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Graduate Student Socialization in Science and Engineering: A Study of Underrepresented Minorities' Experiences

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Introduction

Since the early 1970s, when the underrepresentation of females and U.S. racial/ethnic groups in the engineering professions became an exigent national concern, academia, industry, and government agencies have undertaken practices that have improved the participation of minority groups in science, technology, engineering, and mathematics (STEM). This improvement, however, has been questionable. Recently, for example, Dr. Shirley Ann Jackson has pointed to "a *quiet crisis* building in the United States"--the declining production of American scientific and technical talent "that could jeopardize the nation's pre-eminence and well-being."[1] Left unchecked, "it could reverse the global leadership Americans currently enjoy."[2] Among the priorities and actions that Jackson argues for is to nurture the graduate education of underrepresented groups, who must become an integral part of the U.S. technical workforce and may serve as role models for younger generations.

Overall, the status of students in graduate science and engineering programs has been discouraging. Data from the National Center for Education Statistics[3] show that from 1993 to 2000 the total graduate enrollment in degree-granting institutions in all disciplines increased by 9.5 percent. In contrast, graduate enrollment in science and engineering dropped consecutively from 1993 to 1998. There were slight increases in engineering enrollment in 1999 and 2000; total engineering enrollment in 2000, however, was still nearly 11 percent less than engineering enrollment in 1993. While there was consistency or increases in enrollment in earth sciences, computer sciences, and biological sciences, enrollment in the physical sciences (astronomy, chemistry, physics) also dropped consecutively from 1992 to 1998, increase slightly in 1999, and dropped again in 2000 (amounting to 14 percent less enrollment than in 1992). Mathematics enrollment declined throughout the 1992-2000 period, with 2000 enrollment reflecting a 23 percent drop from 1992.

While total graduate enrollment in science and engineering fell, current National Science Foundation[4] data show that the numbers of minority graduate students in science and engineering have increased since 1990. However, a large percentage of these African American, Hispanic, and American Indian S&E graduate students (more than 50 percent) were in the social and behavioral sciences compared to White students (39 percent) and Asian students (20 percent) in these disciplines. With regard to doctoral degree attainment, of the 17,428 doctorates earned in

science and engineering by U.S. citizens and permanent residents in 1999, 78 percent were earned by Whites, 11 percent by Asians, 4 percent by Hispanics, 4 percent by African Americans, and 0.7 percent by American Indians. African Americans earned more than half of their doctorates in non-science and engineering fields; in S&E fields, 52 percent of the doctorates earned by African Americans were in psychology and sociology. Fifty-five percent of all doctorates earned by Hispanics in 1999 were in science and engineering fields, although 29 percent of these Ph.D.s were in psychology. For American Indians, 56 percent of science and engineering doctorates in 1999 were in psychology and the social sciences.

According to Campbell, Jolly, Hoey, and Perlman, while female enrollment in graduate studies overall has risen to 55 percent of all students in the 1990s, only 27 percent of 36,010 computer science majors and 18 percent of 101,008 engineering majors are women.[5] With regard to graduate degree attainment between 1993 and 1997, women earned 27 percent of Master's degrees and 19 percent of doctorates in computer science; and 17 percent of Master's degrees and 16 percent of doctorates in engineering. Consistent with NSF data, Campbell et al. show that while African American and Latino graduates enrollment has risen in STEM fields, they comprise only between 2 and 4 percent of all graduate students in these disciplines. Percentages are similar for graduate degree attainment. African Americans, for example, comprised only 3.7 percent of all Master's degree recipients in computer science, 2.4 percent of Master's degrees in engineering, and 4 percent of doctorates in computer science. Latino students received 1.8 percent of all computer science Master's degrees, 2.7 percent of engineering Master's degrees, and 3.2 percent of computer science Ph.D.s. The numbers are even more dismal for American Indian students, with only one receiving a Ph.D. in computer science in 1997.[6]

