyman Bass and National Council of Teachers of Mathematics (NCTM) President Gail Burrill sent a letter to Luther Williams, Assistant Director for Education and Human Resources at the NSF. The letter urged the NSF to restore funding for Young Scholars. COE staff and Bass report that no reply was received. The NSF received similar letters from others as well. Gail Richmond has run SSTP and Young Scholars programs since 1959 at Michigan State University and served at the NSF as a Young Scholars program director during 1989–1990. She says that when the termination of Young Scholars was announced she sent letters protesting the move to NSF officials—including Luther Williams and NSF Director Neal Lane—as well as to the National Science Board, the governing body of the NSF. Richmond says she never received any reply. In December 1997, the NCTM Student Services Committee, acting on behalf of the Executive Board, wrote to the NSF expressing concern about the erosion of programs aimed at high ability students and questioning the considerations that appeared to lead to the elimination of Young Scholars.

The fact that the demise of Young Scholars came around the same time as the legal troubles over SSC has led some to believe that the two events are related. After the NSF canceled its summer programs for minorities, it might have been politically impossible to retain Young Scholars, which had to some extent gained the reputation of being for the white and the privileged. It is difficult to confirm whether such considerations actually came into play at the NSF. Harvey Keynes of Minnesota says that, during the legal skirmish over SSC, his Young Scholars program for female students got unofficial word from Washington sources that it should change its rules to allow males to participate. Keynes said they made the adjustment by admitting males but providing financial support only to females. "There are solutions, other than being Chicken Little and saying, 'The sky is falling,'" he remarks. Keynes also believes that certain myths about talented students—such as that embodied

in the statement, "These kids are talented, so it doesn't matter what you do with them"—weakened support for Young Scholars. Other directors of Young Scholars programs express similar views, but it is again difficult to ascertain what role such attitudes may have played in the NSF's decision to end Young Scholars. There are two other factors whose influence is perhaps clearer: a less-than-enthusiastic evaluation report, and a general trend at the NSF toward large, comprehensive programs.

A Lukewarm Evaluation, a Quest for New Programs

The NSF commissioned an evaluation of Young Scholars by COSMOS Corporation, which had been amassing data about the programs since 1988. The 1994 COSMOS report was based on information from questionnaires given to participants at the start and end of the programs, as well as to a group of students who applied to the programs but were not admitted. The questionnaires mostly asked participants about their plans for college majors, graduate study, and careers. A typical table in the COSMOS report presents a breakdown by race and gender of the numbers of Young Scholars participants intending to pursue various college majors.

The report was generally approving of the Young Scholars programs, but questioned whether they were truly effective in encouraging students to pursue careers in science, engineering, and mathematics: it appeared that the students might have chosen such careers without having participated in the programs. Because the participants already had an interest in these fields, the report noted, Young Scholars programs did not change the minds of students not disposed to pursue such careers. The conclusions of the COSMOS report were equivocal and probably not sufficiently negative to be the sole basis for closing down Young Scholars, but the report may have bolstered arguments for its closure.

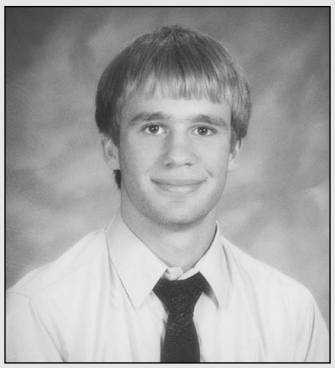
Many of the directors of Young Scholars programs vigorously deny the validity and conclusions of the COSMOS report. William Fleischman of Villanova University, who has run programs under both Young Scholars and SSTP, argues that the questions COSMOS asked the students did not provide a basis for understanding what the students were gaining from the program. David Kelly makes a similar point: One of his students who filled out the COSMOS questionnaire before and after participating in the program said that she gave the same answers but that the words meant something different to her at the end of the program than at the beginning. Kelly also notes that some students might in fact decide not to go into mathematics because of his program. "We give a clearer perception of what the field is, and maybe we lose some because of this," he explains. Such an outcome might look bad, given the tack that COSMOS took in its evaluation.

Trying to come up with quantitative measures to evaluate such programs may be more difficult and subtle than COSMOS realized. Of the success of Young Scholars, Fleischman says: "The data are all anecdotal, but they are massive." "If you go anywhere in the community of biologists, chemists, physicists, or mathematicians," he notes, "you will find people who have a passion for what they do in research and education and as mentors and who trace it to these experiences." Fleischman recently attended a ceremony for recipients of a presidential award for mentors in science, mathematics, and engineering, especially those working with women and minorities. He says he was struck by the fact that those who spoke pointed to programs like SSTP and Young Scholars as having inspired them in the activities for which they were being honored.

