

**National Science Foundation**  
**Graduate Research Fellowship Program**



**Final Evaluation Report**

**September 2002**

**WestEd**

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**NATIONAL SCIENCE FOUNDATION  
GRADUATE RESEARCH FELLOWSHIP PROGRAM**

**Final Evaluation Report**

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Any opinions, findings, and conclusions or recommendations expressed in this report are those of the authors and do not necessarily represent the official views, opinions, or policy of the National Science Foundation.



## EXECUTIVE SUMMARY

WestEd conducted an evaluation of the National Science Foundation's Graduate Research Fellowship (GRF) Program. This evaluation was designed to inform ongoing NSF efforts to strengthen its programs and support the agency's commitment to make optimal use of its resources across program options that address its goals. This report provides findings related to GRF Program effectiveness and examines important contextual issues that influence GRF impact.

The NSF Graduate Research Fellowship Program, started in 1952, continues to play a distinguished and vital role in graduate education. Since then, other fellowship programs have started that confer equivalent stature on their recipients or provide higher levels of funding. None approach the scope or size of the GRF Program. With more than 5000 applications and about 900 new fellowships awarded each year, the GRF Program reaches all fields supported by NSF. It funds students with potential to become leaders of the next generation of scientists and engineers.

NSF fellows pursue graduate study in science, mathematics, engineering, and technology (SMET) fields. The purpose of the GRF Program is to ensure for the Nation a future stream of highly qualified scientists and engineers to undertake careers in research and development. Inherent in this purpose is the commitment to a diverse workforce that includes participation of women and underrepresented minorities in successful careers in science and engineering. From 1978 to 1998, GRF fellowships were awarded through a Minority Graduate Fellowship (MGF) competition in addition to the Graduate Fellowship (GF) competition. Beginning in 1990, additional funds were made available for Women in Engineering (WENG) fellows in both competitions.

GRF support includes a portable stipend and a cost-of-education allowance that the NSF fellow can use at the institution of his/her choosing. Three years of support must be used within a five-year period. The value of the GRF Program stems not only from the direct financial support for fellows, but also from the stature that success in this national competition confers on them and the impact on graduate programs where fellows enroll. Senior university administrators have high praise for the GRF Program and its contributions to graduate education.

Graduate education in the United States is part of a complex system of higher education that includes competition as well as institutional and disciplinary variation. The GRF Program plays different roles at key transition point in graduate students' careers. We focused on three key transition points: entry, graduate experience, and career/life choices.

## The Evaluation Study

WestEd conducted this evaluation of the GRF Program to update information on program outcomes and assess its contributions to NSF goals. The study included the two GRF Program competitions, which awarded fellowships to Graduate Fellows (GF) and Minority Graduate Fellows (MGF) through 1998 when the MGF competition was discontinued. We also included Women in Engineering (WENG) recipients.

WestEd employed multiple methods, including secondary data analysis for 1979-1993 GRF fellows using data from the Survey of Earned Doctorates (SED) and NSF's Cumulative Index (CI). The SED is administered annually to all new doctoral recipients from U.S. institutions, and the CI is an NSF file that contains records for every individual who applies for a Graduate Research Fellowship. In addition, we conducted surveys of the 1989-1993 cohort of GRF fellows and their peers and site visit interviews with 149 graduate students and 75 faculty, administrators, and staff at six major research universities.

### Methods

- **Secondary Data Analysis for 1979-1993 GRF fellows**
- **Graduate Student Follow-up Survey of 1989-1993 cohort sent to three samples of fellows and peers**
- **Six Institutional Site Visits**

In 1999, WestEd administered the Graduate Student Follow-up Survey to three samples: a Disciplinary sample, an MGF sample, and a WENG sample.

### Survey Samples

- **Disciplinary sample: GRF fellows and a comparison group of program peers in Biochemistry, Economics, Mathematics, and Mechanical Engineering at 16 institutions. Responses from 200 fellows and 188 peers.**
- **Minority Graduate Fellows sample: 35% random sample of MGF recipients in 33 disciplines at 62 institutions. Responses from 87 MGF fellows.**
- **Women in Engineering sample: 50% random sample of WENG recipients (1990-1993) in all engineering fields at 46 institutions. Responses from 85 WENG fellows.**

For the Disciplinary sample and the site visits, we focused on four disciplines that represent the range of SMET fields supported by NSF. We were able to identify the comparison group of peers through the national Doctoral Education Database developed by the American Association of Universities (AAU) and the Association of Graduate Schools (AGS) in collaboration with the Educational Testing Service (ETS). The Doctoral Education Database was established in 1989 to collect student-level data from AAU institutions and included the four fields of Biochemistry, Economics, Mathematics, and Mechanical Engineering. Access to this database allowed us to identify a comparison group for GRF fellows comprising individuals who entered the same graduate programs in the same years. The Graduate Education Follow-up Survey and institutional site visits gave us the opportunity to probe the reasons for choices made by graduate students as well as to discover institutional and program factors that influenced decisions.

