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Faculty-graduate student mentoring relationships: mentors' perceived roles and responsibilities

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Abstract Scholars have demonstrated that one of the most important factors that graduate students use to ascertain the quality of their educational experience is their relationship with faculty. Research on faculty-graduate student mentoring relationships has provided valuable insights about effective practices that foster the success of graduate students. While these relationships are beneficial to both the mentor and mentee, the literature on faculty-student mentoring relationships primarily has focused either on mentoring relationships with undergraduate students or on specific types of interactions between graduate students and faculty. This article adds to the existing literature by exploring faculty mentors' perceived roles and responsibilities in their mentoring relationships with their graduate students. Data were drawn from interviews with 15 underrepresented faculty members from one research university. Findings reveal that faculty-graduate student relationships can be described by three broad descriptors that characterize participants' roles and responsibilities—faculty members as Allies, Ambassadors, and Master-Teachers.

Keywords Faculty · Graduate students · Mentoring · Higher education

There is general consensus among scholars that faculty-graduate student mentoring relationships are a significant aspect of the graduate education experience that foster student success (Heinrich 1995; Patton 2009; Patton and Harper 2003). Such relationships benefit students in numerous ways, which include increased employment opportunities (Bova 2000; Cameron 1978), development of professional skills (Bova and Phillips 1984), and professional growth (Harris and Brewer 1986), among others. Without a doubt, research on faculty-graduate student (F-GS) relationships has provided extremely valuable insights about effective practices that foster the success of graduate students in general (Komarraju et al. 2010; Wilde and Schau 1991), and underrepresented students specifically

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(Patton 2009; Swail et al. 2003). While these relationships are beneficially to both the mentor and menteé, the literature on faculty-student mentoring relationships has primarily focused either on undergraduate students (Anderson et al. 1995; Wallace et al. 2000), on specific types of interactions between faculty and graduate students such as doctoral advisement issues between females or between males and females (Heinrich 1995; Schroeder and Mynatt 1993), or on F-GS mentoring relationship from the student perspective (Wilde and Schau 1991). What has yet to be discussed are the broadly perceived roles and responsibilities of faculty members in a *graduate student* mentoring relationship.

The purpose of this article is to provide a foundation from which to extend this body of literature by discussing what faculty perceive to be the roles and responsibilities of both themselves and their graduate students. While the mentoring literature has offered a multitude of approaches and recommendations for faculty who mentor underrepresented students, data show that doctoral degree attainment for those in underrepresented groups is significantly low. For instance, of the 33,350 doctoral degree recipients in science and engineering disciplines in 2008, only 1,160 or 3.4% were Hispanic (National Science Foundation 2008). A comprehensive examination of the perceived mentoring roles and responsibilities of minority faculty may help increase doctoral degree attainment of underrepresented graduate students. Data are drawn from a study that sought to understand the work motivation of 15 underrepresented faculty members in STEM-related (Science, Technology, Engineering, Mathematics) disciplines. The discussion here focuses on the mentoring aspects of faculty work life. I begin by providing an overview of the literature related to the importance of faculty-student mentoring relationships, specifically with regard to student retention and success, and illustrate how motivation issues can be linked to F-GS interactions. I discuss the challenges and benefits associated with F-GS mentoring relationships before moving into a discussion about the research methods and study findings. Data are presented thematically to provide a cross-section of the various faculty roles participants played. Finally, I analyze findings within a F-GS mentoring framework and conclude with a discussion of study implications, drawing upon the literature on F-GS mentoring relationships as a contextual framework.

Minority students and faculty in science and engineering

Before examining the complexities related to F-GS mentoring relationships, it is important to provide readers a broad sense of the issues facing both underrepresented faculty and students in the STEM disciplines. To be sure, the United States has been able to attract top science and engineering faculty from around the world; yet, has been less successful with regard to minority faculty as well as Hispanic and African-American students. Even more problematic is the fact that, "The percentage of tenure-track faculty from underrepresented minority groups at postsecondary institutions is significantly lower than the percentage of students from underrepresented minority groups at these institutions" (National Science Board 2004, p. 2).