Malcom, Van Horne, Gaddy and George[7] conclude that Black and Latino Americans are "losing ground" in science and engineering education. In their report for the American Association for the Advancement of Science, Malcom et al. found that, despite increases in the number of baccalaureate degrees in science and engineering for Blacks and Hispanics, there was an overall decline in minority graduate enrollment in STEM fields, especially first-year graduate enrollment in the natural sciences, computer sciences, mathematics, and engineering. Explanations for this decline include the attraction of lucrative careers in industry, increased debt burden from undergraduate education, and a shift in enrollment from graduate to professional schools, especially medical school.[8]

Given the questionable improvement in participation rates and continued underrepresentation of African American, Latino American, and American Indians in graduate science and engineering, it is crucial to examine more closely the factors that may be contributing to this crisis. Individual scholars and various organizations--such as the National Science Foundation, the National Action Council for Minorities in Engineering, the Commission on Professionals in Science and Technology, and the Engineering Workforce Commission--have examined trends in science and engineering education and employment, or have developed descriptive or predictive models for persistence or attrition (usually the latter). Little research, however, has been undertaken to document and understand the *qualitative* experiences that shape underrepresented minority students' enrollment and persistence in science and engineering graduate programs. Uncovering

the nuances of underrepresented minority (URM) graduate students' experiences is key to addressing issues of enrollment, persistence, and attrition. To this end, the National Consortium for Graduate Degrees for Minorities in Engineering and Science (GEM) is proposing a qualitative research project designed to understand the socialization of underrepresented minority students in STEM disciplines.

Literature Review

GEM's proposed study is placed in the context of current research about the graduate school experience in general, and the status of URM graduate students in particular. Notable is work by Nettles[9] and Nettles and Millett[10], who compared the backgrounds, educational experiences, and outcomes of Black, Hispanic, and White doctoral students. In his review of the literature, Nettles found that prior research had been inconclusive about differences in the graduate school performance of Black, Hispanic, and White doctoral students. Researchers had either limited their focus to a single discipline, failed to disaggregate minorities to examine differences between Black and Hispanic students, or focused only on a single group's performance without comparing it to other groups. In addition, little was known about the relationship of race to performance after controlling for undergraduate education. Furthermore, majoring in the same field in graduate school as in college enhances a student's experiences in his or her graduate program, but researchers had yet to examine if effects are the same for members of different racial and ethnic groups.

According to Nettles' review, research also showed that financial indebtedness was found to have no significant relationship to students' decisions about going to graduate school immediately after completing college, but the long-term effects of indebtedness for students who do not enter graduate school until several years after college are not known. Other research showed that students' social experiences while enrolled in graduate programs were believed to be the most important influences on their persistence and performance in graduate school, even to the point of mitigating the effects of undergrad education and graduate school performance. Nettles also found that research had not determined how students of different minority groups differ in their feelings and perceptions among each other and among majority students, and how these feelings and perceptions relate to performance. Finally, few specifics were available about differences in full-time attendance of Black, Hispanic and White students.

To address the limitations of research studies, Nettles surveyed and interviewed a sample size of 1352 doctoral students at four large, public research universities that were among the leading producers of Black and Hispanic doctoral recipients from 1976-1985 (Florida State University, Ohio State University, Rutgers, and the University of Maryland at College Park). This study compared and contrasted demographic characteristics (age, gender, race, socioeconomic status) of students before they entered college and graduate school; performance and academic preparation in undergraduate school; types of transitions students made into graduate school; and experiences, attitudes, and performance after enrolling in doctoral programs. The main objectives of the study was to provide a basis for the understanding of the differences in educational experiences and performance of Black, Hispanic, and White doctoral students; to

identify factors that contributed to differences among these three groups; and to develop recommendations for improving the doctoral experiences and performance of minority students.

Nettles found the following (among other things):

- Black students attended less selective institutions than White and Hispanic students did. Of the three groups, Hispanic students attended the most selective undergraduate institutions.

