

## **2006-2177: STATUS AND EXPERIENCES OF MINORITY GRADUATE STUDENTS, POSTDOCTORAL FELLOWS, AND FACULTY IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS DISCIPLINES**

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# **Status and Experiences of Minority Graduate Students, Postdoctoral Fellows, and Faculty in Science, Technology, Engineering, and Mathematics Disciplines**

## **Abstract**

This study seeks to determine key factors influencing the career choices and experiences of underrepresented minority undergraduates, graduate students, postdoctoral fellows, and faculty members in science, technology, engineering, and mathematics (STEM) disciplines. Special attention is given to exploring factors influencing decisions to move along paths leading to the professoriate. Questions being studied include 1) what are the key factors influencing minority students' decisions to pursue graduate study in STEM, 2) what are the key factors influencing graduate students' decisions to select the STEM professoriate as a career choice, and 3) what are patterns in the experiences of minority graduate students, postdoctoral fellows, and faculty in STEM disciplines, with particular attention to experiences in engineering fields?

Focus groups and interviews with STEM undergraduate students, doctoral students, and recent doctoral alumni were conducted on two campuses to better understand their experiences before, during, and after graduate school. While most doctoral students primarily interact with others in their department, minority students formed a community across campus through the NSF-sponsored Alliance for Graduate Education and the Professoriate (AGEP) and similar programs. All students commented that success in doctoral programs requires a different skill set than what allowed for success in undergraduate programs. Such skills include working with others, and developing alliances with student and faculty colleagues. Students generally learned these skills through experience, but felt that universities should do more to encourage such habits early in a student's career.

Related research includes current studies by Prof. Christine Grant (North Carolina State University) on minority faculty, Prof. Fitzgerald Bramwell (University of Kentucky) on baccalaureate origins of natural science doctorates, and Associate Dean Janet Rutledge (University of Maryland – Baltimore County) on attrition rates of minority graduate students. Future work on this project includes working with and expanding the aforementioned studies, and conducting an online survey of graduate students on various campuses. The outcomes of this study will include a set of educational best practices and improved policy recommendations. While such information will be targeted at minority students, it is expected that many recommendations will help to improve the graduate school experience for all students.

## **Introduction**

In the United States, the minority doctoral student population in science, technology, engineering, and math (STEM) disciplines significantly lags behind its representation in the overall population. National Science Foundation<sup>1</sup> and Census Bureau<sup>2</sup> data show that, while the population of Blacks and Hispanics in the United States is 12% and 13%, respectively, in STEM doctoral programs these groups only account for 5% and 4.8% of the doctoral student population. These minority student populations have increased slightly over the past decade, but are still

significantly lower than where they could be. On the undergraduate level in STEM, colleges and universities have done marginally better, with Blacks and Hispanics composing 8.5% and 7.2% of the populations, respectively<sup>3</sup>. Therefore, by making STEM doctoral programs more appealing to minority undergraduate students and by implementing effective support programs for current minority doctoral students, the minority population in doctoral programs should rise to more closely agree with that of the undergraduate population.

This study seeks to determine key factors influencing the career choices and experiences of underrepresented minority undergraduates, graduate students, postdoctoral fellows, and faculty members in STEM disciplines. Special attention is given to exploring factors influencing decisions to move along paths leading to the professoriate. Questions being studied include 1) what are the key factors influencing minority students' decisions to pursue graduate study in STEM, 2) what are the key factors influencing graduate students' decisions to select the STEM professoriate as a career choice, and 3) what are patterns in the experiences of minority graduate students, postdoctoral fellows, and faculty in STEM disciplines, with particular attention to experiences in engineering fields? Related research includes current studies by Prof. Christine Grant (North Carolina State University) on minority faculty, Prof. Fitzgerald Bramwell (University of Kentucky) on baccalaureate origins of natural science doctorates, and Associate Dean Janet Rutledge (University of Maryland, Baltimore County) on attrition rates of minority graduate students. In addition to providing an enhanced understanding of the graduate school experience, results from this study will be used to determine educational best practices for a variety of graduate school cultures. Further, they will be useful to inform policy decisions and proposals for related research.

