

Improving the Graduate School Experience for Women in Mathematics: The EDGE Program*

Sylvia T. Bozeman¹ and Rhonda J. Hughes²

¹Department of Mathematics, Spelman College, Atlanta, GA 30314; ²Department of Mathematics, Bryn Mawr College, Bryn Mawr, PA 19010

Abstract

For over a decade, Spelman and Bryn Mawr Colleges have collaborated on initiatives designed to increase the presence of women, with a special focus on women of color, in the upper ranks of mathematical scientists. The most recent initiative is the EDGE Program (Enhancing Diversity in Graduate Education), which addresses this challenge by attempting to decrease the loss of talent from U.S. graduate programs. To this end, the program provides structures that help women make successful transitions from undergraduate into graduate mathematics programs, redirect or refocus their ambitions when a program is inappropriate or unsuitable, and, ultimately, enable them to “accumulate advantages” that will empower them and foster success in their careers. A broader goal of this program is to diversify the mathematics community by creating models for mathematics programs that allow people from all backgrounds and cultures to thrive, advance and contribute to the profession.

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INTRODUCTION: MISSING FACES FROM MATHEMATICS GRADUATE PROGRAMS

A glance at the photographs on the website of any large U.S. mathematics department leads to an unmistakable conclusion: almost all of the faces belong to males. Inevitably, there is a cluster of female faces, but these in all likelihood belong to the non-tenure track faculty and staff. From the vantage point of a student at a women's

college or a minority-serving institution, this revelation is jarring. Students who are educated in an environment where women and people of color are as common as white men (or nearly so) face a challenging transition when entering a graduate program at a large research institution. Even for students from majority institutions, entry into the culture of U.S. graduate mathematics departments can present overwhelming obstacles.

In her book, *Leaving the Ivory Tower: The Causes and Consequences of Departure from Doctoral Study*, Barbara Lovitts (2001) sets forth several basic arguments regarding the factors which affect persistence outcomes and the high rates of attrition among graduate students in all disciplines. One of her main points is that it “is not the background characteristics that students bring with them but rather what happens after they arrive” in graduate school which affects persistence outcomes. She refers to data that show that those who leave doctoral programs and those who stay “are equally academically capable.” Lovitts asserts that:

Their background characteristics, their external commitments and responsibilities, their socialization as undergraduates, and the clarity of their understanding of the system of graduate education in general and their own program in particular, as well as their adaptive capacities, interact with the structures they confront in their programs to determine their persistence outcomes (Lovitts, 2001, p. 41).

In the nineties, sociologists coined the term “accumulated advantage” to refer to the notion that small differences in treatment, whether positive or negative, can accrue, resulting in significant differences in crucial indicators of success such as salary, promotion, and editorial positions (Valian, 1998). An apt mathematical analogy is the idea of “sensitive dependence on initial conditions” from the theory of chaotic dynamical systems, whereby small differences initially (for example, in educational preparation) can result in markedly different outcomes over long periods of time.

This paper describes the origins, philosophy, objectives, structure and outcomes of the EDGE Program. Enhancing Diversity in Graduate Education (EDGE) is a program whose goal is to increase the number of women who successfully complete graduate programs in the mathematical sciences, with a particular focus on women of

color. This goal addresses the high attrition rate of women and people of color from graduate mathematics programs, and the resulting loss of talent from the mathematics community. Even the most talented students often fail to develop their full potential and assume leadership roles, resulting in a lack of diversity at the advanced levels in the mathematics community. While summer undergraduate research programs prepare students for the new level and intensity of academic activity they will encounter in graduate school, the EDGE Program attempts in addition to prepare students for the social and cultural challenges associated with the graduate school experience – challenges that might diminish students’ confidence or even prompt their departure from graduate school before there is sufficient opportunity to demonstrate academic competence.