- Black students and women were less likely to major in the sciences at the undergraduate level.

- Hispanic students took less time off than Black and White students before beginning work on their doctoral degrees.

- Students who took the greatest amount of time off were likely to have relatively low undergraduate GPAs, were more likely to be women than men, had lower amounts of undergraduate indebtedness, and had low socioeconomic status (SES) backgrounds.

- Hispanic students were more likely than Black or White students to receive fellowships or assistantships. After background and undergraduate education were considered, it was found that Black and White students received about the same number of graduate fellowships and assistantships.

- Hispanic students were more likely than their Black or White counterparts to attend graduate school full-time.

- Of the three groups, Hispanic students had the greatest amount of social involvement (making friends easily, socializing informally with students; socializing informally with faculty; participating in clubs, organizations, and student government groups).

- In their perceptions of mentor support, Black students felt more strongly than their White counterparts did that their mentors were supportive.

Some of Nettles' findings seem counterintuitive, given recent reports about continued underrepresentation of minorities in science and engineering fields. For example, the findings that Hispanic students tend to come from more selective institutions compared to White students, and take less time off before beginning their doctoral degrees, counter findings that Latino Americans tend to enroll in less prestigious Hispanic-serving institutions (HSIs) and community colleges, and wait to enroll in graduate programs, if they enroll at all. Indeed, as a recent Educational Testing Service (ETS) report notes,

> while Whites (ages 25-29) with a four- or two-year college degree are 62 percent of those who have some college education, the percent is just 47 for Hispanics;

> more than half are starting and not earning degrees . . . findings clearly show that large numbers of Latinos finish their secondary education but fail to earn a degree.[11]

Like Nettles' study, Nettles and Millett's investigation focused on graduate students in general. They examined the human capital assets of doctoral students to show how differences in these assets relate to differences in students' progress and performance in graduate school. (Human capital included social class standing--a reflection of mother and father's educational and occupational levels--quality of schooling, finances, race, sex, and other demographic distinctions.) Nettles and Millett, however, draw out the experiences of minority students in science, mathematics, and engineering. Nettles and Millett's research involved a stratified sample of 13,160 doctoral students in 11 fields of study at 21 prestigious doctoral-granting universities. This sample was designed to select all of the African Americans, Asian Americans, Hispanics, and Native Americans, 300 randomly selected Whites, and one-half of the randomly selected international students enrolled in the 11 fields. A sub-sample of 1,891 students (114 African Americans, 382 Asian Americans, 94 Hispanics, and 1,301 Whites) comprised the science/mathematics and engineering field groupings. Students were given the Survey of Doctoral Student Experiences, Performance, and Achievement (SDSEPA), a 28-page instrument that Nettles and Millett developed to elicit data about students' backgrounds, current status and activities, academic progress and performance, attitudes, and behavior.

Nettles and Millett found clear differences in students' human capital assets between major fields and among race groups. For example, engineering doctoral students in each of the four race/ethnic group categories (White, African American, Hispanic, and Asian) had more human capital than their science and mathematics counterparts. Compared to science and mathematics graduate students, engineering Ph.D. students had parents with a higher level of education and occupation, attended the most selective colleges or universities, had a higher college GPA and GRE scores, and were more likely to have worked a job between college graduation and entrance into a graduate program. Asian and White students had greater human capital and research productivity (presenting at conferences, submitting research papers, and publishing research papers) than did Hispanics and African Americans. With the exception of mothers' occupational status, African American Ph.D. students had the lowest human capital and research productivity in science and mathematics--although nearly three-quarters of African American doctoral students in engineering submitted papers for publication, and a higher percentage were successfully publishing papers. Nettles and Millett suggest closer examination of the factors that are beneficial to African American engineering graduate students, as these might illuminate the factors that contribute to the lower success of African Americans and other minority students in science and engineering fields.

