

“The EDGE Program: Adding Value through Diversity”

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Introduction

The EDGE Program aims to increase the success of women pursuing doctoral degrees in mathematics by focusing on retention through the first year of graduate school. The community created by the program embraces diversity in novel ways that have a long-range impact on the women who participate. This paper will point out some indications of how the program creates a spirit of diversity, as well as demonstrate the measurable benefits of the EDGE Program and the value that it adds to the academic and professional lives of the individual program participants.

A Brief History

In 1998, the EDGE Program (Enhancing Diversity in Graduate Education) began as a joint project of Bryn Mawr and Spelman Colleges. Since its inception, the aim of the program has been to improve retention of women students by providing a supportive and positive learning environment during the summer prior to graduate school. That support continues into the first year of graduate school by insuring that students are mentored and integrated into the social and academic community of their departments. In the past two decades, there has been considerable focus on retention of students, particularly women and members of underrepresented groups, in graduate programs in mathematics (Herzig, 2002), and the continuing scarcity of women and

people of color from the upper ranks of mathematical scientists warrants the ongoing efforts of programs like EDGE to diversify the mathematics community. (Notices, 2007)

The idea for EDGE evolved from an earlier program, the Spelman-Bryn Mawr Summer Mathematics Program, an REU (Research Experiences for Undergraduates)-type program for undergraduate women from the Atlanta and Philadelphia areas. When the funding for that four-year program, funded by the National Science Foundation, ended, the co-directors (Bozeman and Hughes) realized that there remained a need for a program that addressed graduate school attrition, particularly since many of their own undergraduate students often struggled in graduate school despite the fact that they excelled academically. At the same time, the NSF launched a new initiative that focused attention on graduate education, and the concept for EDGE was developed.

The proposal for EDGE did not readily receive funding, and it took over a year and the efforts of a supportive Program Officer to bring EDGE into existence. The original proposal requested funding for a six-week program, but budget constraints shaped the four-week program that was eventually supported. Supplementary funding was later obtained from the National Security Agency, and ultimately the Andrew W. Mellon Foundation took over from NSF and provided core support, with NSF assuming a supplementary role. Most recently, the NSF has provided funding for the program through 2011. In all cases, Program Officers who were committed to the basic philosophy and goals of EDGE were crucial in the effort to garner funding.

To date, the program has helped prepare 119 women for graduate school in mathematics. The summer session initially alternated between Bryn Mawr and Spelman Colleges. In 2003, the

program began to expand geographically, moving first to Pomona College. Since then, EDGE has been held at Spelman (2004), North Carolina A & T State University (2005), New College of Florida (2006), and Pomona (2008). Teaching faculty come from colleges and universities across the country, and are invited based on their experience and commitment to the goals of EDGE. Radunskaya has participated in the program every year since its inception, either as an analysis instructor or as Local Coordinator(in 2003 and 2008).

Philosophy and Goals

The EDGE Program is guided by the philosophy that students who have been successful in earlier mathematics courses, but may have had limited exposure to advanced mathematics, can still earn doctorates. This philosophy is supported by research conducted on student success and failure in graduate school. (Herzig, 2002) Most departments of mathematics select graduate students based on a range of indicators: undergraduate grades, letters of recommendation, GRE scores, courses taken, and involvement in undergraduate research (REUs, etc.), with different departments assigning different weights to these criteria. For example, some departments look closely at GRE scores, while others do not require them. Several studies (Herzig, 2004; Lovitts, 2001) agree that the indicators of grades and GRE scores are unreliable in predicting student persistence in graduate programs.

Another guiding principle of the program is that exposure to graduate-level mathematics and the culture of graduate school, along with a rich support network and positive feedback, will significantly enhance a student's ability to obtain a Ph.D. Herzig (2004) points to several studies that emphasize the importance of social and intellectual integration into the communities of the department in order to sustain membership in an academic community. She found that "doctoral

students who persisted were more likely to have entered graduate school already in possession of important forms of cultural capital that facilitated their integration into mathematics.” Most EDGE participants belong to groups that do not possess this “cultural capital,” namely women (100% of all EDGE participants), minority students (49%), students from four-year colleges (44%), and first-generation college graduates (10%).