## **Background**

Recently there have been publications and initiatives related to the general doctoral student experience and the experiences of minority doctoral students in particular. The University of Arizona studied the considerations that students make when they decide to apply to graduate school<sup>4</sup>. The sample population was comprised of students who applied to Arizona and responses were separated out by race (“White” vs. “Minority”) and gender. Top factors for all doctoral program applicants included the match between degree program and student interests, department reputation, whether the program is accredited, research done by an individual faculty member, department’s responsiveness to questions, and overall school reputation. For minority applicants, however, factors such as printed materials from the department of interest, recommendations from faculty at other universities, and proximity to the student’s home were significantly more important than they were for the overall applicant pool. For women and minority applicants, the responsiveness of a program to an applicant’s questions also played a very important role. Therefore, the effective recruitment of underrepresented groups requires different techniques and training than what is necessary for the majority groups.

The University of Maryland, Baltimore County (UMBC) has also published their findings about successful programs to create a diverse doctoral student body on their campus<sup>5</sup>. Some such programs are the Meyerhoff Graduate Fellows and the PROMISE Institute, the University of Maryland Alliance for Graduate Education and the Professoriate (AGEP). These programs have been modeled around similar successful graduate programs at other schools as well as the

undergraduate programs at UMBC. From these programs, the authors found certain components to be especially important in supporting minority students before, during, and after graduate school. These components are: *preparation for graduate study* (GRE and application support); *graduate program selection* (factors to consider); *graduate admissions* (changing how faculty do admissions); *summer bridge programs* (student bonding and assessment of academic preparation); *peer support* (with advanced students in one's discipline and through interdisciplinary opportunities); *faculty mentorship and advising* (from one's research advisor and from other faculty); *adequate and stable financial support*; *staff support and professional development* (someone to look out for minority graduate students and minority graduate student organizations); and *exposure to the profession* (funding for travel to professional conferences, funding to bring successful minority professionals to campus for a short or long period). It is important to note that these components are more focused on changing the doctoral programs from the university's side, instead of forcing the students to adjust.

In addition to these academic institutions, some non-university organizations have researched issues related to doctoral students. The Woodrow Wilson Foundation published reports in 2005 on doctoral programs<sup>6</sup> and minorities in doctoral programs<sup>7</sup>. In *The Responsive Ph.D.*<sup>6</sup>, the Foundation highlighted four themes that have been successfully used at schools across the country to improve doctoral education. These are: *new paradigms* (what encourages or discourages truly adventurous scholarship?); *new practices* (by what means can we make all aspects of doctoral training, including pedagogy, truly developmental?); *new people* (the doctorate should make all people within the population feel included and that their research is socially relevant); and *new partnerships* (improved relationships between academia and the sectors that hire doctorate recipients). By considering these issues at each academic institution, the Foundation believes that the doctoral experience will be improved for all students, regardless of race and gender.

Underlying the four themes are four principles that have been shown to work at the institutions studied in the report. These principles are: universities should have a strong and centralized graduate school with a significant budget and power; the doctorate must not be viewed in a vacuum with little or no concern for how the research affects and is affected by society; students from a diverse range of backgrounds must be included in doctoral programs; and doctoral programs must be regularly assessed using reasonable objectives, rewards, and consequences. While these principles are followed at some institutions, they are not followed at many. Therefore, through this report, the Foundation hopes to effect change in the mentality and operations of doctoral institutions in order to change the reality of doctoral education.

Likewise, in *Diversity & The Ph.D.*<sup>7</sup>, the Woodrow Wilson Foundation recommends seven principles to improve the recruitment and experiences of minority doctoral students: *communication*, *research*, *vertical integration*, *intellectual support*, *mentoring and professionalizing experiences*, *race and need together*, and *leadership*. As previously mentioned, programs must *communicate* better to share resources and best practices. In addition to anecdotal evidence of what works well, *research* must be done in order to quantitatively assess how well programs work and what could be done better. *Vertical integration* describes how K-12, undergraduate, and graduate programs must work together to make sure that students are engaged early and often. In *intellectual support*, the Foundation recommends that the

doctorate become more socially responsive and improve the image of the programs so that they are more attractive to a diverse audience. The category of *mentoring and professionalizing experiences* includes issues related to the relationship between a student and her or his advisor, as well as financial matters that might draw a student away from opportunities to interact with her or his professional colleagues. Next, *race and need together* describes how graduate programs should attempt to consider race as well as need in programs, admissions, and financial aid, instead of focusing on need as many programs currently do in order to avoid the sometimes negative opinions of affirmative action. Finally, *leadership* is recommended for the government and its agencies in order to provide better guidance and oversight of how federal funds are being spent to ensure that the funds are being used on the desired people and programs. While some of these principles are similar to those that the Foundation suggests need to be improved for all doctoral students, some are specific to the minority experience.