Higher education studies of graduate student socialization, which have typically focused on the development of new professors (that is, the anticipatory socialization to the academic profession that takes place during graduate school), also provide glimpses into the lives of graduate students. Austin's research[12] on the preparation of the new generation of faculty, for example, found that graduate student development is shaped by factors that take place in non-linear,

complex ways. These factors include age, educational background (i.e., liberal arts vs. science), family situation (role models, mentors in same profession), and previous employment. Development also depends on a student's locus of control (i.e., the extent to which a person perceives that he or she has power to make decisions and manage the graduate experience), sense of self-efficacy, and ability to make connections with people and opportunities.

Among Austin's conclusions:

- What graduate students are trained for is not what they want.
- They receive little guidance about [academic] careers in different types of institutions.
- They do not receive focused, regular feedback or mentoring.
- Graduate students value their interactions with peers for both social value and information shared. (Austin suggests that this finding raises questions about the faculty's engaging in serious and sustained ways with students about the graduate experience, career goals, and options.)

Study participants make several recommendations for improving graduate school socialization, including: more attention to regular mentoring, advising, and feedback; structured opportunities to observe, meet, and talk with peers; and regular and guided reflection.

Nerad and Miller examined the experiences of students in graduate and professional programs, focusing primarily on attrition and making recommendations for increasing retention.[13] This qualitative study tries to explain attrition by identifying when students leave their programs and what the characteristics of early leavers are. "Early leavers" are those who left their programs between years one and three, and "late leavers" are those who left between years four and 11. Nerad and Miller found that the biological sciences and physical sciences had lower percentages of early leavers (20 percent) and late leavers (6 percent), whereas the professional schools, the arts, and languages and literature had the highest proportion of early leavers (31, 33, and 29 percent, respectively) and the highest proportion of late leavers (14, 19, and 15 percent, respectively).

Categories of early leavers include: 1) those who did not intend to earn a Ph.D. (enrolled in doctorate to get financial support to earn a Master's degree); 2) field switchers; 3) institution switchers; 4) mismatched students (mismatch of interests and those of the program); 5) frustrated expectations (with regard to student life); and 6) student professionals (those who saw the Ph.D. as a means toward further professional advancement but had a difficult time with the academic culture). Categories of late leavers include: 1) the undecided student; 2) those with poor student-advisor relationships; 3) those with lack of financial support; and 4) those who perceived a chilly departmental climate. Similar to the recommendations made by Austin's research participants for improved retention, Nerad and Miller propose that institutions do a better job of

monitoring students' progress, provide more advising and mentoring, and implement orientation and career preparation programs, and other socialization experiences.

Lovitts'[14] study of "the invisible problem" of graduate student attrition scrutinizes the organizational culture of graduate school and the process of graduate education. Lovitts argues that faculty and administrators tend to place the burden of attrition on students, rather on departmental and institutional attitudes and practices. Examining the social structures of graduate school, Lovitts found that attrition is often due to students' lack of information about graduate school, absence of community, disappointment with the learning experience, and poor advisor-student relationships. Non-completers, however, exit their programs without giving voice to discontent, which denies the members of an institution the opportunity for feedback and redress of underlying causes. Lovitts recommends that researchers conduct more longitudinal studies of persistence, rather than retrospective studies of attrition such as hers, as this approach to the problem can capture more time-relevant information about students' full range of experiences.

Some notable examples of qualitative research related to minority graduate education include Brazziel and Brazziel[15], who identified factors that influence the success of institutions in sending underrepresented minorities into Ph.D. science and engineering studies. Brazziel and Brazziel's 2001 study also examined the perspectives of students themselves, who shared concerns about the ability to finance Ph.D. studies, lack of knowledge about the rewards of doctoral employment, and uncertainty about post-graduation employment. Similarly, Etzkowitz, Kemelgor, and Uzzi found that factors such as geographic mobility, personal considerations (e.g., marriage, children), obtaining information about important career moments (e.g., establishing a lab, preparing for tenure), connections to information sources, advising, professional identity, daily interactions, generational discrepancies, time conflicts, and quality of departmental relationships were important factors that affected men and women's experiences differently.[16] Overall, however, numerous variables that have an impact on graduate student persistence, particularly for underrepresented minorities and women, have been understudied or neglected altogether.