The EDGE Program is designed to create positive initial conditions for students, and to assist them in replacing disadvantages or setbacks with a series of small positive advantages that can have a long-term cumulative effect. The program seeks to help students overcome any collection of past circumstances that have impeded the advancement of certain groups and of many individuals in the study of mathematics, and in their professional advancement in the field. The structure of the program is designed to strengthen the ability of its participants to negotiate the transition from undergraduate to graduate school, and to develop strategies to persist to the doctorate. The program addresses a student’s ability to adapt to and interact with graduate program structures as it provides a supportive community for the participants; facilitates the first-year adjustment to graduate education; helps students establish a point of support within the faculty of the department and enhances the creation of connections to other graduate students; and helps students understand the nature of the graduate-school culture and anticipate the types of difficulties that generally arise.

It is natural to ask whether such a program is needed in the U.S., particularly one targeted towards women and students of color. A recent article in the *Chronicle of Higher Education* noted “only 13%, or 127, of those who earned doctorates were female U.S. citizens [in 2002]” (Wilson, 2003). The data show that 7% of those degrees were awarded to Black or Hispanic women; for example, “six such degrees were awarded to Black women [that year]” (Wilson, 2003). Such statistics led two women’s colleges, with positive environments for women interested in science and mathematics, to combine their efforts and address an issue of national concern.

THE CREATION OF THE EDGE PROGRAM

Since its inception in 1998, the EDGE Program has operated as a joint effort and shared vision of the Mathematics Departments of Bryn Mawr College and Spelman College, two women's colleges, each with a history of success in the production of women in mathematics. The program is a successor to an earlier collaboration aimed at identifying and encouraging talented undergraduate women to pursue careers in the mathematical sciences. In 1998, the two Co-Directors shifted their attention from undergraduate women to women making the difficult transition from undergraduate to graduate education. Phase I of the program, from 1998-2001, was funded by the National Science Foundation, the Andrew W. Mellon Foundation, and the National Security Agency. In 2001, the Co-Directors re-examined their goals and embarked on an expanded version of the program (Phase II), with funding from the Mellon Foundation and the NSF.

At Spelman College, an undergraduate liberal arts historically Black college, approximately 5% of the graduates earn bachelor's degrees in mathematics, and another 20% earn bachelor's degrees in the sciences. Bryn Mawr College has a long history of offering the Ph.D. degree in mathematics in a department which was the academic home of Emmy Noether, generally regarded as the preeminent woman mathematician of the twentieth century. In addition, Bryn Mawr College has enjoyed a productive history of undergraduate mathematics majors; in recent years, approximately 10% of graduating seniors are mathematics majors, with roughly one-third of the graduating class majoring in the sciences. These two institutions are a part of a small group of institutions, primarily liberal arts colleges, where the percentage of graduating seniors who are mathematics majors is significantly higher than the 1% national average (Spencer, 1995).

The EDGE community consists of participants, typically women who have just graduated from college and will begin their graduate work in mathematics the following fall; graduate students mentors; faculty instructors; staff; and the Co-Directors, all of whom spend a summer laying the foundation for a continuing relationship. The core structure of the EDGE Program consists of a four-week summer session, during which the participants engage in intensive mathematical and cultural preparation for graduate school, and a follow-up mentoring program during

the first year of graduate study. For the first five years, the summer session of EDGE rotated between the campuses of the two founding colleges, while the program's student participants, faculty and graduate mentors were selected from a national pool. As the program enters its second phase, the summer program has been made portable, with the first new site at Pomona College in 2003, an expanded mentoring program, and the inclusion of participants who have interrupted their formal education before deciding to return to graduate school. In its philosophy and objectives, the program responds to many of the problems identified above by Lovitts.

THE EDGE PHILOSOPHY AND OBJECTIVES

The philosophy of the EDGE Program springs from the notion that students who have been superstars in high school and college mathematics, but have had limited exposure to upper-level mathematics courses and the graduate school culture, are still quite capable of earning doctoral degrees in mathematics. Frequently graduate programs provide students, particularly women and those from small or minority-serving institutions, with their first real taste of failure, as they are not able to achieve their usual high levels of performance. Those from small liberal arts colleges may simply lack some of the mathematical sophistication of their peers from research universities who may have already taken graduate courses and attended research seminars. Without their customary support systems, including close relationships with faculty and peers in nurturing environments, students struggle to maintain their self-confidence, create new supportive relationships, and manage the higher work demands of graduate school (Bozeman and Hughes, 1999). All too often, they leave graduate programs early. Discouraged and convinced that they are not capable of the work expected of them, they are often unaware that their difficulties are shared by many other students.