Similarly, a 2007 national report of Black, Hispanic, and Native American tenured/tenure-track faculty in the "Top 50" science and engineering departments stated that females and minorities are significantly underrepresented in these disciplines (Nelson 2007). As Weinberg (2008) asserts, "it is well known that women and URM [underrepresented minorities] continue to be underrepresented in the STEM fields as students and as faculty" (p. 381). An issue of concern with regard to the low representation of minority faculty in the STEM disciplines pertains to the difficulties institutions will face in

recruiting minority students into the sciences and engineering, and retaining them through graduation when minority faculty representation is low. In other words, such circumstances can have a detrimental effect on the mentoring of minority students by faculty of color (National Science Board 2004).

Faculty-graduate student mentoring relationships

An important feature of most graduate training programs is that, more often than not, graduate students experience a significant level of contact with faculty members. In fact, graduate students "consider their relations with faculty members to be one of the most important factors in determining the quality of their educational experience" (Schroeder and Mynatt 1993, 556). Mentoring relationships between faculty and students are particularly important in graduate school in that they are the vehicles from which students are socialized into their respective disciplinary cultures (Becher 1989). Research has demonstrated that faculty-graduate student (F-GS) relationships play an integral role in shaping graduate students' research training, their professional identity, and career dedication in addition to providing socialization into academe (Bova 2000; Harris and Brewer 1986; Schroeder and Mynatt 1993).

Scholars also have found that mutual support and comprehensive relationships (i.e., those that extend outside the academic environment) are two of the most important factors that contribute to successful mentoring of graduate students (Johnson and Nelson 1999; Wilde and Schau 1991) in both formal and informal settings (Lee 1999). Which is to say that successful F-GS mentoring relationships require extensive efforts by both parties to create a partnership that is mutually beneficial to the faculty mentor and the graduate student menteé. In their study of graduate students' perceptions of mentoring, Wilde and Schau (1991) found that students reported career and psychological components as beneficial to their mentoring experiences, in addition to more general benefits both for themselves and their mentors. Komarraju et al. (2010) found, "Colleges and universities that actively foster close and frequent contact between their students and faculty members are more likely to reap a host of benefits from such initiatives" (332). Yet, Stanley (2006) asserts, "more work needs to be done to ascertain the nature and effectiveness of mentoring relationships" (705).

Faculty-graduate student relationships have been examined in a variety of ways. Scholars, for instance, have explored these relationships by focusing on particular interactions between students and faculty, some of which have been found to be more beneficial than others (Ei and Bowen 2002). For example, Christensen and Menzel (1998) found that verbal and non-verbal immediacy behaviors—such as smiling, a relaxed posture, providing positive feedback, and directly addressing students by name—during faculty-student interactions influence students' state motivation. In her study of doctoral advising relationships between female faculty and students, Heinrich (1995) demonstrated how power dynamics influenced the kinds of advising students received and the perceptions they held about their advising relationship with their mentors. Wilde and Schau (1991) found that male and female students perceived of their mentoring relationships with their professors differently. Both sexes observed of a strong psychological component to the mentoring relationships, but female students perceived of an additional component, which the authors suggests is evidence of broad-based interactions between mentor and menteé outside of the work environment.

Ethnic/cultural backgrounds as well as gender also can influence the types of mentoring interactions students prefer (Hagedorn et al. 2000). Schroeder and Mynatt (1993) revealed how female graduate students often felt ignored, invisible, and dismissed by their male faculty advisors. Evans and Fisher (2000) found that frequent interactions with faculty who require hard work are a strong predictor of learning for Asian/Pacific Islanders and Mexican–American students. In her study of African-American female graduate students, Patton (2009) illustrated how her participants preferred having an African-American female mentor because they "would have the capacity to relate to them in unique ways" (530). Graduate students from underrepresented groups, however, have difficulty finding suitable mentors with similar backgrounds that can provide the proper academic and social support because of their small numbers (Patton and Harper 2003).

