

# Women, EDGE, and the Ph.D. in Math

by Michelle Adam

**I**t was 2001 – her first year as a graduate math student at the University of Arizona – and Alejandra Alvarado was overwhelmed. She was a single mother, alone in Arizona without family, and struggling to understand the material in her classes.

“I remember my first semester crying because I just didn’t get it,” said Alvarado. “I would spend 20 hours on homework, and I didn’t get it.”

As with so many graduate students, especially those underprepared for or underrepresented in graduate programs, Alvarado thought she was the stupid one. She discovered, however, that was not quite the case when she learned about EDGE, a program designed to strengthen the ability of women and minority students to complete graduate programs in the mathematical sciences successfully.

“I had a really tough time my first year, and then I heard about the program,” she said. “I thought, ‘Oh, my God!’ It was perfect timing and a perfect opportunity.”

A Mexican-American from San José, Calif., Alvarado joined a diverse group of about 14 other women embarking on graduate work in mathematics. Later she discovered that she was the first Hispanic among African-American and Caucasian women to participate and complete the summer program since its inception in 1998.

“When I went to EDGE in the summer of 2002, it was nice to meet other women in math who were going through a similar experience. The mentors were also great because they were able to share what they had gone through in graduate school,” said Alvarado.

Alvarado was the only one during the 2002 EDGE program to have already started graduate school; most were about to embark on graduate studies. Nonetheless, the program provided all students with rigorous math classes designed to prepare students for the intensity of graduate work that awaited them or, if they had already



begun school, give them an additional boost to make the following years more manageable.

For Alvarado, four weeks of EDGE coursework provided review for material she had already covered her first year – but had struggled through – and pushed her forward so she could pass qualifier exams that students in graduate programs must get through to continue their course of study.

“The first days of the EDGE program were a refresher, but, after that, it got more intense and helped me pass the qualifiers,” she said. “There were also other students I could share information with.”

Being able to establish connections and relationships with other women and minority students was a tremendous asset to Alvarado. During her first year of graduate school, most of her professors were men, as were the majority of students. As a consequence, she often felt intimidated and scared to ask questions or consult with other students.

With the help of EDGE mentors and students who shared similar academic struggles, Alvarado saw that she wasn’t alone. “Sometimes you think you are the only one who feels like you do, but I saw that we are all just struggling,” she said. “The big thing is not to be afraid to ask

questions. Who cares what anyone else thinks? We women work as hard as anyone else.”

Alvarado also came to see that part of her struggle was in having to compete with other students, most of whom had fellowships and no children and had a lot more time on their hands. She was the first in her immediate family to obtain even a bachelor’s degree and had not received rigorous enough coursework during her undergraduate years at community colleges and a state university to prepare her for graduate work.

“I know for me a lot of the challenges I faced had to do with a lack of preparedness and being afraid to ask questions,” she concluded.

Alvarado’s story is not unique. It’s fairly common for women of different backgrounds to struggle through graduate school in a male-dominated field like math. And that’s precisely why two women, Sylvia Bozeman from Spelman College and Rhonda Hughes from Bryn Mawr College, decided eight years ago to begin a program for prospective and current women in graduate math.

As professors at small liberal arts colleges, they were determined to address what they called “the unacceptable national statistics” on women pursuing math careers.

According to the American Mathematical Society, in 2002, women were 42 percent of the undergraduate mathematics majors in the country but only 31 percent of those who earned Ph.D.s in math. In addition, only 13 percent, or 127, of those who earned doctorates in 2000 were female U.S. citizens, and, in the same year, only 17 percent of those tenured in math at four-year institutions were women.

Initially, the two professors envisioned a program that would encourage undergraduate students more broadly to major in mathematics, to go to graduate school, and ultimately to pursue careers in the mathematical sciences. They established the Spelman-Bryn Mawr Summer Mathematics Program aimed at women of first-year/sophomore undergraduate levels. The program, funded for four years by the National Science Foundation (NSF), ultimately achieved its goal. Of the 32 women who participated, approximately 60 percent have pursued graduate degrees in the mathematical sciences or related areas.