Research Questions

Given the limited research that delves deeply into the experiences of graduate students in science and engineering, especially from underrepresented racial and ethnic groups, the National GEM Consortium (GEM) is proposing to undertake a multi-methods research project to understand more clearly the phenomenon of graduate student socialization. Specifically, the principal investigators will ask the following research questions:

1. What is the nature of graduate student socialization for African American, Latino American, and American Indian students in science and engineering disciplines?

2. What elements of their socialization affect the persistence or attrition of underrepresented minorities (URMs) in their graduate programs?

3. What are the similarities and differences in the graduate student socialization experiences among African American, Latino American, American Indian, White Anglo/European-Americans, and foreign nationals?

Conceptual Framework

Concepts about socialization (or "organizational socialization") are useful for framing research and interpreting findings about the experiences of graduate students. Socialization is understood most generally as "the process by which individuals acquire the attitudes, beliefs, values and skills needed to participate effectively in organized life."[17] It is "learning the ropes" of a particular job, the important passage of "breaking in" to organizations in which individuals "experience and often commit themselves to a distinct way of life complete with its own rhythms, rewards, relationships, demands and potentials."[18]

In general, scholars have conceptualized socialization in four ways, as: 1) a *series of stages* through which individuals progress; 2) an array of institutional *strategies,* formal and informal interventions (*what* the organization *does* to individuals); 3) *desired outcomes*, e.g., commitment, identification; and 4) *turning points*. Despite these different conceptualizations, scholars tend to agree that socialization is a process of communication/interaction among members of an organization.

Turning points analysis provides a framework that may be especially helpful in a study of graduate student socialization. Two empirical studies that focus on graduate student socialization adopt this approach. Communication scholars Bullis and Bach[19] and Kirk and Todd-Mancillas[20] offer turning points analysis as an alternative to the typical stage model, stating that it is more sensitive to multiple variables in socialization because it describes specific points of change. Baxter and Bullis[21] define turning points as events or occurrences that are associated with change in a relationship. This conceptualization is reminiscent of Baldwin and Blackburn's critical events framework[22], although turning points include negative as well as positive events; and, while critical events in Baldwin and Blackburn's study were typically formal benchmarks (e.g., sabbaticals, workshops, grants, promotions, role changes), many turning points involve informal activities. In addition, Dunn et al. suggest that, because turning points analysis gives primacy to individuals' perceptions, "it provides a more phenomenologically anchored account" of socialization."[23]

Bullis and Bach examined: 1) what events, in the perception of graduate students, were significant turning points, 2) whether or not events coincided with particular socialization stages, and 3) to what degree turning points affected graduate students' identification with the organization. Using the Retrospective Interview Technique (RIT), Bullis and Bach asked students to identify and plot on a graph turning points that affected their levels of identification with their department during their first year of graduate school. During interviews (the first one conducted four months after the start of the academic year, and the second conducted four months later), students provided details about their turning points and changes in identification.

Bullis and Bach found 14 turning points to be pivotal in graduate student socialization. These are outlined below, in order based on frequency of reports (with those marked by asterisks indicating a tie in frequency of reports).