The other factor that contributed to the demise of Young Scholars is a general trend at the NSF toward large, comprehensive programs. As Harvey Keynes puts it, the NSF thought it could get "more bang for its buck" by moving toward larger programs and away from the "10 kids here, 20 kids there" mode of Young Scholars. In fact, the NSF maintains that it has not actually terminated Young Scholars but has transformed it into Teacher and Student Development Through Research Experiences Projects (TSD/REP), which will support summer programs that give students and their teachers a taste of scientific research. "There is no doubt that students who participated in Young Scholars benefited immensely, so from that perspective Young Scholars was highly successful," notes Judd Freeman, a program director for TSD/REP. They "did wonderful things for the kids who participated in them. But that's where the impact stopped." The NSF is hoping to broaden the impact by including teachers in the summer programs. The general model is to have one teacher and up to three of his or her students, so that during the regular school year these students can act as "peer mentors". As with Young Scholars, the programs would generally be directed by college and university faculty, who would involve the teachers and students in research projects.

The shift from Young Scholars to TSD/REP dovetails neatly with NSF's moves in recent years toward "systemic" programs in education, most visibly manifested by the State Systemic Initiative grants it has given in recent years. The emphasis at the NSF is clearly on raising the general level of scientific and mathematical literacy rather than on creating an elite group with a very high level of skills and education. In addition, the NSF sees its role as a catalyst for new ideas, not as a perpetual funder of proven ones. Of the Young Scholars model, Freeman says, "The value of that is proven. Now

In His Own Words: Bryden Cais, High School Student and PROMYS Participant



Bryden Cais is a high school student in Virginia Beach. By the ninth grade he had finished all of the courses available at his high school, and there was no college nearby where he could take more advanced courses. PROMYS allowed him not only to learn more mathematics but also to meet professors and undergraduate mathematics majors who could give him suggestions on books to read during the school year. A budding mathematician, he presented a paper, "Using Ramanujan-like Techniques to Derive Series and Infinite Products" in the student paper session at the 1996 Mathfest in Seattle. Below are some of his observations about PROMYS.

"I think a really big and important difference is the teachers [in PROMYS]. They are really, really enthusiastic about math, and they instill that in their students. It's just a great feeling when everybody's thinking math, and you're all working on it.

"Another really great thing is we do a lot of numerical exercises in our problem sets. We don't do that a whole lot, at least not in the high school I go to. I find that actually immersing yourself in the numerical work when you're solving the problems really helps you understand in depth exactly how it works so you can formulate things in precise terms and prove theorems. For example, one problem was to find all numbers less than 100 that are the sum of two squares. And from that you make a few conjectures, maybe prove them if they're good.

"The problem sets are very well designed. Certain problems come up, and they will give you a hint of what's coming next, and you'll say, 'That's nice.' Then you find other problems, and you'll find they're connected. The more problems you do and the more types that you do, you find that they're all connected in this really deep way, and you can then prove much deeper things. It gets so interesting, it's great.

"I went through fourth, fifth, and sixth-grade math, and it's the same stuff over and over again. I thought it was pretty boring at first. I read a couple of books, really simple stuff, and I started playing around with some algebraic stuff. I accidentally stumbled upon this really nice theorem of Fermat. And I thought, 'Wow, this is really cool,' because I thought I'd discovered it. Then I got this book, Hardy and Wright, and I found it in there. I was really crushed that somebody else had it before me. But at the same time it felt so great just to have discovered something that Fermat had discovered 300 years before. Discovering is just so much fun. Ever since then I loved the discovery part. At PROMYS we do exactly that."

we need to push for another model that works as well." The thinking at NSF is that programs with a track record of success should be able to raise funds from other sources or get institutional funding. Indeed, according to Freeman, the TSD/REP program emphasizes the need for substantial cost sharing by institutions or fundraising to keep the projects alive after NSF support ends. These considerations are taken into account in reviewing proposals.

Some of the directors of Young Scholars programs have applied for funding from TSD/REP, but there is skepticism about how well it suits mathematics. Glenn Stevens of PROMYS notes that the TSD/REP guidelines say that the participants are supposed to work as "research" apprentices to scientists, which is a "wonderful idea for the laboratory sciences, but unrealistic for most of mathematics." On the other hand, Stevens says that he has for some time been wanting to include teachers in some of the PROMYS activities, and TSD/REP may provide this opportunity. Others are not sure that putting students and their teachers together in the same program is a good model. Goldberg says that he is very interested in teacher development but believes that the needs of teachers and students are so different that putting them into the same program would not be successful in all circumstances. Some point out that providing what teachers need would fundamentally alter the programs. According to Keynes, teacher enhancement programs are "much more elaborate and extensive" than Young Scholars programs and would require a great deal of additional effort.