In support of its philosophy, the program has as its basic tenet that providing academic preparation, encouragement, positive feedback, and a supportive network will enable each participant to negotiate setbacks and accumulate advantages, rather than disadvantages, from the outset of her graduate education. With these "accumulated advantages" a student can overcome any lack of exposure to advanced mathematics. In order to achieve its goals, the EDGE Program focuses on several program objectives:

- providing an academic bridge from undergraduate to graduate mathematics;
- increasing awareness of the social, psychological and political aspects of graduate education;
- networking women to form support structures;
- mentoring women throughout their graduate programs; and
- understanding, accepting, and learning from the differences among people, related to race, culture, educational and social backgrounds, preferences and values.

Assessment of the program to date indicates that with some awareness of the culture and challenges of the graduate environment, students are more likely to persist. The program encourages students to seek options and take positive action when challenges are encountered. Even if students drop out of one program, they should not be so discouraged or disillusioned as to end their graduate studies; rather, they might consider entering another program that better fits their needs. This view has contributed significantly to the success of the program.

The EDGE Program is designed to achieve the following specific objectives with each entering graduate student participant:

- to strengthen her ability to move from undergraduate to graduate level in basic abstract and linear algebra and in real analysis, and provide the mathematical tools needed to succeed in her first year of graduate school;
- to create a support network that provides mentoring and acquaintance with other women who have similar academic goals;
- to convey a realistic image of the graduate school culture and of what will be expected of her in a graduate program;
- to broaden her perspective regarding mathematics and its connections to other disciplines; and
- to develop an understanding of her own strengths and weaknesses under stress, in group activity, and in a competitive environment.

STRUCTURE AND ACTIVITIES

The Summer Program

The EDGE Summer Program consists of a four-week session, usually in June, during which participants, graduate mentors, and non-local instructors are housed in close proximity on the campus of the host institution. The academic portion of the program takes place on campus, in suitable classrooms, seminar, and lecture rooms usually centered in the institution's mathematics department. There is always access to a computer classroom or laboratory, as well as a lounge for informal discussion and social interaction.

The summer program features two core courses, one in abstract algebra and one in analysis. These subjects were chosen as those most likely to form the basis of graduate work in mathematics in the first year, and are introduced in a way that bridges the undergraduate and graduate content of these areas. Homework assignments are given, and work is critiqued in a way that provides constructive feedback rather than grades or criticism. Students are encouraged to work both individually and in groups, and to present their results to one another. Problems are often selected from preliminary examinations in the core subjects. From the outset, participants are asked to organize themselves to take notes so that these may be compiled at the end of the program, published and sent to each participant as a study resource in her graduate work.

In addition, there is a one-week minicourse on an exciting area of current mathematical research taught by a short-term visitor from academia or industry. Each week, there is a guest speaker who gives a talk on a timely area of mathematical activity, and has lunch with the students. An effort is made to include in these lectures topics that demonstrate the connections between mathematics and other disciplines, to highlight the applications of mathematics, and to expose students to a variety of career options.

Several problem sessions each week, led by the graduate student mentors, serve as the focus of individual participant's mathematical growth. Each woman is encouraged to find the level at which she is comfortable, regardless of how that compares with others, and to advance from that point during the four-week session.

The "Difficult Dialogues" seminar, which was introduced in the second year of the project and is now a regular feature of the summer program, is a series of participant discussions on diversity. Usually led by a sociologist or psychologist, the series seeks to help participants better handle discussions involving differences of race, culture, geographical origins, and any other background differences or personal preferences. One of the most apparent differences results from the racial diversity of the group, a diversity that is deliberately visible in the participants, faculty, staff and graduate student mentors. In the creation of an atmosphere more open to new ideas and people, the program hopes to enhance the participants' ability to engage in, contribute to, and benefit from communication with fellow graduate students within both informal and structured study groups, beginning in the EDGE summer session.