Despite their successes, however, Bozeman and Hughes altered the program five years later to address more specifically the needs of minorities and women pursuing mathematics at the highest levels. They saw that the high school and undergraduate stages of the pipeline received significant attention from private and governmental agencies, but attrition still impacted women at the graduate level.

As a result of their concerns, they established the EDGE program, which attracted graduating seniors who had applied to graduate programs in mathematical sciences, recent recipients of undergraduate degrees who were entering graduate programs, and first-year graduate students.

Since then, the summer program has consisted of two core courses taught by four professors in analysis and algebra/linear algebra, as well as mini-courses in vital areas of mathematical research in pure and applied mathematics. Students have also benefited from short-term visitors from academia and industry, guest lecturers, graduate student mentors, and problem-solving sessions. In addition, they receive follow-up mentoring and a support network established with the participants' respective graduate programs.

"This has become a growing family. Students feel they are not alone and have a place they can turn to when they have concerns," said Diana Campbell, EDGE program coordinator and a Ph.D. math recipient who began as a mentor

with the program with its inception in 1998.

Campbell has seen the total number of EDGE students grow to 91 over the eight years. Of these students, eight have been Hispanic; the rest, an equal number of African-American and Caucasian women.

With support from the Andrew W. Mellon Foundation and the NSF, the summer program was initially held at Spelman and Bryn Mawr but has since moved to other school locations. The most recent program was held at New College of Florida in Sarasota from June 12 to July 7.

At the time of our interview, Alvarado had passed her qualifier exams and had been invited to become a mentor in the program. "I am really excited to be a mentor," said Alvarado, who had transferred from the University of Arizona to Arizona State University, almost completed her Ph.D., and was about to embark on her graduate-level research.

Alvarado is in the process of becoming an EDGE success story. Of the 91 students, she is one of 81 who have enrolled in graduate work or obtained a degree. Twenty-seven students have earned degrees, and 54 are currently in programs. Only two left graduate school before the beginning of their second year.

It seems EDGE has put a dent in the attrition rate of women in graduate math programs, a success that will help more women one day serve as professors and role models for others interested in higher degrees in math.

It gives hope to students like Alvarado, and to Campbell, who have seen the lack of representation in their own careers.

"All the women in our graduate program shared concerns that there weren't more women in our department who were graduating," said Alvarado. "There were four to five of us, and only one of us made it to a Ph.D. while most of the men in the program are graduating with a Ph.D."

Campbell, an African-American, earned a Ph.D. at Rutgers University. "There were a couple of women that had come and gone at Rutgers, and there were a couple of African-American men that had come and left. There may have been a few others in the pipeline, but, at any one time, there weren't more than three to five."

In graduate school, Campbell felt "out of the ordinary." As she described it, "Pursuing a Ph.D. is an academic as well as a social experience. Everyone has to grapple with the culture of pursuing a Ph.D. But certain things are amplified for minorities and women. Family life may create a bigger burden for women, and there is the cul-

ture of being smart that comes with graduate school, but when you take on the burden of stereotypes, then the burden gets a little harder."

Today, through EDGE, Campbell helps students in the pipeline learn how to negotiate this place of feeling "other than" in graduate school.

"If you are having a problem in a class, you may have the false impression that you are the only one having a problem. And, rather than talk more to peers or the professor, you may retreat to solve the problem yourself," she said, describing an experience common for women or minorities in male-dominated programs. "We encourage the women to engage in the process and see that the process is about having problems and tackling them. Otherwise, if you take on the stereotypes in a way that is counterproductive, you can spiral down."

Recognizing this component of challenges students might face, EDGE provides a diversity component to its program in which students talk in private with a social scientist and with each other to help break down social gaps that can exist among students.

The program also provides students with a network of friends and peers they can turn to when they feel alone in the male-dominated world of mathematics.

"Friends and family think it's amazing that I'm in school and even more so studying math. My friends say I am crazy. A lot of kids don't like math. It has a bad reputation," said Alvarado. "But EDGE has made a difference. It's been a stepping stone. I have met so many people and shared experiences with them."

Alvarado plans either to teach or work with encryption and decryption of private information on the Internet. But, for now, she is near the end of her graduate work and is an example for other women in math who are coming up the pipeline. She is someone who has found a home for herself in the world of math. And, as she concluded, "I really like what I am doing. This is where I belong."