## **What Did We Find?**

Graduate education plays a critical role in the preparation of the academic, business, industry, government, and non-profit workforce in the United States. The contemporary world of graduate education is complicated, dominated by disciplines, and very different from what existed when the GRF Program was created nearly 50 years ago. NSF remains a major source of support for graduate education and includes research grants to faculty, which they use to support graduate students and graduate training programs that advance a research agenda. In contrast, the GRF provides direct support to highly qualified graduate students who enroll in top graduate programs in SMET fields. Because NSF fellows study in a variety of disciplines at public and private research universities, the impact of the fellowship on recipients differs. The GRF Program also affects graduate programs, particularly programs that enroll large numbers of NSF fellows.

NSF fellows value the GRF for the financial support and prestige as well as for the choices it gives them. However, fellows and faculty consider the 1998-1999 GRF stipend (\$15,000/year for 3 years) and cost of education allowance (\$9,500 /year) levels too low for prevailing costs. Further, GRF support was lower than several other prestigious fellowship programs that offer higher stipends, expense allowances, full tuition reimbursement, more years of support, and/or networking opportunities. Although the GRF Program is larger, involves a national competition, and supports more students for graduate study in a greater variety of fields than other graduate fellowship programs, it is important to keep the GRF stipend competitive with other graduate fellowships to attract the best applicants and maintain its reputation. (Since we concluded the evaluation, the GRF Program has increased the value of the annual stipend to \$18,000 for Fiscal Year 2001 fellows and \$20,500 for Fiscal Year 2002 fellows and increased the cost of education allowance to \$10,500 per year.)

### *Transition Point One: Entry into Graduate Education*

Entry into graduate education involves decisions about whether to apply to graduate school, where to apply, and which fellowships to apply for. These decisions are influenced by many factors, including perceptions about chances of success, which may also be related to the type of undergraduate institution attended. Both NSF applicants and fellows increasingly graduate from Research 1 universities.

	<b>GF</b>	<b>MGF</b>
1979 Applicants	49%	27%
1993 Applicants	53%	40%
<b>Difference</b>	<b>+4</b>	<b>+13</b>
1979 Fellows	66%	33%
1993 Fellows	69%	66%
<b>Difference</b>	<b>+3</b>	<b>+33</b>

Traditionally, many underrepresented minorities have attended historically minority institutions as undergraduates rather than the Research 1 universities that produced most GRF fellows. However, between 1979 and 1993 the percentage of MGF fellows who graduated from Research 1 universities increased from 33% to 66%. We also found that 1993 GF fellows were more diverse. Furthermore, comparing 1979 to 1993 GRF fellows, we found that the latter were also more likely to be women, in large part due to the WENG awards.

	1979 Fellows	1993 Fellows	Difference
GRF Women	29%	43%	<b>+14</b>
GF Fellows - White	90%	71%	<b>-19</b>

The GRF Program is implemented within the context of graduate programs in which competition for top students can be intense. Faculty and staff describe admissions and recruitment in market terms, indicating that they offer as much as they can to be competitive because enrolling the best graduate students is considered critical to attracting and retaining top faculty. Consequently,



most doctoral students receive offers of financial assistance when accepted into a Ph.D. program, which means that GRF support alone is not likely to be the critical factor in an NSF fellow's decision to enroll in a particular institution.

Both NSF fellows and their peers said they enrolled in a particular program for reasons ranging from academic quality to personal preferences. Of all fellows from 1979-1993 who had completed doctorates by 1999, 62% of GF fellows did so from programs rated as Distinguished by the National Research Council. Fewer MGF fellows (48%) enrolled in programs rated as Distinguished. MGF fellows are also less likely than GF fellows to enroll in and complete doctorates from programs ranked among the top five or ten graduate programs in their field.