A typical day includes a one and one-half hour lecture in a core subject, a two-hour problem session, and possibly a guest lecture or panel discussion, or other program activity. The schedule leaves ample time for individual and group work, and most evenings participants work together in the dorm on problems and ideas from the course lectures. Thursday afternoons are designated "time off," and participants and graduate mentors are encouraged to explore the area, have dinner together (the "Thursday night dinners," funded by the program), and get to know one another. In the last week, each participant gives a brief talk on any area of mathematical interest; these typically involve projects done in other summer programs, or an idea or favorite problem learned in the EDGE Program.

Finally, each summer the previous year's participants are invited back for a weekend reunion that is the high point of the summer program. The participants eagerly await the arrival of their predecessors, who hold a panel discussion relating their experiences from their first year of graduate school. The current participants entertain with a talent show, and invaluable networking results from the interaction of the two groups.

The Follow-Up Mentoring Program

During the summer and early fall, the Co-Directors work with each participant to try to identify a suitable faculty mentor (distinct from the graduate mentors in the summer program) at her respective graduate institution. That mentor, contacted by the Co-Directors, acts as an advocate for the student in her first year of graduate study, helps to identify early difficulties in first-year courses, and assists with the adjustment to graduate work and the culture of graduate study. In some cases, intervention of the faculty mentor has been crucial in a student's decision to stay the course in her graduate program. With the student's approval, the program maintains some limited contact with the faculty mentor. There is added value in this aspect of the program, for it helps to identify institutions that are interested in collaboration with the EDGE Program, and that are committed to addressing the same issues that are of concern to EDGE. Through these contacts, the Co-directors have begun to cultivate relationships with certain graduate programs that value student success and that are serving as models for U.S. graduate education (Cooper, 2000).

Participants may obtain research support from the program in their first year of graduate study, in order to attend professional meetings, purchase books, software, or other research needs. This support enables students to sustain some of the momentum from their undergraduate experiences and the summer session.

The participants, graduate student mentors, and selected faculty keep in touch via an electronic bulletin board on the program's website, www.edgeforwomen.org. The website serves as an advertising vehicle for the program, providing online application and information. The bulletin board provides a forum for participants as they enter into and progress through their graduate programs.

ADMINISTRATION AND OPERATION

The two Co-Directors are responsible for the planning and implementation of all aspects of the program. However, the success of the program depends on a very capable and committed staff that includes the program coordinator, teaching faculty, graduate mentors and administrative assistants. Each year the Co-Directors engage a team of four faculty to provide instruction in analysis and abstract algebra and two or three graduate students, who are performing well in their own graduate programs, to serve as graduate mentors. EDGE instructors are currently on or have been on the faculties of Bryn Mawr College, Emory University, Howard University, Pomona College, Rice University, Spelman College, Swarthmore College, University of Montana, Wake Forest College, North Carolina A&T State University, and New College of Florida. Other faculty members are invited to give a mini-course or to give a guest presentation.

Mathematics department chairs at more than 1200 colleges and universities are sent notification of the program each year. In addition, the program is advertised in newsletters or news journals of several professional organizations, at professional meetings and at student conferences. Advertisements refer students to the website for more information and the application materials.

Students are selected for participation based on faculty recommendations that speak to their potential to earn a doctoral degree in mathematics. The number of applicants is usually three or four times the number of positions in the program, with many well-prepared students applying. Each student submits a statement of interest, which is used in conjunction with the faculty recommendations and academic record to ascertain the need for both academic and non-academic support in graduate degree pursuits. The Co-Directors, using the rankings and comments of a Selection Committee, complete final selection of each year's group. The result has always been a diverse group of eight to thirteen women, all very promising, whom the directors felt could benefit from the structure and activities of the EDGE Program. With such a strong applicant pool, it would be easy to accept students into the EDGE program based solely on their likelihood to earn the doctoral degree in mathematics. However, the goal of this program is to diversify the mathematics community by assisting students who have the talent and determination to complete a doctoral program but might not do so without some intervention.