Given that faculty participants were drawn from STEM fields, certain disciplinary norms are important to discuss. In previous work (Lechuga, under review), I demonstrate how the culture of specific STEM disciplines often require faculty to carefully balance the type and degree of input they provide to junior faculty (underrepresented or not) because the cultural environments in these disciplines views mentoring in ways that differ from faculty in other fields. For example, participants expected a high level of autonomy from their junior faculty and the notion of "over-mentoring" was consistently mentioned. Thus, one can argue that such disciplinary norms would trickle down to the faculty-graduate student mentoring relationships. To better understand specific areas of importance with regard to F-GS mentoring relationships, I offer findings that focus on key components of such relationships from the perspective of 15 underrepresented faculty members. My intent is to provide a foundation from which to expand our knowledge about mentors' perceived roles and responsibilities within F-GS mentoring relationships.

Methods

Naturalistic inquiry

This study utilized a qualitative methodology to explore work life issues of underrepresented faculty members in STEM-related (science, technology, engineering, and mathematics) fields. I utilized a constructivist paradigm of naturalistic inquiry that allowed for the co-construction of knowledge between myself and study participants. Naturalistic inquiry is based on the assumption that knowledge exists within the meaning that is attached to the phenomenon under examination (Lincoln and Guba 1989). Thus, an understanding of F-GS mentoring relationships can be constructed from the perceptions of individuals involved in this process; in this case faculty mentors. As such, data were drawn from semi-structured interviews with 15 faculty members from one research university located in the southwestern United States. I relied on semi-structured interviews as the primary data collection mode to provide an in-depth examination of mentoring relationships between faculty and graduate students, and to allow for variations in participants' responses and researcher probes (Patton 1990).

Data collection and participants

I selected participants through a purposeful sampling of tenured and tenure-track Latino faculty members in STEM disciplines. As previously mentioned, the primary focus of this study was on work motivation issues pertaining to underrepresented faculty in these fields.

I focus here on mentoring aspects of faculty work life. Potential participants were identified using publicly available data on the university's website. Fifty-three email invitations were sent to faculty members in the Biological Sciences, Computer Sciences, Engineering, and Mathematics departments, of which I received 21 responses. Scheduling conflicts allowed for only 15 of the 21 respondents to be interviewed. Faculty members were evenly distributed by rank, i.e. 5 Assistant, 5 Associate, and 5 Full professors. Interviews took place in participants' offices or laboratories, ranged from 50 to 90 min in length, with the majority lasting approximately 60 min. Interviews were audio taped and transcribed for analysis. Subsequent communication took place either by email or by telephone for purposes of seeking clarification of data and/or to probe for additional data that would allow for a more thorough analysis. Participant time constraints did not allow for multiple interviews to take place. The study site was chosen primarily for two reasons. First, the institution is a member of the Association of American Universities, a 63-member association of the top research universities in the US and Canada. And second, many of the university's STEM programs from which participants were housed, consistently rank among the top within public US universities. Most recently, the College of Engineering was ranked among the top 10 in the 2010 US News & World (Table 1).

Analysis

Data were subject to a line-by-line analysis and were initially coded thematically based on the concepts and experiences participants discussed. For example, a quote that described how a participant became aware of his students lack of analytical skills was simply coded as "skills". I analyzed initial codes to develop categories that spoke to broader topical areas, and used the constant comparative method during data analysis (Glaser and Strauss 1967; Strauss and Corbin 1990). Which is to say that interview data were continuously analyzed and compared to one another, and categories were integrated in numerous ways so as to offer multiple interpretations of the data to allow for "thick description". After grouping data by category, I focused my analysis on refining each category before "re-assembling" data into broad themes (Strauss and Corbin 1990). Four themes emerged from that data analysis process, which will be subsequently discussed. Trustworthiness (Lincoln and Guba 1989) was accomplished by reviewing multiple data sources, evaluating