Becoming part of a community of scholars is not only valuable, it is deemed necessary for success. (Herzig, 2004) Several studies have identified barriers that negatively affect the persistence of women and minorities. (Herzig, 2004; Davis, et.al., 1996, p. 133) Isolation is often cited as a problem contributing to the challenges of minority students and women in the graduate community. (Bozeman, 1989) Several other factors may be responsible for this inability to develop crucial relationships. For example, women may be excluded from informal social networks of their departments; the absence of a critical mass of women or students of color may lead to feelings of isolation or alienation; in a male-dominated department, the assertive communication style of some faculty may be uncomfortable for them; their commitment to an ethnic, cultural or family community may alter their opportunity to participate in the activities of the academic community; and they may have fewer opportunities to develop mentoring relationships if they are perceived as different.

The EDGE Program helps students to anticipate and prepare for first-year difficulties. Faculty often consider students unproven until they have passed preliminary or comprehensive examinations, because such tests are often considered a first indicator of success. Also, faculty may give less attention to first-year students, and there is little flexibility for a student who experiences hardships in the first year, even if those difficulties arise from non-academic sources. The presence of an EDGE-arranged mentor at each participants’ graduate institution helps

students view obstacles and setbacks as temporary, rather than proof of an inability to “cut it.” (cf. Herzig, 2002) EDGE directors and instructors have intervened on several occasions, with students’ permission, to arrange for another opportunity after a setback.

There are several individual goals for the EDGE participants that tie into the larger goals and philosophies of the program: an understanding of their strengths and weaknesses that enables them to make a successful transition from undergraduate to graduate programs in mathematics; an increased level of confidence that is sustained through temporary setbacks; the ability to redirect their ambitions when a program is deemed unsuitable; membership in an active support network of mathematicians; and a broadened perspective of mathematics and the culture of graduate school. The long-range goals of the program are to increase the presence of women, particularly women of color, in the upper ranks of mathematical scientists, and to create models for mathematics programs that allow people from all backgrounds and cultures to thrive, advance, and contribute to the profession.

Primary Components of the Program

The cornerstone of the program is the four-week summer session, usually occurring the summer between students’ undergraduate and graduate work, and consisting of both academic and social components. The academic program consists of:

- two four-week core courses in abstract and linear algebra, and in analysis, taught at a level that bridges standard undergraduate and graduate study in these fields;
- problem sessions conducted by three graduate student mentors;
- a minicourse and special guest lectures on timely areas of mathematical research;

- TEX sessions; and
- concluding presentations by participants.

Algebra and analysis are chosen as the primary academic courses since, traditionally, these subjects form the core of the first-year graduate school curriculum for most students. Although many EDGE participants are headed to programs in statistics, operations research, and applied mathematics, the content of the courses is secondary to the process of intense exposure to material and mastery through problem-solving.

The social aspects of the program are designed to build a community of scholars in a collegial and supportive environment. Panel discussions on graduate school culture and expectations give students a glimpse of what lies ahead. Thursday-night dinners at an off-site location contribute to bonding between participants and mentors and the forging of lasting friendships. A Reunion Weekend, an integral part of the program since the second year, provides an opportunity for participants from the previous year to share their first-year experiences with current participants. The reunion weekend is often a highlight of the program, and offers participants invaluable insight into the graduate school experience.

A major component of the EDGE experience is the use of study groups. Many students who have always been at the top of their classes have no experience in working collaboratively with peers, although they have often tutored students taking lower level courses. The strong emphasis on study groups within the EDGE environment is intended to improve collaborative skills and prepare students to take full advantage of the diverse environments they are likely to encounter in their graduate departments. Efforts are made to keep the study groups dynamic in membership, thereby giving students the greatest exposure to the work habits of peers. While the

use of study groups is encouraged by the faculty, it is facilitated by the three advanced graduate mentors, who live in the same or nearby quarters, who oversee several scheduled problem sessions each week, and who often provide consultation at evening informal sessions. Students who return to the reunion following their first year of graduate school often emphasize the importance of study groups and, for some, the benefits of having experienced study groups during the EDGE summer session. Students report that in graduate school, study groups may alleviate stress and combat isolation as well.