Due to the timing of admissions decisions, which are made before GRF awards are announced, the fellowship award has virtually no impact on admission to graduate programs. However, the GRF may be an asset for late admission or for changing programs, although few take advantage of this option. Once an admitted student receives GRF funding, some graduate programs work actively to attract them to enroll and may enhance GRF fellowship support. Since NSF fellows continue to be admitted to, enroll in, and complete degrees in highly ranked graduate programs, the selection criteria for the GRF Program appear to be consistent with the criteria used by top graduate programs. We also found that GRF fellows tend to enroll in and complete degrees in a small number of institutions; more than 90% chose graduate study in RU1 institutions.

### ***Transition Point Two: The Graduate Experience***

The path to the Ph.D. is frequently a long and arduous journey, and many of those who begin that journey do not complete their degrees. NSF fellows value GRF support for different reasons, and the fellowship's value to graduate students also varies in different disciplines. Disciplines both shape the graduate experience and affect completion rates and time to degree.

#### ***Value of the Graduate Research Fellowship***

NSF fellows reported that GRF advantages were related primarily to financial assistance and prestige. We also found that GRF funding increased the freedom of fellows to make important choices regarding teaching and research. Individual fellowship funding is thought to carry with it dangers of intellectual and social isolation and reduced opportunities to teach, but we did not find these to be major concerns for NSF fellows.

### **Major Advantages and Disadvantages Reported by NSF Fellows**

<u>Advantages</u>	Disciplinary Fellows	WENG Fellows	MGF Fellows
Financial support (stipend)	84%	89%	89%
Reputation among faculty as a good student	70%	74%	60%
Having it on my CV helped/will help in job	67%	59%	66%
Tuition assistance (COE allowance)	65%	74%	69%
Full-time study allowed quicker start in program	57%	51%	58%
<u>Disadvantages</u>			
Support only lasted 3 years	46%	42%	46%
Less opportunity to teach (TA)	23%	18%	18%
Could not live on stipend alone	9%	17%	15%
Isolated from other students in program	6%	3%	4%
Less opportunity to work with faculty on their research projects (RA)	5%	5%	5%

### *The Disciplinary Difference*

Graduate school is experienced differently by every student because of differences in background, educational preparation, and personal factors. The norms and expectations of the particular disciplines and institutions to which the student belongs also influence how students experience their education. Graduate programs in the SMET fields supported by the NSF GRF Program have distinctive disciplinary cultures situated within complex institutional settings. In many cases these disciplinary factors color the effect of the GRF Program. For example, norms, expectations, and requirements vary substantially by discipline in terms of financial support, teaching requirements, organization of research, activities, productivity measures, degree value, and career options.

### **Variation in Activities Reported by GRF Fellows (Disciplinary Sample)**

	Mechanical Engineering	Mathematics	Biochemistry	Economics
Work on Team	<b>62%</b>	<b>33%</b>	<b>53%</b>	<b>29%</b>
Collaboration	<b>66%</b>	<b>55%</b>	<b>73%</b>	<b>59%</b>
Interdisciplinary Research	<b>54%</b>	<b>25%</b>	<b>48%</b>	<b>20%</b>
Learn Organizational or Managerial Skills	<b>48%</b>	<b>14%</b>	<b>32%</b>	<b>14%</b>
Interact with Professionals in Field	<b>50%</b>	<b>8%</b>	<b>19%</b>	<b>20%</b>

Disciplinary differences include the nature of research and the relative importance of teaching. Faculty and graduate students told us about the impact of GRF support in different disciplinary contexts. For example, where research and graduate study are focused in laboratories (Mechanical Engineering and Biochemistry) GRF support greatly benefits faculty by saving research funding that supports large research projects and benefits NSF fellows by giving them greater flexibility in selecting research projects that interest them. In contrast, in Economics and Mathematics, where research is more individual and less likely to be externally funded, the primary benefit of GRF support to NSF fellows is the flexibility to pursue research rather than devote considerable time to teaching responsibilities.

***Ph.D. Completion***

Goldman and Massey<sup>1</sup> recently concluded that three-quarters of science and engineering graduate students never receive a Ph.D. However, of GRF fellows in the 1984-1988 cohort, 73% completed their doctorates within 11 years. For some disciplines, such as Engineering, the Ph.D. is not the goal of most graduate students. More recent GRF cohorts have higher proportions of Engineering fellows than earlier cohorts, which would have the effect of lowering overall Ph.D. completion rates. Even in Engineering, 69% of GF and 55% of MGF fellows in this cohort completed within 11 years. In this context, completion rates for GRF fellows are exceptionally high.