Table 1 Distribution of faculty participants by discipline and rank

Number of participants	Discipline	Rank		
		Assistant	Associate	Full
4	Biological Sciences	1	3	–
1	Computer Science	1	–	–
1	Aerospace Engineering	–	1	–
2	Chemical Engineering	–	–	2
1	Civil Engineering	1	–	–
2	Electrical Engineering	1	1	–
1	Industrial & Systems Engineering	–	–	1
2	Mechanical Engineering	1	–	1
1	Mathematics	–	–	1
Total-15		5	5	5

data across interviews, and rechecking data with participants during and after the data collection period. Other data sources included publicly available demographic information about students and faculty, information gathered from department, college, and university websites, as well as university reports from the institution's office of assessment and office of admissions. This reassured that data were not misread or misinterpreted (Merriam 1998). Moreover, this process allowed me to "examine conclusions (assertions, claims, etc.) from more than one vantage point" (Schwandt 2001, 257) and to ensure that findings were "worth paying attention to" (Lincoln and Guba 1989, 290).

Limitations

As with most qualitative research, findings cannot be generalized (Lincoln and Guba 1989). The relatively small sample size limits the findings and recommendations one can suggest; nonetheless, care was taken to ensure that the stories told to me by faculty were interpreted in ways that reflect their own experiences. As an underrepresented faculty member of Latino decent, I took care in keeping my biases in check with regard to participants' experiences as faculty members in a predominately White institution. After each interview I took 30 min to write and reflect on the participants' experiences, being careful not to interpret their words through my lens as a faculty member of color to make certain to keep a balanced perspective. Given that the research site consisted of one research university, it would be incorrect to assume that the research findings would apply to other similar (or different) types of institutions.

Findings

I would like to begin by offering broad data that pertain to the type and degree of mentoring graduate students received based on their faculty mentor's rank, as well as discuss differences in mentoring received by students in terms of their race and/or ethnicity. As previously mentioned, faculty participants were evenly distributed amongst rank. Thus minor differences in the types of mentoring graduate research assistants received varied slightly based on whether the mentor was tenured. Junior (untenured) faculty expected their research assistants to have the ability to work autonomously, to have high computational and mathematical skills, and to take initiative. Junior faculty focused more heavily on developing these areas with their graduate students. Tenured faculty had similar expectations, but also seemed to focus on developing their graduate students' abilities to present at national and international conferences, to network with senior faculty from other institutions and to learn how to create their own networks in general. Lastly, tenured faculty focused on developing their students' social skills and their ability to relate well to other scholars in non-academic ways.

With regard to race and ethnicity, all faculty participants worked with graduate research assistants from underrepresented groups. Faculty with large laboratories, supported by large amounts of external funds, usually had many research assistants from underrepresented groups—Asian and Latino students made up the majority. Although, white American males are considered underrepresented students in the certain STEM fields such as engineering, faculty mentored them in similar ways. The major difference being that the degree of self-efficacy, especially in the Latino students, was much lower when compared to domestic White males. As such, Latino faculty participants spent additional time mentoring Latino students in ways to increase their confidence in their abilities to succeed in their academic endeavors.

Discussions with faculty centered around four areas of importance that illustrate the roles and responsibilities associated with F-GS mentoring relationships, as perceived of by participants. The first theme, *Faculty as Advisor,* speaks to issues regarding faculty mentors as a source of academic advice and personal support or counsel. Next, *Faculty as Instructor* relates to an awareness to create formal or structured learning situations to help graduate students develop particular skills. The third theme, *Faculty as Employer,* refers to a component of the F-GS relationship that resembles that of a supervisor and staff member. And the final theme, *Faculty as Agent of Socialization,* reflects the notion of faculty members as a socializing group, assisting in the development of students' professional skills and initiating them into the norms and values of their respective disciplines.

Faculty as advisor

Faculty participants viewed academic guidance as an integral component of their work, which is to say that faculty felt a responsibility to ensure that their students were well prepared academically. A mathematics professor explained that he was particularly sensitive to the academic needs of his high achieving underrepresented graduate students, and took steps to make certain they were enrolled in courses that appropriately matched their knowledge and skill levels.

> I think it has to do with catching up a little bit with the classes, and that involves many things. One is that they are selecting the right classes because, you know, they may have been at the top of their [high school] class, so they've skipped a few undergraduate classes.

