BOSTON UNIVERSITY COMMUNITY'S WEEKLY NEWSPAPER
B.U. Bridge

Week of 12 November 1999 Vol. III, No. 14

Feature Article

Reflecting on the aftermath

Menu of math is high school students' summer specialty

By David J. Craig

Gene Shuman, a senior at Byrnes High School in Duncan, S.C., is a certifiable math whiz. He taught himself calculus in ninth grade, received As in every math class offered at his school, and is the star of the Byrnes High math team.

This summer, however, while participating in BU's Program in Mathematics for Young Scientists (PROMYS), he was in for a shock: a math problem he couldn't solve right away. The deceptively complex true or false question involved the properties of a simple sphere -- a subject he thought he'd mastered in junior high school geometry.

Alex Marsceill, of Coral Springs, Fla., Marjory Baruch, a Syracuse University adjunct professor of electrical and computer engineering, Yonina Murciano-Goroff, of Cambridge, Mass., Rani Fischer (SED'00), and Leon Li, of Queensborough, N.Y. (clockwise from bottom left) discuss a group project during last summer's PROMYS

program. **Photo by Kalman Zabarsky**

"It turns out that when you divide the spheres into pieces and put the pieces into two groups, you can form two separate spheres out of either group," says Shuman, who spent several days working to create a proof for the problem. "It's the same principle as the one that says there are the same amount of positive numbers as negative."

The solution to the problem, from an advanced branch of mathematics called number theory, was counterintuitive by design, according to Glenn Stevens, a CAS mathematics professor who founded PROMYS in 1989 with a fellow CAS math professor, David Fried. "It's easy to find things in number theory that are true experimentally, but that you still have no idea how to prove," says Stevens. "Students get baffled by that, in a good way."

For the past 11 summers, 60 high school students from around the country have spent six weeks at BU immersed in graduate level mathematics as part of PROMYS. The program recently received a $120,000 grant from the Toyota Corporation to train high school teachers to integrate basic number theory principles to their curriculum. The grant also pays for workshops in advanced math for local teachers, held throughout the year at the Educational Development Center in Newton.

Shuman, who says that "six weeks of just math sounded great" when a high school teacher recommended that he apply for the program, is typical of the high school participants. All are unusually adept at mathematics and likely headed for careers as scientists or mathematicians.

But even for them, PROMYS is no breeze. The objective of the program is to find high schoolers who are no longer sufficiently challenged in the classroom and inspire them with a new sense of awe for the subject. That is accomplished by using complicated problems from number theory, the study of the principles of whole numbers.

Students may be asked to solve a simple algebraic equation using only integers, for instance, a stringent constraint that gives the work a more abstract quality than anything typically studied in high school. Students, with the help of college-age counselors from universities all over the country, then come up with proofs for their solutions based on a list of 10 basic mathematics axioms -- such as any number multiplied by one equals itself -- that they create themselves in the first days of the program.

The PROMYS morning lectures lag three days behind the assigned homework, ensuring that students find their own way through the complicated problems. They are responsible for managing their own time, but "should be working all the time," says Stevens.

And instead of following the typical linear path of progressively more complex problems in one area of mathematics, PROMYS students are encouraged to explore problems in geometry, algebra, and calculus to find fundamental principles common to all.

"The problems are all based in discrete math and remain very concrete, but get deeper and deeper, and build into one another in this rich structure that students don't expect," says Stevens. "We're giving them the experience of feeling that math is something that is to be explored, done creatively, and that it's something you can't always be on top of.

"It's also something you can bring personality into," he continues, "because students given these problems aren't necessarily going to discover the same things."

And because students are assigned so many problems, the competitive atmosphere prevalent in high school classrooms and math clubs is thrown by the wayside.

"There are so many things going on here that the students can't possibly expect to do them all, so they're not going to have the same feeling about math," says Stevens. "And they've all been at the top of their class, so competing becomes pointless. Then, when they complete a problem, they can decide if they liked the math for its own sake, independent of whether or not they're the best in the room."

Shuman was relieved to be just another student in class for a change. "I really enjoyed the fact that I met other persons with my mental level, who I could talk to," he says. "There's nobody at home who I can really talk to about math."

Students also worked for a few hours each week with 10 high school teachers from around the country and 9 prospective high school math teachers studying at SED.

Gisele Zangari, who teaches 8th grade algebra and 10th grade pre-calculus at BU Academy, was one teacher who didn't need to be reminded that there is more to numbers than often meets the eye. To her, mathematics is "the essence of everything," and she admits that she's spent many hours pondering the relationship between fractals and the melodies that are repeated at different octaves and at varying lengths in the music of Bach.

Participating in PROMYS inspired Zangari, a teacher for more than 25 years, to reach deeper into her bag of tricks in the classroom to show students the wonder in mathematics.

"One thing I'm doing this year is that when we talk about the Fibonacci sequence, instead of simply talking about the pattern in the numbers, we discuss its relationship to the Pascal triangle," she says. "That gives a visual representation of the same pattern.

"I discovered that I can talk about very theoretical problems," Zangari adds, "and use them in class and make the students appreciate the beauty and the power of the problem."

The Toyota grant will pay for high school teachers' participation in PROMYS for the next three years. PROMYS is funded mostly by the National Science Foundation, and also benefited recently from a partnership with the new Clay Institute for Mathematics in Cambridge, which last summer provided $31,000 to bring back previous PROMYS students to participate in more advanced activities. Stevens says the funding from the Clay Institute should continue through 2001.