PHASE I PROGRAM OUTCOMES

During the six-year period from 1998 to 2003, a total of 63 women entered the EDGE program. EDGE participants came from diverse racial (49% underrepresented minorities) and educational (44% liberal arts) backgrounds. They share a common desire to study mathematics intensively, to develop connections with other women who share that goal, and to be guided and mentored by those who have already committed to similar degree and career paths. In 2003, approximately 45 applications were received for the 13 student openings, representing an increase of 68% in the applicant pool over the past three years. The increase in applications is attributed to the increasing visibility of the program among undergraduate faculty advisors, and to a growing number of graduate departments that see the benefits of the program and recommend it to their incoming students. In addition, there is an increasing number of participants, many of whom recommend the program to peers.

Of the first fifty EDGE students, who make up the cohorts from the years of 1998-2002, forty-five (90%) persisted in their graduate programs to either earn the M.S. degree or continue studying in a doctoral program or both. Thirty percent of the students have earned at least one degree and are no longer enrolled while 60% remain in graduate programs. By June, 2003 the first EDGE participant had earned the Ph.D. degree in mathematics, while several others had completed the required departmental exams and were on the path to degree completion. (Auster, 2002)

Data is collected by the program and analyzed by Dr. Carol Auster, a sociologist at Franklin and Marshall College. Dr. Auster, who serves as program evaluator, presents her findings in a way that provides some insight into student perceptions of the experience both prior to and after the first year of graduate school. Students are surveyed at the beginning and end of the summer session and at the end of their first year of graduate study following the summer session. Responses collected from the 1998 - 2002 participants at the end of the four-week summer session are used to determine their level of satisfaction with the program and the immediate benefits derived. The follow-up survey, administered after the first year of graduate study, offers students an opportunity to reflect on the impact that the EDGE program has had on their lives during that year, and provides the Co-Directors

with data to assess the degree to which the EDGE Program is achieving the specific program objectives set out earlier.

Before attending graduate school, a post-summer survey revealed that many students had little idea of what to expect in graduate school. For most participants, the EDGE summer program provided a preview of what was to come, altering the expectations of two-thirds of the participants. Participants considered the graduate mentors a very significant and valuable part of the program and gave overwhelming approval (92%) to the particular choice of graduate mentors. The overall program rating was between very good and excellent each year, with most participants (96%) likely to recommend the program to others (Auster, 2002).

More important than the initial reactions are the survey results from the 1998 - 2001 cohorts after one year of graduate study. From the 37 students in this group, an 86% response rate was achieved. The survey revealed that the most beneficial activities of the summer were the problem sessions and the panel discussions followed by the abstract algebra and real analysis courses. More than 85% found the algebra or the analysis course either somewhat or very helpful in their first year course of study. Many reported that the program played an important role in providing a realistic expectation of the academic demands of graduate school in a way that prepared them to better meet those demands. "After EDGE I had a much better grasp of the level of difficulty to expect [in graduate studies] and how to deal with it," was the reaction from a 2000 EDGE participant, while a 1999 participant valued a different aspect and wrote, "The greatest benefit to me from the EDGE Program was the way that I was able to gain confidence going into grad school." (Auster, 2002)

According to the survey responses, students benefited from their interactions with the various constituents of EDGE, including the graduate mentors and the other EDGE students. A '98 EDGE participant stated: "I kept those voices and conversations [from panelists and directors] with me throughout the year. This really kept me going when it was rough, particularly in my first term." The most highly-rated activities in helping to create a sense of community among EDGErs (as EDGE participants are called) were the reunion weekend, and the Thursday night dinners. Students in EDGE '02 felt that both the reunion and the Thursday dinners also helped to develop an appreciation for cultural and racial differences (Auster, 2002).

Students had a wide range of responses to the very diverse community of participants and staff. Seventy percent of the students considered the racial and cultural diversity of the participant group to be very significant but attribute much less significance to the diversity of the guest speakers, teachers and other staff. However, the diversity of the graduate mentors was considered highly significant by students of each year, and held greater significance in those years when the program was conducted on the Bryn Mawr College campus than in years when it was on the Spelman College campus. Others felt that the significance of the group diversity was due to one or more of the following: it affirmed the ability of people from all groups to prosper in mathematics; it provided an important contrast to the more homogeneous department which they entered; it helped them to prepare for the diverse backgrounds and views encountered in their graduate department; and it made the program more interesting. Several felt that the EDGE diversity was more important to students from underrepresented groups (Auster, 2002).