He continued by stating, "You may think you know what you need whereas that, sometimes, is not always true." Faculty also spoke about the importance of making sure students received a wide range of skills and training. "I can identify students that are in an early stage of their studies and mentor them and advise them in their course of study…[to] be sure that they have a nice breadth of knowledge and so on."

Offering academic guidance was one component of the *advisor* responsibility; yet, an area that participants discussed more often pertained to a sense of concern for their students psychological and emotional health, and overall wellbeing. An assistant professor of engineering aptly summarized participants' assessment of the advising component of the F-GS relationship. "There are so many issues that, I mean it becomes a very interesting advising experience that goes beyond the academic relationship…" Some faculty expressed the importance of ensuring that their students were physically healthy.

> You start learning about how well they are. I mean, [by asking] "How can I help you? Are you exercising? Are you eating well? I see you gained weight in the last year, are you doing okay?"….You do want your students to feel great so that they can be very productive.

Others discussed ways in which they made certain that their underrepresented graduate students were emotionally well adjusted. "We always try to be reassuring, and contact them and make sure [they] did or didn't do so good in this, but [we'll say] 'Let's try to find a reason, and don't feel bad because you are not the only one'". A faculty member explained that he understood the importance that family plays in the Latino culture. He explained that, although his work could be impacted, he made certain allowances to ensure the psychological wellbeing of his research assistants.

> I have people from Colombia, for instance. And every Christmas they disappear at the beginning of December and at the beginning of January they are back, which is a little too long. But they would not be able to survive. It's like plants, if you deprive them from light then they die, you know? They need it…

He explained that, as a Latino, he understood the cultural importance of remaining connected to family and friends. "The culture you know, they are closer to each other and being away, then it becomes of factor that one cannot neglect."

Faculty as instructor

Faculty participants often discussed structured or formalized instructional activities they offered their students outside of the classroom. An engineering professor explained that his graduate students often asked him about what it means to seek a Ph.D. At their request, he began providing new graduate students with an overview of his work expectations.

> The graduate students, they ask me to give a seminar on how to get this work done. Many students have the idea that, for example, to get a Ph.D. the first two years they take class work and the third year they are going to do research. And that's not true.

A mathematics professor expressed a similar approach taken by his department with regard to structured mentoring of graduate and postdoctoral students. He spoke about formal mentoring seminars that senior faculty conduct to assist their students in various ways. "We have little seminars [and] we engage [postdocs and graduate students] into those seminars and that works well." He discussed how the seminars cover many different aspects of scholarly work life. "[Senior faculty] help them in their processes of learning, how to handle the profession, how to write grants, how to conduct a job interview, and all the aspects of the profession."

An engineering professor stressed the importance of teaching engineering students particular "soft" skills such as interpersonal communications, an apparent priority for some engineering accrediting organizations. "Since the year 2000, the accreditations boards have asked us to give students the tools that they need to succeed in the twenty first Century, and those are not just for them to take classes in engineering and mathematics." He explained that faculty have created formal sessions where their students "also learn other skills that we call soft skills…those imponderables. This is something that we give the students." He added, "Many of [these skills] are the skills that industry needs—functional and keen [employees]. So, engineering [education] steadily covers their ability to communicate effectively."

In discussing the types of formalized or structured learning opportunities faculty created for their students, the overarching goal was to prepare students to function successfully in the workplace. An engineering professor similarly provided his students with a particular set of research skills to perform more effectively in the lab. "We have less and less Ph.D.s being prepared in the analysis [component]. They would like more numerical work and a systems approach, so I have been doing a lot of that." Others spoke of formal structures that were being created to help mentor underrepresented graduate students through their programs.

> I can tell you also what we are doing as far as minorities and underrepresented groups are concerned. We, actually right now, we are creating a mentoring sub-committee, a graduate committee, about mentoring…We have special mentoring strategies for the minorities and underrepresented students and this is one purpose.

He explained that the formal mentoring program was currently being supported by a federal grant, but he and other faculty members want "to make sure that [it's] sort of permanent fixture of the graduate program, regardless of having this or that grant or anything like that."