1. Sense of community (an overall sense of identification with the department)
2. Approaching formal hurdles (completing courses, jumping through "hoops")
3. Socializing (informal conversations with graduate students or faculty outside the classroom)
4. * Disappointment (when organization or its members were less than perfect than originally perceived)
5. * Receiving formal recognition (positive informal feedback)
6. ** Gaining formal recognition (receiving awards, grades, being asked to work with professor)
7. ** Settling in (establishing a routine, becoming comfortable with role as graduate student)
8. Jumping informal hurdles (gaining confidence)
9. Alienation (perceived lack of community, internal sense of difference between self and others)
10. *** Doubting one's self (experiences that lead to self-questioning)
11. *** Getting away (decreased physical, emotional involvement with department; associated with greatest decrease in identification)
12. Representing the organization (interacting with others outside department as a representative of department)
13. Protecting one's self (conscious move to disassociate from department to feel less overburdened by requirements or social contacts)
14. Moving in (establishment of physical territory or space–mailbox, office, carrel–and becoming familiar with the surroundings)

Kirk and Todd-Mancillas replicate and advance Bullis and Bach's research by investigating graduate students' commitment to advanced studies, as well as socialization and identification with their departments. Their sample of 29 graduate students identified 171 turning points, 161 of which were coded and assigned to three broad categories: 1) intellectual identity, which refers to events that affect an individual's self-evaluations of competence as teacher and student, and in relation to peers; 2) socio-emotional identity, which refers to acceptance, belonging, and emotional support between and among peers and superordinates; and 3) occupational identity, which refers to events involving organizational structure and climate (e.g., awareness of one's "place" in the department, department policies that support or failed to support student).

Kirk and Todd-Mancillas' three broad categories of graduate student identity, as well as Bullis and Bach's turning points of graduate student socialization, call attention to variables in day-to-day socialization that are often understudied or neglected in research about academic/ departmental culture. GEM's research design will focus on examining whether underrepresented minority graduate students identify similar turning points, and perhaps others. The proposed study will also delve more deeply into the nuances of these turning points, and perhaps better

describe and understand the elements of effective socialization for URMs in science and engineering programs.

Research Design

GEM is proposing an exploratory, mixed-methods study that will include a survey of graduate students in science and engineering at various universities nationwide. The survey instrument will be developed based on data gathered from qualitative interviews with a sample of graduate students. The study will also include qualitative interviews, based on phenomenological inquiry, of a sample of URM graduate students from these universities. Interviews will be designed to tap into individuals' perspectives, particularly their most immediate experiences of graduate school.

Phenomenological Inquiry The phenomenological method resonates well with the conceptual framework described above. Husserl, who developed the philosophy underlying this method, believed that phenomenology could reveal truths about human experience through methods of inquiry that were as rigorous as the scientific method. According to Husserl, all claims to truth are disclosed within the realm of immediate experience, "that substratum of experience whose aspects are wholly contained within consciousness."[24] Husserl considered it important that investigations into human experience do not presuppose the legitimacy of any particular theory, such as logic or deductive proof, in explaining the experience. He sought, rather, to use data of immediate experience because its availability was certain and unquestionable.

The phenomenological method attempts to describe and interpret the more complex and hidden facets of experience. The challenge is to reflect upon an experience repeatedly in order to obtain accurate and comprehensive descriptions of it and discover its hidden meaning. Phenomenology, then, is an especially appropriate method for gaining insight into the experiences of underrepresented minority graduate students, because it "attempts to eliminate everything that represents a prejudgment, setting aside presuppositions and reaching a transcendental state of freshness and openness."[25]

Sampling Strategy A sample of five to eight institutions--perhaps from the top 10 universities that enroll the most GEM fellows--will be considered: Georgia Tech, University of Michigan, Purdue University, Stanford University, North Carolina State University, Michigan State, Northwestern University, University of Maryland-College Park, University of Illinois-Urbana Champaign, and North Carolina A&T State University. This would allow for a variety of minority student perspectives. To allow for comparisons of disciplinary cultures, surveys and interviews of graduate students enrolled in four fields of study will be conducted: biological sciences, engineering, mathematics, and physical sciences (including chemistry and physics). Finally, a purposive sample of graduate students, comprised of African American, Latino, American Indian, Asian American, and White students, will be invited to participate in individual interviews.