The Council for Graduate Schools recently created the Ph.D. Completion Project<sup>8</sup> to examine issues related to retention and time-to-degree of students in doctoral programs. This program has corporate sponsorship from Pfizer and Ford. Students in specific degree programs at a select group of universities were tracked, and surveys were used to better understand the experiences of students who graduate and those who leave their program without a doctorate. From the initial research for the project, the promising practices that were observed were the use of *mentoring, financial support, program environment, research mode, and processes and procedures*. These practices agree well with those that the Woodrow Wilson Foundation recommends.

Finally, a public-private partnership called Building Engineering and Science Talent (BEST)<sup>9</sup> has examined the practices that have worked well to support underrepresented students in STEM disciplines. These observed practices include institutional leadership, targeted recruitment, engaged faculty, personal attention, peer support, enriched research experience, bridging to the next level, and continuous program and personal evaluation. For graduate support, BEST has recognized the National Consortium for Graduate Degrees for Minorities in Engineering and Science (GEM)<sup>10</sup> and the Compact for Faculty Diversity<sup>11</sup> as effective.

The aforementioned best practices and observations are being used to inform questions used in this study. As previously discussed in the Introduction, this project seeks to better understand the experiences of minority STEM undergraduates, doctoral students, postdoctoral fellows, and faculty, and factors that contribute to their decision to move along paths leading toward the professoriate. In order to accomplish this, the current status of graduate education is being studied through on-campus focus groups and interviews, and an upcoming online survey. The focus groups will be discussed in the next section, while the survey will be described further in the Future Work section.

## **Methodology**

Focus groups on two campuses with current STEM minority graduate students, STEM minority undergraduate students interested in graduate school, and a diverse group of STEM graduate students have been completed in order to better understand students' academic/professional and social experiences before and during graduate school. By speaking with a diverse group of graduate students, the differences between the minority experience and the general graduate

student experience can be studied. One additional focus group was held with non-STEM graduate students in order to better understand why students do not pursue STEM disciplines. Interviews with recent minority doctorate recipients and faculty advisors to minority students were performed in order to understand the more complete graduate school and career search experience. The questions used during the focus groups and interviews are given in the Appendix.

## **Results and Discussion**

In all, a total of seven focus groups were held at two universities, Institution A and Institution B. Institution A is public and classified by the Carnegie Foundation<sup>12</sup> as a Research University (very high research activity). It has approximately 22,000 total students and is located one hour from a large city. Underrepresented minority students make up 10% of its graduate student population of 3,100 students. However, within STEM disciplines on the graduate level, the total population is 1,800 and there are 90 underrepresented minority students. Institution B is also a public university and is classified as a Research University (high research activity). It has approximately 14,000 students total, with 2,800 graduate students and 200 underrepresented minority graduate students. Within this there are 800 STEM graduate students, 40 of which are classified as underrepresented minorities. Institution B is located in a more rural area than Institution A, and the nearest large city to Institution B is approximately three hours away.

At Institution A, it was found that many minority students were attracted to the school through their experience as participants in the AGEP-sponsored summer research program. For all students, departmental research, mentor recommendations, and personal or family goals influenced students' decision to apply to graduate school and choose Institution A, similar to the findings in the University of Arizona study<sup>4</sup>. Once at Institution A, many focus group participants felt that the university graduate orientation was not useful or attractive. However, departmental orientation events were perceived to be very informative and relevant to the students' transition. In order to ease the transition to graduate programs, some departments invite certain students to come early and take classes or start doing research, based on the student's background. While this is similar to the summer bridge program at UMBC<sup>5</sup>, it is not an institutionalized program at Institution A. Instead, only a small number of departments utilize this option when they feel a student could benefit from it.