Faculty as employer

Faculty members, in general, created work environments in which their graduate students were given major responsibilities, yet were expected to work under minimal supervision. Here, the relationship between faculty and graduate student takes a different tone, one in which clear distinctions were made with regard to the roles and responsibilities of the faculty mentor and their graduate student(s). A biology professor explained, "Every student that works for me, I consider him or her to be responsible and I treat them as such. I am not in the business of spoon feeding or telling them what to do." He described the qualities he considers to be most important when hiring potential research assistants explaining that "the ability of the individual to perform independent work and to disseminate writing … are key for me". An electrical and computer engineering professor described how he enjoyed assisting his students with their research duties, but could only do so much before relying on them to work on their own. "You get to a point where most of the work is being done by your Ph.D. students. You are advising them and helping them in the process, but you cannot do more because you have too many things to do." He, and others, consistently mentioned the importance of having graduate students that could take direction well and work efficiently and independently, as illustrated by the following quote. "With a good quality graduate student you can write papers. With a good quality graduate student you can have ideas for proposals."

Participants discussed learning as a benefit for them in their "employer" relationships with students. Many spoke of research ides formulated as a result of student input, while others expressed excitement about gaining insights when assisting students in developing their presentation proposals. An aeronautical engineering professor explained it best,

> I like interacting with sharp students. I give them ideas and they run with the ball and push it in a direction, then I'm like 'wow!' That is really something, I mean it's great. I like it because, from a selfish point, I'm learning and I love it.

A civil engineering professor described the importance of engaging in work that benefited both himself and his students. "I want to do work that I can share with the students, to see the impact that our work has on the real world."

Still, some participants were at odds with having to draw strict employer-employee boundaries with their students. In one instance, such restrictions contradicted cultural norms.

> In the Latin culture…it's not unusual that some of your friends at the workplace will be involved in your social life…. It's just the culture. [In US culture] with your students, you have to be so, so detached, very distant and I understand that now because I am an employer as well.

He explained that when graduate students who are not familiar with US culture,

> …come here as research assistants and they are picked and they are employees. And you put your [boss] cap on, and [say] "you have to do this, this, and that. That is what you are being paid for." For many of the students, if they are doing research that aligns to their degree even better, but otherwise they are just employees.

Adding, "So it's quite different [culturally]. I am still at odds with that."

The employer-employee relationship marked by independent work and personal responsibility served as a means to achieve a greater end for graduate students and faculty—increased productivity for faculty and job-preparedness for students. A faculty member remarked, "They struggle yes, I agree… That is part of the process, and once they are finished they become more of a professional seasoned researcher." He explained that his role in working with students was to "educate the students in ways they would continue to have employment." Providing students the space to make mistakes and demonstrate self-sufficiency formed the basis of faculty participants' responsibilities to their students in the employer-employee mentoring relationship component.

Faculty as agent of socialization

The notion of faculty members as socializing agents focuses on the ways participants provided their students with professional development opportunities. A life science professor explained that, although he understood their reluctance, he was proactive in developing his graduate students' public speaking skills. "I actually force all of my students to go to national meetings of at least one of the [professional] societies that are important…They go out and give talks there. They practice talking in public." A mechanical engineering professor explained how he is able to provide his graduate students with opportunities to become active in the scientific community while also motivating them to conduct high quality research.

> I have [research] money [so] I usually ask them to write papers….The deal I made with them is that if you write a paper and it is accepted [to a conference], I will send you wherever it is. Many are in Europe, Russia, China, Korea, Singapore. It is a way to manage, since I have many researchers.

This component of the mentoring relationship offered a greater understanding of how participants were able to socialize their students into the norms and values of their discipline. He explained that "my graduate students are very productive and they do their work" which has the added benefit of increasing the research output of his lab.

Others spoke about the importance of having their students interact with well-known faculty in their fields. "It's very important to me that they interact with scientists. I force them at the beginning, it feels terrible because they are all nervous, but in the end they really appreciate the value." Another added, "I want my students to speak in public and not be afraid of colleagues that publish like crazy, you know, [to] be able to talk to scientists that are very famous, you know, on a one-to-one basis, very relaxed." His rationale for asking his students to engage with such scholars was to provide them with an,

> …understanding that this is a community, like a science community. There are no celebrities, even though there are. But I ask them to approach them and then if these people are nasty to them, then let them realize it's their problem, not [the student's]."