Interviews of women doctoral recipients from underrepresented groups in mathematics identify stress and isolation, which are most prevalent in the first year, as factors that contribute to difficulty in the pursuit of a graduate degree. (Bozeman, 1989) Students who encounter an overdose of both stress and isolation often disappear from the department without anyone knowing what has happened. In view of these observations, the Co-Directors deemed it necessary to address networking and community-building in the structure of the program. To this end, the EDGE Program has a Follow-Up Mentoring Program as its second major component. The Co-Directors and Local Coordinator arrange for a faculty mentor to maintain contact with each participant at her graduate institution. The mentor is a person to whom the student might turn in the event of any academic difficulties. In addition, the EDGE staff maintain contact with students during the year, and provide a small research allowance for books and professional travel. With program support, each student is invited to return to the next EDGE summer session for Reunion Weekend, and students are encouraged to attend the January Joint Mathematics Meetings for a mini-reunion. The goal of community building is further supported by a bulletin board on the program's website, which affords alumnae the opportunity to share triumphs and challenges throughout their graduate school years.

The number of participants has grown steadily over the years, from eight in 1998 to the current level of fourteen, which has been the norm since 2003. The selection criteria include outstanding undergraduate academic achievement; acceptance into a graduate program in the mathematical sciences (including statistics and operations research, but not computer science); an expressed desire to obtain a doctorate degree; interest in being part of a network of women scholars; academic and leadership potential identified by faculty recommendation letters; and the need for exposure to graduate-level mathematics or the graduate school culture. EDGE participants have all excelled in their undergraduate institutions, where excellent grades, leadership roles, and involvement in undergraduate research have combined to make them outstanding students who have mastered that which has been offered to them. However, due to the differences in size and nature of these institutions, the students' preparation shows significant variation within the group. Students are encouraged to avoid competition and comparison of themselves with other participants, and instead to identify appropriate levels at which to work, and set individual goals for themselves, even as they take common classes and assignments.

To most participants, the EDGE Program represents their first introduction to the culture of higher mathematics and offers their first encounter with the graduate mathematics community. The EDGE Program helps to establish norms for operating within that community while simultaneously raising cautions regarding the environment one is likely to encounter in graduate school. The EDGE Program helps each participant become part of the community of scholars at her institution by connecting her with a graduate faculty member in her department who serves as a first-year mentor; by promoting the use of study groups as a means of countering isolation; and by providing her with a network of students and faculty, across institutional boundaries, so that she always has peers with whom she can identify.

Student Outcomes and Program Results

A total of 119 women participated in the EDGE Program from 1998 to 2008. As of 2005, data show that EDGE participants are from diverse racial (49% underrepresented minorities) and educational (44% liberal arts) backgrounds. Furthermore, they are taking a variety of paths through their graduate programs. The success of the summer sessions, along with the rate of student achievement, has sparked a growing interest in EDGE among students, faculty, and institutions. The list of colleges and universities from which applicants are pooled has continued to expand.

In the first eight years of the EDGE Program (1998-2005) there were 91 student participants. More than 90% of these have either obtained a graduate degree or are persisting in their graduate programs. For the fifty EDGE participants in the first five years of the program, only 8% discontinued their studies without earning the master's degree. To date, sixteen EDGE participants (17.5%) and four other EDGE graduate mentors have earned their doctorate, with several other participants from this cohort expected to complete degree requirements by the end of 2009. It is estimated that in some years of the program, the percentage of students who receive Ph.D.s will exceed 60%, much higher than national retention rates. (Herzig, 2002) Another indicator of success is that EDGE students who find their initial choice of a graduate school unsatisfactory often relocate to a second university rather than drop out of graduate school altogether. To date, at least five women have successfully transferred to a new graduate program after realizing their first one was not an appropriate match.