Of course, no amount of prior experience and advice is sufficient to prepare a student for all of the eventualities of graduate school. Reflecting on prior preparation that they received from all sources, students reported in the survey that there were still aspects of graduate school for which many of them were unprepared. These included “the loneliness,” “bad advisement,” “embarrassing situations that faculty put you in,” “politics of the department and the isolation I felt as a victim,” “incomprehensible courses,” “my own disappointment with myself,” “teaching responsibilities,” “the amount of homework and the lack of tests,” “time management needs,” “the lack of guidance and mentoring,” “the stress and inconvenience associated with living on my own,” and “trying to balance school with time for family and friends.” Afterwards students gave their own advice to others about how to cope.

“Grad school is hard, but it is much harder if you isolate yourself. You have to find people in your program ...that you can talk to.”

Message from '98 EDGEr to new graduate students

“Try to have an outlet. Get involved in something outside of the math department.”

Message from '01 EDGEr to new graduate students (Auster, 2002)

Following four years of implementation, the Co-Directors convened a group of experts to aid them in analyzing the results of Phase I, and planning for and implementing Phase II of the program.

MEASURING SUCCESS: “THE BALTIMORE TEN”

In July 2001 the challenge of defining “success” for the EDGE program was offered to the EDGE Planning Group (hereafter called The Baltimore Ten), an assembly of ten mathematical scientists and graduate students assembled in Baltimore for two days to review the past four years of program operation and offer suggestions for the future. Led by Dr. Lida K. Barrett, a distinguished retired professor and dean, and former President of the Mathematical Association of America, the group decided that the primary criterion for success is the program’s ability to increase the number of women who persist to a graduate degree after entering a graduate program in the mathematical sciences.

In addition, The Baltimore Ten identified several other “acceptable indicators of success,” both short and long-term, as well as other contributions of the program. Their concerns are phrased below as questions.

- 1) Has the program further developed each student’s realization of her ability to tackle and independently learn difficult topics and handle abstract concepts?
- 2) Have students been empowered to respond positively to their own successes, failures, and needs?
- 3) Has the program provided, either directly or indirectly, support in addressing day-to-day concerns and in addressing crises that arise?
- 4) Are there indications that the program has or will contribute to diversifying the profession?
- 5) Has the program expanded each student’s ability to relate to those with different backgrounds and life styles?
- 6) Do EDGE students contribute to the graduate school culture at their institutions based on their participation in EDGE?

- 7) Are there indications that EDGE participants will be productive in all mathematical endeavors, including teaching, research and service to the profession?
- 8) Are graduate institutions changing and/or responding as a result of interaction with EDGE participants?

With the report of the Baltimore Ten in hand (Barrett, 2001), the Co-Directors returned to the Mellon foundation and the NSF to seek support of the second phase of EDGE, the principal features of which are a portable summer program, and an expanded mentoring program. In June 2003, the EDGE Summer Program took place at Pomona College in Claremont, CA, under the direction of Professor Ami Radunskaya, the Local Coordinator.

CONCLUSION AND IMPLICATIONS

In analyzing the results of Phase I of the EDGE Program, it is necessary to examine first those factors that lead women and students of color to terminate their graduate studies, and those factors that encourage them to persist. Even when factors are identified that affect the general student population, it is critical to identify additional factors that may be pertinent to the specific populations targeted by EDGE. In mathematics, perhaps more so than in other disciplines, those who attempt to enter the profession seem to be susceptible to “crises of confidence” at several points in the journey. Many of these crises occur at well-known points in one’s graduate education. A loss of confidence may lead to disillusionment with graduate study, or to dissatisfaction with one’s particular graduate program.

Based on anecdotal evidence provided by EDGE participants, mentors, faculty, and others in the community, there are several kinds of events that trigger such crises. For example, students who are not impressive to faculty in their first semester or year of courses or do not score well in their first attempt at taking preliminary examinations are often counseled to discontinue pursuit of their degree goals, with the euphemistic advice “perhaps you should do something else in life.” Such early negative feedback may constitute a serious blow when given to

women, students from certain racial or cultural groups, liberal arts graduates, or others for whom the entry into graduate school requires a major adjustment.