Academically, students felt that their undergraduate preparation made a tremendous difference in their success and transition to graduate school. However, most found that their study habits had to become more regular and intense compared to what they were in undergraduate classes in order for them to be successful in graduate school. Tutors were available in some departments when a student appeared to be struggling. Most departments expected the students to ask for help, while in others, especially smaller departments, the faculty members intervened when they recognized a problem. Many students found that graduate school is much more political than an undergraduate program, and realized that in order to be successful they had to develop a close network and allies in the department faculty and staff. Some students learned this early in their graduate school career, while others learned it later. This political aspect of graduate school is something that students felt all incoming students should know, but that they are generally not told. Advisor selection was another issue in which students said that they needed better

guidance. Many students said that they chose an advisor because she or he did research that was of interest to the student. However, they later realized that the advisor's personality or style did not mesh well with the student's. Therefore, students felt that a better orientation on the personal and political aspects necessary for success in graduate school could be done. The need for proper guidance on these issues agrees with the need for proper mentoring that the related studies and projects stress.

Students in some departments at Institution A mentioned that research funding was sometimes limited and, after their first few years, students were expected to write proposals to external agencies to fund their research projects. In other departments, a lack of funding meant that the students had to be teaching assistants frequently, and some even taught at other local colleges because there was significant competition for the few teaching assistant opportunities in their area(s) of expertise. For minority students, however, this issue of funding did not come up as much as it did for non-minority students. This is partially due to certain internal and external fellowships available to minority graduate students. The offices that administer internal fellowships for minority students also organize events for the students in the program. Such events help to build a university-wide community among minority students that non-minority students often do not have. This university-wide community allows for the peer support necessary for many minority students to be attracted to and remain at Institution A. This finding is similar to what Bass, et al.,<sup>5</sup> at UMBC have observed in their programs.

Socially, many students commented that there was little to do in the area around Institution A. Many students spend weekends in the nearby larger cities because they are attracted to the social opportunities there. This also influences their desire to stay at Institution A for a postdoctoral or faculty position. Some students even mentioned that they want to leave the area because they personally are not happy. However, others felt that the proximity to large cities is the reason Institution A's local area does not have more activities. While most considered it to be a negative factor, some students said that this lack of social activities on or near campus proved to be motivation to graduate.

When nearing graduation and considering what career to pursue, many students and recent alumni expressed the importance of their relationships with their advisor and other faculty. Some students said that they were initially interested in academic positions, but they lost that interest after watching the hectic lifestyle their advisor led. Many minority students expressed interest in pursuing a faculty position at a minority-serving institution or at a teaching-focused college near their home region so that they could spend much of their time mentoring students, especially those of their ethnic background. Students and recent alumni in general felt that their interest in an academic position was also competing with the draw to earn more money in an industrial position. While the salary gap cannot be easily closed, universities can work to change the academic culture and show students a variety of academic lifestyles.

At Institution B a few significant differences were observed. In this environment, personal contacts were very important for recruiting. Many students and faculty stated that word-of-mouth recruiting done by graduate students, current faculty, or alumni was essential to their recruiting efforts. In addition to personal contacts, students chose to attend Institution B because they enjoyed the area and felt that it would be an ideal location to have a young family. It should

be noted that most students who participated in the focus groups at this campus were married or partnered, and a significant number had young children.

At this university, mandatory online orientation courses were used to introduce incoming students to the code of conduct and issues related to ethics in research. Additional social events were held at the beginning of the academic year to allow students to meet each other and learn more about the campus. These events were considered to be very useful and many students spoke highly of them, in stark contrast to the situation at Institution A. This attention to orientation is perhaps due to the isolated location of the campus and, therefore, the perceived necessity for students to have a strong connection with the university and their fellow students. This agrees with the positive impact of peer support on the retention and success of graduate students, as discussed by Bass, et al.,<sup>5</sup> and BEST<sup>9</sup>.

While minority graduate students at Institution A expressed gratitude for having a university-sponsored minority graduate fellowship, some minority students at Institution B felt that a similar fellowship forced them to spend an excessive amount of time as teaching assistants. After the first year of graduate school, the fellowship does require students to be graduate assistants or teaching assistants, full-time for one semester of the year or half-time for two semesters. Certain programs expect their students to hold teaching assistantships and will not support students as graduate or research assistants. Further, some faculty in these programs often will not advise students who hold the fellowship due to the amount of time students spend as teaching assistants. This practice was viewed as a significant problem in some departments and a minor issue in others. It should be noted that the administrative office for this fellowship program is working to clarify the expectations on students so that accepting the fellowship is not viewed as undesirable. However, this echoes the concern in *Diversity & The Ph.D.*<sup>7</sup> related to mentoring and professionalizing experiences. In the case of some students at Institution B on this fellowship, instead of benefiting from the funding opportunity, they were drawn from opportunities to work with certain faculty and participate in professionalizing activities.