Interviews To keep the interviews fairly open-ended and unstructured, the PI will develop a broad set of questions to facilitate the gathering of vital, substantive descriptions of participants' experiences.[26] Questions will focus on turning points that participants encounter throughout their graduate studies. Organizational studies scholar Jablin[27] suggests that the organization and its management, specific supervisors, co-workers/colleagues, and social networks are especially significant sources of communication. The types and nature of discourse and discourse relationships that graduate students engage in may involve deans, department chairs, faculty, off-campus professional colleagues, peer students, spouses or partners, children, friends, etc. Thus, the PI will focus on variables that participants may identify as significant to their life as graduate students.

Timeline GEM proposes a three- to five-year study of graduate student socialization. This will allow for investigation of students' experiences at critical periods during graduate school. Thus, students will be surveyed and interviewed 1) during the first year or two of coursework, 2) during the comprehensive examination period, 3) during the dissertation proposal phase, and 4) during the dissertation research and writing phase.

Data Analysis Phenomenological data analysis involves imaginative variation, examining and interpreting the different manifestations of a given phenomenon by using imagination, varying the frames of reference, using polarities and reversals, and approaching the phenomenon from diverse perspectives.[28] The goal of this systematic process is to discover the essence of the phenomenon--that which remains unchanged throughout the various manifestations of the phenomenon.

Conclusion

Documenting and analyzing trends in the participation of underrepresented minorities in science and engineering education is useful, especially for identifying particular areas where recruitment may be improved. More attention, however, needs to be paid to the retention of students of color in these disciplines. Research must be undertaken to understand more fully the *qualitative* experiences that shape underrepresented minority students' enrollment and persistence. Moreover, researchers must tap into the perspectives of students themselves, as they are best equipped to provide insight into the decisions they make about their educational journey. Uncovering the nuances may eventually help faculty, administrators, and other stakeholders address more effectively the issues related to graduate student socialization, and ultimately ensure the success of underrepresented minorities.

Bibliography

[1] Jackson, S. (2002). *The Quiet Crisis: Falling Short in Producing American Scientific and Technical Talent.* Washington, D.C.: Building Engineering & Science Talent (BEST), p. 1.

[2] Jackson, S. (2002). *The Quiet Crisis: Falling Short in Producing American Scientific and Technical Talent.* Washington, D.C.: Building Engineering & Science Talent (BEST), p. 1.

[3] National Center for Education Statistics. (2002). *Digest of Education Statistics, 2002.* Washington, D.C.: Department of Education.

[4] National Science Foundation. (2002). *Women, Minorities, and Persons with Disabilities in Science and Engineering.* Arlington, VA: The National Science Foundation.

[5] Campbell, P., Jolly, E., Hoey, L., & Perlman, L. (2002). *Upping the Numbers: Using Research-Based Decision Making to Increase Diversity in the Quantitative Disciplines.* Report Commissioned by the GE Fund. Newton, MA: Education Development Center.

[6] Campbell, P., Jolly, E., Hoey, L., & Perlman, L. (2002). *Upping the Numbers: Using Research-Based Decision Making to Increase Diversity in the Quantitative Disciplines.* Report Commissioned by the GE Fund. Newton, MA: Education Development Center.

[7] Malcom, S., Van Horne, V., Gaddy, C., & George, Y. (1998). *Losing Ground: Science and Engineering Education of Black and Hispanic Americans.* Washington, D.C.: American Association for the Advancement of Science.

[8] Malcom, S., Van Horne, V., Gaddy, C., & George, Y. (1998). *Losing Ground: Science and Engineering Education of Black and Hispanic Americans.* Washington, D.C.: American Association for the Advancement of Science.

[9] Nettles, M. (1990). *Black, Hispanic, and Doctoral Students: Before, During, and After Enrolling in Graduate School.* Report of the Minority Graduate Education (MGE) Project. Princeton, NJ: Graduate Record Examinations Board and Educational Testing Service.