Since the EDGE Program was created primarily to reduce first year attrition in mathematics, we conclude that in its first eight years of operation, the EDGE Program has

demonstrated its effectiveness with a success rate of 90%. Although funding supports students only through the first year of graduate study, the program seeks to mentor students through their graduate years, until the doctorate is earned.

The EDGE program has been evaluated since its inception by Dr. Carol Auster, Professor of Sociology at Franklin and Marshall College. Dr. Auster has expertise in the area of gender and science, and for the past fifteen years has conducted a study of the persistence of women in the engineering profession. EDGE participants complete extensive questionnaires at the start of the summer program, at its completion, and at the end of their first year of graduate work, in order for Dr. Auster to assess the effectiveness of the program. In 2006, Dr. Auster prepared a comprehensive study of the surveys completed by EDGE participants at the end of the program, and those completed at the end of their first year of graduate school (Auster, 2006). On a scale from 1 to 3, with 1 being “Not very important” or “Not very beneficial” and 3 being “Very important” or “Very beneficial,” the average score in each of the years 1998-2005 on the following criteria are given:

Criteria	Rating
Importance of graduate mentors	Rated 3 in four years; 2.5 in two years
Significance of diversity of participant group	Rated 2.5 in five years; above 2.3 others
Significance of diversity of graduate mentors	Rated above 2 in all but one year
Benefit of panel discussions by the previous year’s participants	Rated at 2.5 each year

Interactions with directors, graduate student mentors, and other EDGE participants had ratings similar to those of the panel discussions .

Ratings of several other questions illustrate the value of the program in helping students anticipate what they should expect in graduate school. When asked “To what extent did this program alter your expectations of graduate school?” the average response was above 3 in four years, and above 2.5 in three others (on a scale of 1 (“Not at all”) to 4 (“A lot”)). Students highly valued the interaction with the graduate mentors and rated the “choice of graduate mentors” between 4 and 5 on a scale of 1 to 5 (Excellent), in every year except one. Using the same scale, students rated the overall program between 4 and 5. Almost all students said that they would “very likely recommend the program to others.” In response to the question “To what extent did the summer program prepare you for the actual experience of graduate school?” the average each year was between 3 and 3.7, with 3 being “Some” and 4 being “A lot.”

Graduate mentors make a significant contribution to the quality of the academic program and facilitate mathematical communication between the students and the instructors. Almost every year, participants rate highly the selection of mentors and the value of interactions with mentors. Mentors who have themselves been in the program or who have served repeatedly in this role enhance the sense of community by conveying traditions, transmitting stories, and connecting students across the various years.

Creating a Supportive Academic Environment: When Diversity Matters

In the face of a national mandate to diversify the science and engineering workforce, many institutions and programs have been created over the years to address the issue of the underrepresentation of certain groups pursuing careers in science and mathematics. Nevertheless,

progress in this area has been disappointing. Although the percentage of women receiving a Ph.D. in mathematics has risen to nearly 30% (AMS, 2003), women remain seriously underrepresented in the upper ranks of academia. Moreover, the numbers of women and men from underrepresented minority groups remains so low they are assigned a numeric value, rather than a percentage. With this challenge in mind, the authors have attempted to determine those aspects of a program that might contribute to improving diversity in the mathematical sciences.

Approximately one-half of the EDGE participants come from groups that have been historically underrepresented in the mathematics community; this same level of diversity is reflected in the composition of the staff. In the EDGE Program, this is the first step in creating a diverse community. In addition, the participants come from undergraduate institutions in more than 30 states and are attending more than 35 graduate institutions. Their undergraduate institutions range from large Research I universities to small private liberal arts colleges, including several historically Black and women's colleges. Although most participants come directly from undergraduate school, students who are in their first year of graduate school are allowed to apply, as are women who have been out of school for perhaps two years before deciding to return and enter a doctoral program. The EDGE program begins each summer session with a diverse group of students and staff and creates a community that encourages each person to reach her academic goals and to develop her full potential.