## **Future Work**

Future work on this project includes continuing these studies and expanding the studies by Grant, Rutledge, and Bramwell, and continuing research on support programs and first-hand experiences of minority students. Since attempts to hold focus groups with non-STEM doctoral students yielded low attendance, these will be revisited in order to better understand how some non-STEM departments have been successful at increasing diversity. As mentioned in the Introduction, the outcomes of these studies will include a set of educational best practices and improved policy recommendations for doctoral students in STEM disciplines. While such information will be targeted at minority students, it is expected that many recommendations will improve the graduate school experience for all students.

An online survey of STEM doctoral students at four universities is being planned and will soon be implemented. This survey will cover the graduate school application/decision process, the transition to graduate school, academic and social experiences during graduate school, and the career decision and transition process. Invited survey participants will include minority and non-minority students in a variety of STEM disciplines so that trends based on ethnicity, gender,



discipline, and school may be observed. In addition to a student survey, a similar survey of graduate school administrators and select faculty is being planned. This survey aims to better understand what faculty and administrators know about published best practices and available support services (AGEP, research society-based initiatives, etc.) related to graduate recruitment, retention, and professional development, and what has worked or not worked on their campus. For consistency, focus group and interview questions will be used as the basis of these surveys, and other related surveys will be used for additional questions and wording. Some of these related surveys include those available from Assessing Women in Engineering<sup>13</sup>, the CGS Ph.D. Completion Project, Athena Unbound<sup>14</sup>, and the University of Arizona study of factors used by students to choose to apply to a specific graduate school<sup>4</sup>.

Finally, evaluations of current programs to recruit graduate students have begun and will be expanded. By evaluating these programs, we will gain a greater understanding of their impact on a student's decision to attend graduate school, choice of where to attend graduate school, and experiences during graduate school.

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## Appendix: Questions Used for Faculty Interviews and Student Focus Groups

### I. Questions for Faculty

1. What personal qualities do you look for in an incoming graduate student?
2. What does the department do to evaluate the academic preparedness of entering graduate students?
3. Do college study habits and time management skills serve most students well in graduate school?
4. What do you do about students who do not seem adequately prepared for a particular course?
5. What are some good predictors of success in graduate school?
6. In what ways have you changed your approach to teaching and learning in recent years? Why have you made these changes? How effective have they been?
7. What problems, needs, or opportunities do you think minority graduate students face at this institution?
8. Why do you think that black, Hispanic, and Native American students are underrepresented among graduates STEM disciplines?
9. What kinds of mentoring and support activities are available for minority graduate students at this institution?
10. What recruiting activities do you think might succeed in attracting minority graduate students to this institution?

### II. Questions for Grad Students/Recent Alumni

#### A. Graduate School Decision and Preparation

1. When did you first start to think about graduate school?
2. What were key people or experiences that started you thinking about graduate school?  
[Prompt: undergraduate research, teachers, family]
3. Why did you select this institution for graduate school?

#### B. Initial Experiences

1. Did you feel you were made welcome by the department in which you are studying?  
[Prompt: early interviews, advice, activities]
2. Did you find you were academically prepared for graduate school? In what areas were you best prepared?
3. How do you see diversity (reminder: diversity=underrepresented minorities) being taken into account in the graduate student orientation and welcome events?

#### C. Academic Experiences

1. What sorts of experiences have you had with your academic and research mentors at this institution, particularly at key transition points? [Special institutional or departmental issues?]

2. How has your interest and motivation in science developed or changed since you started graduate school?
3. Did your college study habits and time management work well in grad school?

D. Personal Experiences

1. What personal qualities served you well as a graduate student?
2. What problems, opportunities, or issues have you experienced as a graduate student? [How would you compare minority and majority student experiences?]
3. What have you seen from other institutions that seemed especially useful as a means to increase their diversity? Not useful?

E. Support Services

1. Was academic and social support available?
2. How well do you view students groups as supportive of diversity and welcoming of students from diverse backgrounds? Please give examples. What more could groups do?

F. Career Decisions

1. What do you hope to do after graduate school?