The women in the EDGE program often express concern that the issue of academic achievement cannot be considered separately from other issues of life. While the program promotes balance in one's life, it recognizes the challenges often encountered by women in trying to achieve these high academic goals. Dr. Rita R. Colwell, Director of the National Science Foundation, acknowledged one of those concerns in her recent interview with the Editor-in-Chief of *Black Issues in Higher Education* as she was asked "How do you differentiate the problems that confront women in terms of access to science careers?" Her reply began with, "In a word: children." A mother of two, she went on to say, "We don't make allowances for women who are brilliant, pursuing careers in science and engineering, to have enough time to have children and pursue their careers. It can be done." (A Scientific Mandate, 2003)

As the National Science Foundation becomes increasingly concerned with the decreasing number of U.S. citizens in graduate mathematics programs (Lorden & Slimowitz, 2003) the impact of any program that increases the number of students in graduate programs may be far-reaching. In recent years, the NSF VIGRE Programs (Vertical Integration of Research and Education in the Mathematical Sciences) have been widely established at selected institutions to increase the numbers who are successful at the graduate and post-doctoral levels, as is the new initiative "Enhancing the Mathematical Science Workforce in the 21st Century, EMSWF21" (National Science Foundation). The EDGE Program seeks to have a specific impact on improving retention among graduate women across a large number of institutions, and, ultimately, among all graduate students.

The EDGE Program demonstrates to its participants many paths by which "it can be done," primarily through a variety of role models who appear as speakers, panelists, and visitors, in addition to the faculty and staff. As each student begins to construct her own path to achieve both her academic and personal goals, the EDGE staff continues to face the ultimate challenge of constructing quantifiable goals that define "success" both for individual participants and for the overall program. It is anticipated that through the work of the EDGE Program and its

collaborations within the mathematics community, structures and strategies will be identified that can be used to create a more positive environment for all mathematics graduate students.

REFERENCES

Barrett, Lida K. (Ed.) (2001). *Report from The EDGE Planning Workshop, July 20-21, 2001*.

Auster, C. (2002). *The EDGE Program- Report on the Pre-Program, Post-Program, and Post First-Year Graduate School Surveys, 1998-2001*.

Bozeman, S. & Hughes, R. (1999, March). Smoothing the Transition to Graduate Education. *Notices of the AMS*, 347-348.

Cooper, Duane A. (2000). Changing the Faces of Mathematics Ph.D.s: What We Are Learning at the University of Maryland. *Changing the Faces of Mathematics: Perspectives on African Americans*. Reston, VA: National Council of Teachers of Mathematics, 179-192.

Lovitts, Barbara E. (2001). *Leaving the Ivory Tower: The Causes and Consequences of Departure from Doctoral Study*. Lanham, MD: , Rowman & Littlefield Publishers, Inc.

National Science Foundation (n.d.) Retrieved November, 30, 2003, from <http://www.nsf.gov/pubs/2003/nsf03575/nsf03575.pdf>

Lorden, J. & Slimowitz, J. (2003, March 26). NSF Workshop Examines the Future of Graduate Education. Retrieved November 30, 2003, from <http://www.ehr.nsf.gov/dge/InnovM03.html>

A Scientific Mandate. (2003, March 13). *Black Issues in Higher Education*. p. 22-26.

Radke Sharpe, N. & Sonnert, G. (1999). Women Mathematics Faculty: Recent Trends in Academic Rank and Institutional Representation. *Journal of Women and Minorities in Science and Engineering*, 5, 207-217.

Spencer, A. (1995, August). On Attracting and Retaining Mathematics majors – Don't Cancel the Human Factor. *Notices of the AMS*, 859-862.

Valian, Virginia. (1998). *Why So Slow - The Advancement of Women*. Cambridge, Massachusetts and London, England: The MIT Press.

Wilson, R. (2003, July 18). Strength in Numbers. *The Chronicle of Higher Education*, A10-A12.