Such encounters can be beneficial to students in numerous ways. Interacting with senior scholars "helps a lot of them to have interesting collaborations, just by doing that. Like they are invited to learn techniques in labs for no cost, and things like that."

Developing graduate students' sense of professional competence was a key mentoring component for faculty who participated in the study. Public speaking and presenting at conferences were but one aspect of students' professional development experiences. A faculty member explained that he asks his (and other) graduate students to provide

feedback on his journal manuscripts. "I usually ask for them to review things because they are going to do a good job….these young students are being cultivated and are natural. They have fresh knowledge and are in courses getting specialization." In addition to reviewing manuscripts, an engineering professor spoke about other ways that his students were active in the scientific community.

> They are also providing voluntary services to the professional societies. [My] Ph.D. students are already organizing technical sessions, chairing technical sessions, conferences are being organized by [my] graduate students. They are the ones looking for papers. They are looking for reviewers. They already have a network established and they do very, very well.

Faculty participants were well aware of the importance that professional development and disciplinary socialization plays in the educational experience of their graduate students. While this may not come as a surprise to many, data here were presented to illustrate an important responsibility encompassed by the F-GS relationship.

Discussion

Generally speaking the F-GS relationships described by participants can be characterized by the relational contexts of the interactions between participants and students, and the expectations within the types of interactions. Said differently, the four relationship components subsequently described can be characterized by the *context* of the F-GS interactions that define each component. Three broad descriptors can provide a clearer understand the nature of the various F-GS mentoring relationship contexts derived from the findings—allies, ambassadors, and master teachers (versus apprentice). In the advisor component of the F-GS relationship, the relationship between faculty participants and their graduate students can be characterized as interpersonal in nature. Faculty participants, in effect, were *allies* to their students and took a supportive approach in working with them. Participants were apt to focus on the specific individual needs of their graduate students, either academically or otherwise. This finding is in line with other research on faculty-student relationships that has demonstrated the importance of providing personal support through formal and informal interactions (Lee 1999; Thompson 2001). Given the ethnic background of the participants, more often than not, faculty understood the personal ramifications of demonstrating cultural sensitivity towards their underrepresented graduate students. Similarly, research on mentoring underrepresented student populations highlights the importance of respecting cultural values in mentoring relationships (Leon et al. 1997; Nora 1987).

As employers, faculty participants viewed their roles and responsibilities in working with their graduate students to be part supervisory and part developmental; however, the developmental component was a result of the level of supervision faculty provided. In this *master-apprentice* relationship, autonomy was strategically utilized for developing graduate students into expert researchers. Reciprocity was also key in this component of the F-GS relationship in that students received direction from faculty while faculty members were able to benefit by learning from their students. The roles of graduate students were quite clear. In cases where faculty members created structured learning environments, students were expected to be active learners who could apply new knowledge into practical settings. In the lab, graduate students had a responsibility to demonstrate an ability to work independently and with minimal supervision. The reasons for this were two-fold. First, the

ability to work in an autonomous environment helped to socialized graduate students into the culture of the professoriate. Second, faculty members increased their level of productivity by working with "high quality" graduate students who are able work independently and with minimal direction. These findings extend previous work (Busch 1985) that has demonstrated the mutual benefits associated with successful F-GS mentoring relationships. Recall the quote by an engineering professor who stated, "With a good quality graduate student, you can write papers…you can have ideas for proposals." As Tillman (2001) argues, a productive mentor-protégé relationships accrues benefits for the mentor and the protégé, including higher publication rates, greater research collaboration, and support for promotion and tenure. While increased productivity was a reason for establishing an autonomous work environment in which graduate students were expected to work independently, it also provided the means by which students could demonstrate their research abilities, through an "apprenticeship" relationship with their faculty employers.