The consequences have been dramatic. Participants have formed friendships and alliances based on their shared goals, rather than more familiar aspects such as race or class. The directors have seen this broader view extend beyond the EDGE Program to affect participants in their academic and professional associations. Long-standing friendships and professional relationships have developed across the barriers these perceived differences present. EDGE

students regularly attend mathematics conferences where they participate in mini-reunions, meet former EDGE staff and attend each other's presentations, thereby strengthening a peer mentoring system. They have also found mentors among faculty outside of their institutions. In general, EDGE students have established networks of support within the mathematics community that continue to fuel their development into their early careers. These networks help give legitimacy to the concerns of women, from balancing family life to finding post-doctoral opportunities.

The Challenges

Although diversity in numbers is a necessary step, it is not sufficient for the creation of a diverse community, as the program directors learned during the first year of the program. Since then specific steps have been taken to assist students in embracing the elements of diversity that are present in the environment, thereby generating a spirit of diversity as well as a sense of community. Three elements of the program are designed to create a sense of community within the cohorts of a given year—the diversity seminar (“Difficult Dialogues”), the use of study groups, and the Thursday night dinners.

Even in a supportive and relatively homogeneous environment (all-female), students tend to initially stratify themselves on the basis of perceived ability, preparation, and cultural, racial, or economic factors. The Difficult Dialogues seminar is a response to these challenges. Conducted by an experienced sociologist or psychologist, the seminar encourages students to confront their views about themselves and others and to open lines of communication with those who are different from themselves.

Even students with the best academic preparation often need an extra dose of encouragement—especially since they often face failure for the first time in graduate school. One of the greatest challenges is to identify characteristics of a student who will be successful in a doctoral program. Given that students graduate from college with varying levels of mathematical maturity, a second challenge is to construct a program that effectively meets the need of every student, regardless their level of mathematical maturity. The study groups provide a forum for students to improve their communication skills, and to gain comfort asking for and offering help. The EDGE Program attempts to provide enough flexibility to address the needs of those students who have a lower level of proficiency but exceptionally high motivation and good study skills. The Thursday night dinners give students an opportunity to socialize in an unstructured setting, and to form friendships that will extend beyond the summer and throughout graduate school.

Although the EDGE staff continued to maintain contact with participants beyond the first year of graduate school, the challenge of doing so became greater as the EDGE cohort grew. In 2005 EDGE created Regional Mentoring Clusters, consisting of geographical clusters of senior faculty, junior faculty and graduate students who mentor one other. There are currently five Mentoring Clusters in California, North Carolina, Indiana, Georgia, and the Mid-Atlantic Region. The groups, comprised of approximately a dozen members, discuss issues related to the advancement of women in academia, as well as issues related to graduate school success. The goals of the Mentoring Clusters are to provide more face-to-face mentoring to graduate students and to continue to mentor junior faculty women as they enter academia.

Further Indicators of Success

Many mathematicians are likely to know someone who completed the a doctorate but is so bruised by the experience that he/she is never able to thrive and grow in the discipline. Another goal for EDGE is to counter this phenomenon, insuring that students have a positive graduate experience, so that in their subsequent careers, they become “stewards of the discipline.” (Bass) Early involvement of EDGE Ph.D.s in research, service, and outreach activities suggests that the program has been effective in achieving this aim. For example, Dr. Rachelle DeCoste, a participant in the first EDGE Program in 1998, is collaborating with former EDGE participants and mentors to offer a Career Mentoring Workshop at Wheaton College, for graduate students preparing to enter the job market. These “second-generation” activities are significant indicators of the far-reaching possibilities for EDGE students.

Conclusions

For the past ten years, the EDGE Program has provided a mathematical environment in which women students have learned and thrived. The program brings a diverse group of students together each summer, and creates a community that encourages each person to reach her academic goals and to develop her full potential. The program’s success suggests that the creation of a supportive learning environment might also enable graduate programs in mathematics to improve their acceptance, retention, and success rates for women and minority students.

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