NSF officials do not believe that these concerns represent serious impediments to mathematicians' participating in TSD/REP. Margaret Cozzens is the director of the Elementary, Secondary, and Informal Education Division, which was the home of Young Scholars and now oversees TSD/REP. Cozzens, who is a mathematician, says she has taught in programs involving teachers and students at DIMACS at Rutgers University. Even though the programs for teachers and students were separate, they provided ways for the groups to interact. Rather than having everyone doing the same things together all the time in a "one-size-fits-all" mode, she points out that one can have some activities for teachers only, some for students only, and some for the two groups together. She acknowledges that it might be easier to set up such a program in a laboratory science, but also contends that "the opportunities in mathematics are every bit as present." Projects in applied mathematics might be the easiest to construct, but she also believes that areas such as group theory,

geometry, discrete mathematics, and combinatorics are amenable to such projects. "This is an opportunity to think differently about high-potential and gifted students and our ability to work with them and to affect more students than before," she declares. Given the emphasis on mathematics in high school, she says it would be natural for 50% of the TSD/REP grants to be in mathematics. However, only about 10% of the proposals were in mathematics.

A few years back, Fleischman says, the NSF suggested that teachers be included in the Young Scholars activities, and his program did so. "In fact, it was a wonderful part of our experience," he says. But "the truth is, there is a difference in the level of intensity with which we can connect with teachers." This is partly because the teachers bring with them a heavy set of responsibilities—relating both to their families and their demanding profession—while the students have few responsibilities and great energy to learn. The NSF has argued that the Young Scholars programs reached only the students in them, while TSD/REP programs would in time touch far more students because of the inclusion of teachers. Fleischman sees another perspective in having college and university faculty work directly with the students: it helps open up dialogue between faculty and teachers. Says Fleischman, "The most productive means for understanding what I can do in working with high school teachers is to have the sort of 'laboratory' that Young Scholars provided for working with their students."

Programs Fight to Stay Afloat

Stevens and Fleischman have submitted proposals for TSD/REP, but they are uncertain about their chances (at the time of this writing decisions about the proposals had not yet been made but are likely to have been announced by the time this issue of the *Notices* reaches readers). Max Warshauer is also applying for a TSD/REP grant, despite a negative reaction to a preliminary proposal he sent to the NSF. Dan Shapiro says the Ross program got a similarly negative reaction to its preliminary proposal to TSD/REP and as a result decided not to apply.

The NSF was betting that many Young Scholars programs would survive without its help, and it turned out to be right: a lot of them have scraped by. In 1996 David Kelly's program missed a year—for the first time in twenty-four years—but managed a comeback in 1997 by cutting corners ("like my salary," he says wryly). PROMYS was in much the same situation, and in 1997 it relied on unspent funds from previous years' NSF grants as well as some support from Boston University. Stevens says PROMYS will definitely run in the summer of 1998, but that the costs to students will go up "dramatically" if the TSD/REP proposal falls through. He is also pursuing other fundraising avenues. The Ross program is in a similar situation, though it benefited from a special one-time grant from the National Security Agency in 1996; it has also started a small endowment fund. Some programs are pursuing corporate funding but have not met with much success so far. Many are raising student tuition to cover costs. Max Warshauer of Southwestern Texas University reports that while he had NSF funding about half of the students in his program would have been unable to attend without support; now that he has had to raise the tuition, such students probably will not participate. After the loss of NSF funding, Southwestern Texas provided institutional support for the next two years. Permanent institutional funding for such programs can be hard to secure, because the programs do not act as recruiting vehicles for the sponsoring institutions; the students who participate are usually very well prepared academically and choose to attend college at higher-tier institutions.

What the future holds for such programs is not clear. Kelly suggests that the AMS, the Mathematical Association of America, and the National Council of Teachers of Mathematics might be able to collaborate on an allocation of NSF funds for these programs. "They could do it better, it would be real peer review, and it would save a lot of NSF money on administration," he notes. A new, up-and-coming organization called MathCamps has launched an aggressive fundraising drive and even rented booths at mathematics meetings to promote itself. Its efforts might provide a model for fundraising that other programs can use, but the result may be that they all chase the same dollars.

Without the Young Scholars programs, mathematically talented students would lose opportunities to grow beyond their usual coursework. On the other hand, they would likely remain among the top students, attend top colleges, and have productive careers. It is not clear that any more or fewer of them would go into mathematics without these programs; many who have never attended such programs have nevertheless become mathematicians. What then would be lost were these programs to disappear? Perhaps the greatest loss would be to the mathematical community, which would lose exactly the thing that is hardest to explain to funding agencies and writers of evaluation reports: a connection to the wellspring of mathematical enthusiasm. As Fleischman puts it, "The kids come here with this tremendous thirst and this tremendous tide of energy.... They just come tumbling at us." Were the mathematical community to lose that connection, it would be a profound loss indeed.