We looked at trends in completion rates and time to degree from 1979-1993 by analyzing three five-year cohorts (1979-1983, 1984-1988, and 1989-1993). Secondary data analysis (SED/CI) reveals that 68.3% of 1979-1983 NSF fellows and 73% of 1984-1988 NSF fellows completed the Ph.D. within 11 years of entering their graduate programs.

<b>Ph.D. Completion Rates for NSF Fellows Completing in 11 Years or Less</b>	
<b>1979-1983 Cohort</b>	<b>68.3%</b>
<b>1984-1988 Cohort</b>	<b>73.0%</b>

To update findings from previous studies, WestEd compared Ph.D. completion rates for GRF applicants who are assigned to different Quality Groups during the selection process. Past studies have compared QG2 fellows and non-awardees, although fellowship awards are not made on a random basis within this Quality Group (QG2). All applicants in Quality Group 1 (QG1) receive fellowships based strictly on competitive ratings. However, those applicants assigned to Quality Groups 2 and 3 (QG2, QG3) receive either a fellowship or an Honorable Mention based on competitive ranking plus other factors such as field of study, level of earned graduate credits, and geographic location of applicant’s high school.

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<sup>1</sup> Goldman, C. A. & Massey, W. F., 2001. *The Ph.D. Factory: Training and Employment of science and engineering doctorates in the United States* (Boston: Anker Publishing Company).

Looking at NSF fellows (QG1 and QG2) and QG2 non-awardees, we found consistent results in 11-year Ph.D. completion rates between the 1979-1983 and 1984-1988 cohorts. QG1 fellows (72% to 75%) continued to complete doctorates more often than QG2 fellows (65% to 69%), who in turn completed somewhat more often than QG2 non-awardees (63% to 65%). This pattern is consistent with findings of prior studies. We also found that while QG1 MGF fellows increased completion rates from 56% to 68% for the 1984-1988 cohort, the QG2 MGF fellows saw a more modest increase from 46% to 51%.

We also compared completion rates by gender and found that women have substantially closed the completion gap with men.

- 11-year completion rates for women in the 1984-1988 cohort were 72%, compared to men at 74%.
- 11-year completion rates for 1984-1988 women fellows in most discipline areas are within  $\pm 6$  percentage points of men's completion rates; however, there were much greater differences in computer science/math and social sciences.
- At the 6-year completion mark, WENG fellows (1990-1993) are completing doctorates at rates (40%) approaching those of all other fellows in Engineering (men and women) (45%).

We also found that the 11-year doctoral completion rate for MGF fellows increased more than it did for GF fellows.

	1979-1983 Cohort	1984-1988 Cohort	Difference
GF Fellows	<b>71%</b>	<b>74%</b>	<b>+3</b>
MGF Fellows	<b>50%</b>	<b>61%</b>	<b>+11</b>
Men Fellows	<b>70%</b>	<b>74%</b>	<b>+4</b>
Women Fellows	<b>64%</b>	<b>72%</b>	<b>+8</b>

Despite faculty and student beliefs that GRF support may shorten the time to degree for NSF fellows compared to their peers, this is more perception than reality. While some NSF fellows think they will finish in less time because of the GRF, others indicate they choose more coursework or research experience over speedy completion. Such choices are made in relation to

important contextual differences associated with graduate study in different disciplines and/or at different institutions, as well as those that stem from rapidly changing fields and job markets. Faculty and student estimates of time to degree ranged between five and six years across the programs that we visited, with only one Economics program indicating an average of six years for completion. However, in our analysis of SED/CI data, we found that fewer QG2 non-awardees than NSF fellows complete doctorates within six years, and that about one-third of NSF fellows who complete degrees within 11 years still take more than six years to earn doctorates. Faster does not necessarily mean better to all graduate students, and the benefits of the GRF freeing up discretionary time should not be underestimated.

### *Transition Point Three: Career and Life Choices of Graduate Students*

The goal of NSF support for graduate study is to ensure the quality and diversity of the next generation of the SMET workforce. NSF fellows told us that having GRF is an asset in getting postdoctoral fellowships, securing research funding, and searching for a job. Although the likelihood of pursuing faculty careers varied greatly by discipline, Disciplinary fellows (56%) indicated that faculty advised them to pursue academic careers with somewhat greater frequency than did the Disciplinary peers (45%).