In their role as agents of socialization, faculty served as *ambassadors* of the profession by imbuing students with a sense of professional responsibility and introducing them into the culture of academe. Participants provided support for students to participate in activities meant to socialize them into their profession. Faculty expected their graduate students to give research presentations; one provided incentives for his students to write conference papers. In addition, faculty participants spoke about how their students organized conferences and reviewed journal manuscripts. What is important here is the notion that, as ambassadors, participants familiarized students with the types of activities they would be expected to perform in their future careers. Faculty neither performed nor coerced students to participate in these activities; rather, they imbued a sense of responsibility upon their graduate students to engage in their professional and career growth. To be sure, faculty offered personal support to their students, but also provided them with the autonomy to discover the necessary knowledge and skills to navigate through the academic arena.

Findings cannot speak to whether the underrepresented 'status' of the faculty participants positively or negatively influenced faculty-graduate student relationships. Participants often discussed cultural sensitivity as an important element of the F-GS relationship, in cases where their students were from underrepresented backgrounds. While cultural similarities are significant to mentoring relationships (Okawa 2002) in that "Individuals tend to identify with persons who are like themselves on salient identity group characteristics" (Welch 1996, 10), data presented here are unable to provide insight regarding whether or how demonstrations of cultural awareness by faculty participants influenced the F-GS relationship. Research has shown that mentoring relationships are more authentic when mentors and mentees share similar cultural experiences, language, and interests (Athey et al. 2000). Recall the quote by one participant whose students were from Colombia. Given his Latino background, he understood his students' need to spend extended time with their families outside the US, and made allowances accordingly, even at the expense of his own productivity. One can surmise that the Latino background of this participant and his mentee contributed to a successful mentoring partnership. Nevertheless, more research is needed to better ascertain the extent to which cultural similarities and/or differences influence the success of faculty-graduate student relationships.

As the literature suggests, mutual support and comprehensive relationships arguably are the most important factors of a successful F-GS relationship (Johnson and Nelson 1999; Wilde and Schau 1991). Findings presented here speak to the multi-faceted components that comprise these relationships. An important element of the F-GS relationship components outlined here is that they are fluid in nature rather than a set of compartmentalized

behaviors. Much overlap exists between the relationship components in that an apprentice can be viewed as a friend and teaching moments do not occur solely in structured learning environments or in a lab. Moreover, F-GS mentoring relationships should not be viewed as monoliths, which is to say that no two relationships are alike. My point is not to suggest that faculty ought to view their roles and responsibilities in working with their graduate students simply as a set of discrete activities. Rather, my aim is to provide a modicum of clarity to the caprices of faculty-graduate student relationships. By shedding light on important elements of F-GS mentoring relationships, the hope is to offer faculty members some insight about how F-GS mentoring relationships in science and engineering can be structured to help underrepresented students persist and succeed. As well, findings may also serve as a springboard for others to take a more nuanced approach to explore this important area of research.

Implications from this study also suggest that senior faculty might consider assigning graduate assistants with relatively more research experience to junior (untenured) faculty members. Junior faculty are more likely to be consumed with seeking external funds and producing publications. Moreover, they likely have less time to mentor or "train" a new graduate research assistant on how best to best serve the needs of their supervisor/faculty member. Conversely, senior faculty ought to consider the mentoring of both graduate students and junior faculty a major job responsibility. To be sure, senior faculty member are likely to be the busiest faculty members in their departments. Nevertheless, one could argue that developing future scholars is a responsibility that lies with tenured Associate and full Professors. Findings also suggest that the roles and responsibilities of faculty can be viewed as discrete. Which is to say that faculty mentors and graduate student mentees ought to learn how to view themselves as playing various "roles". Much like a person can be considered a daughter, a wife, a professor, and a mother, faculty mentors and graduate student mentees ought to understand that they are going to be viewed as employers, as peers, as confidants, etc. The difference here being that it is the mentor that is viewing the mentee in various ways; thus, making it difficult and challenging for the mentee to understand what "roles" they and their mentors are playing at any given time. Yet, because the faculty-graduate student relationship is one that develops over a period of many years in many cases, it would be wise for both the mentors and mentees to focus on the nuances of these relationships from the start.

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