[10] Nettles, M., & Millett, C. (1999). *The Human Capital Liabilities of Underrepresented Minorities in Pursuit of Science, Mathematics, and Engineering Doctoral Degrees.* National Center for Postsecondary Improvement Technical Report Number 2-13. Stanford, CA: NCPI, Stanford University School of Education.

[11] Barton, P. (2003). *Hispanics in Science and Engineering; A Matter of Assistance and Persistence.* Policy Information Report. Princeton, NJ: Educational Testing Service.

[12] Austin, A. (2002). Preparing the Next Generation of Faculty: Graduate School as Socialization to the Academic Career. *The Journal of Higher Education 73* (1), 94-122.

[13] Nerad, M., & Miller, D. (1996). Increasing Student Retention in Graduate and Professional Programs. *New Directions for Institutional Research, No. 92*, 61-76.

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

[15] Brazziel, M., & Brazziel, W. (1995). *Distinctives of High Producers of Minority Science and Engineering Doctoral Starts.* Report of Research Grant No. RED-9355867, National Science Foundation.

---- Brazziel, M., & Brazziel, W. (2001). Factors in Decisions of Underrepresented Minorities to Forego Science and Engineering Doctoral Study: A Pilot Study. *Journal of Science Education and Technology, 10* (3), 273-281.

[16] Etzkowitz, H., Kemelgor, C., & Uzzi, B. (2000). *Athena Unbound: The Advancement of Women in Science and Technology*. Cambridge, United Kingdom: Cambridge University Presss.

[17] Dunn, R., Rouse, L., & Seff, M. (1994). New Faculty Socialization in the Academic Workplace. In J.C. Smart (Ed.), *Higher Education: Handbook of Theory and Research, Vol. X.* Bronx, NY: Agathon Press, p. 375.

[18] Van Maanen, J., & Schein, E. (1979). Toward a Theory of Organizational Socialization. In B.M. Staw (Ed.), *Research in Organizational Behavior, Vol. 1* (pp. 209-264).. Greenwich, CT: JAI Press, p. 210.

[19] Bullis, C., & Bach, B. (1989). Socialization Turning Points: An Examination of Change in Organizational Identification. *Western Journal of Speech Communication, 53*, 273-293.

[20] Kirk, D., & Todd-Mancillas, W. (1991). Turning Points in Graduate Student Socialization. Implications for Recruiting Future Faculty. *The Review of Higher Education, 14* (3), 407-422.

[21] Baxter, L., & Bullis, C. (1986). Turning Points in Developing Romantic Relationships. *Human Communication Research, 12*, 469-494.

[22] Baldwin, R., & Blackburn, R. (1981). The Academic Career as a Developmental Process: Implications for Higher Education. *Journal of Higher Education, 52* (6), 598-614.

[23] Dunn, R., Rouse, L., & Seff, M. (1994). New Faculty Socialization in the Academic Workplace. In J.C. Smart (Ed.), *Higher Education: Handbook of Theory and Research, Vol. X.* Bronx, NY: Agathon Press.

[24] Freeman, C. (1980). Phenomenological Sociology and Ethnomethodology. In J. Douglas (Ed.), *Introduction to the Sociologies of Everyday Life* (pp. 113-154). Boston, MA: Allyn and Bacon.

[25] Moustakas, C. (1994). *Phenomenological Research Methods.* Thousand Oaks, CA: Sage Publications, p. 41.

[26] Moustakas, C. (1994). *Phenomenological Research Methods.* Thousand Oaks, CA: Sage Publications.

[27] Jablin, F. (1987). Organizational entry, assimilation, and exit. In F.M. Jablin, L.L. Putnam, K.H. Roberts, & L.W. Porter (Eds.), *Handbook of Organizational Communication: An Interdisciplinary Perspective.* Newbury Park, CA: Sage Publications.

[28] Moustakas, C. (1994). *Phenomenological Research Methods.* Thousand Oaks, CA: Sage Publications.

Biography

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