With the exception of Mechanical Engineering, the majority of Disciplinary fellows and more than one-third of the Disciplinary peers responding to the survey had positions in higher education. For a substantial number of respondents, however, these were postdoctoral positions or non-tenure track teaching appointments. Only in Economics were these early career appointments likely to be tenure track faculty positions, where 64% of the Disciplinary fellows and 35% of their peers had tenure track appointments. In the other fields represented in our study, very small percentages of NSF fellows or peers were in tenure track faculty positions at the time of the survey.

We found that career choices shift during graduate school. Many graduate students become less inclined to pursue academic careers as time passes—a shift precipitated by a number of factors, including the tight competition within the academic job market, better pay in the private sector, and disillusionment with academia. Some choose academic careers at teaching institutions over research universities. Many men and women view life at research universities in negative terms due to academic politics, heavy work demands, or the challenges of balancing an academic career and family life.

Both NSF fellows and peers are increasingly likely to pursue careers in government, business, and industry, and most respondents indicated their primary responsibilities were research and development (R & D). However, there are disciplinary differences, with 76% in Mathematics, 75% in Economics, 62% in Mechanical Engineering, and 60% in Biochemistry reporting R & D emphasis in their positions. Fewer than 10% of NSF fellows in each discipline indicated teaching was their primary responsibility.

## Recommendations

Given the high level of national regard that the GRF Program continues to garner, we offer recommendations to strengthen its impact and enhance its capacity to contribute to NSF and national goals of science and engineering discovery and building a diverse, globally oriented workforce. Recommendations arising from the evaluation of the GRF Program fall into two broad categories. The first focuses on *tactical* recommendations, or actions that can be taken to streamline or strengthen day-to-day operation of the GRF Program, which is widely regarded as a well-run program.

The second set of recommendations is *strategic* in nature, in that each recommendation focuses on actions NSF might consider to move the program in desired directions and/or to bring program policies and practices into closer alignment with its overarching mission.

### Tactical Recommendations

- **Increase GRF Stipend and Cost of Education Allowance**
  - **Create an Allowance for Related Education Expenses**
  - **Announce GRF Winners Sooner**
  - **Maintain or Expand Use of the On-line Application Process**
  - **Foster Development of an NSF Fellows Network**
  - **Remove the First-year Deferral Prohibition**
- 
- Increase the GRF stipend and cost of education allowance to ensure that the award continues to convey to its recipients the national honor that currently accompanies it by providing an adequate level of financial support.
  - Create an allowance for related education expenses such as travel, books, and computers.
  - Announce GRF winners sooner to increase the likelihood of the GRF influencing admission decisions and financial support packages.
  - Maintain or expand use of the on-line application process since students find it efficient.
  - Foster the development of an NSF fellows network using a combination of on-line and in-person arrangements, regarding issues of fellowship use, graduate school experience, careers, research, teaching, and job search.
  - Remove the first-year deferral prohibition to allow fellows the flexibility to use the three years of support to their best advantage during the five-year period.

## **Strategic Recommendations**

- **Change the Number of Years of Support**
- **Eliminate the Eligibility Cap on Prior Graduate Units**
- **Restructure the Selection Process to Expand Access**
- **Collaborate with Other NSF Programs**

- Change the number of years of support to emphasize support of graduate-level, not primarily doctoral-level, studies. Changing job markets in fields like engineering and biochemistry have led to an increased demand for master's level members of the SMET workforce.
- Eliminate the eligibility cap on prior graduate units to support career transitions and/or later entry to graduate programs.
- Restructure the selection process to expand access for applicants from a broader range of undergraduate institutions by allowing multiple ways for applicants to demonstrate their capacity to engage in research.
- Collaborate with other NSF Programs to develop joint strategies to boost the numbers from underrepresented minorities who apply for and win the GRF.

## **GRF Program Changes**

Since the initial draft of this report was submitted to NSF, there have been substantial changes in the Graduate Research Fellowship Program, including increasing the annual stipend and the cost of education allowance. In addition, revised eligibility criteria allow more advanced graduate students to apply for the GRF and increase the flexibility of fellowship use. The changes are in line with several of the tactical and strategic recommendations found in this report.