AC 2007-1557: CONTEXTUAL FACTORS AFFECTING GRADUATE STUDENT MENTORING

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Contextual Factors Affecting Graduate Student Mentoring

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Abstract—The numbers of students pursuing graduate education at the master's level has increased nearly four-fold since 1966. In engineering, the number climbed from 13,705 masters degrees and 2,301 doctoral degrees awarded in 1966 to 33,872 masters and 5,776 doctoral degrees awarded in 2004[2]. Women and under-represented minorities' (URM) share of engineering doctoral degrees have increased but members of these groups are still underrepresented at the doctoral level. This paper uses draw evidence about 24 faculty members' retrospective views of mentoring experiences from semi-structured qualitative interviews. Case study analysis of data about 24 URM student participants in a targeted program that seeks to increase the number of minorities who receive Ph.D.s in engineering provide information about recent graduates' mentoring experiences. The paper discusses findings and suggestions for how engineering faculty can provide high-quality mentoring to students within the larger social context of demographic change in graduate-level engineering education.

Introduction

The numbers of students pursuing graduate education at the master's level has increased nearly four-fold since 1966. In engineering, the number climbed from 13,705 master's degrees and 2,301 doctoral degrees awarded in 1966 to 33,872 master's and 5,776 doctoral degrees awarded in 2004[2]. While temporary residents' share of doctoral degrees in engineering has increased dramatically (in 2004 temporary residents accounted for 57% of engineering Ph.D.s), women and under-represented minorities' (URM) share of engineering doctoral degrees also increased: women earned 17.6% while URMs earned 3.2% of engineering Ph.Ds. Data showing the increasing diversity of U.S. master's and doctoral recipients of engineering degrees are shown in Table 1.

As shown by the data presented in Table 1, graduate education in engineering has undergone substantial structural changes: the numbers of degrees earned per year has increased while the diversity of students has undergone dramatic changes over the past 25-30 years. This increasing diversity poses special challenges for faculty who may need to moderate conflicts among groups of students with various demographic characteristics. Furthermore, engineering faculty have experienced pressure to generate more funds via grants and contracts and time demands have become increasingly acute for engineering faculty.

The role of the faculty advisor in graduate school is more expansive: rather than merely assisting the student in maintaining her or his sequence of classes towards graduation, the graduate advisor ideally serves more as a "mentor" with both the instrumental function of advisement as well as the psychosocial functions in what is often described as more "family-like" relationship. Additionally, graduate education is meant to provide students with an opportunity to learn first-hand about the research process via a more individualized program of study. This is in contrast to undergraduate education, which is characterized by a fairly rigid set of prescribed classes with few opportunities available for most students to engage in independent research. Furthermore, undergraduate programs of study involve substantial credits outside their major department while at the graduate level, students spend most of their time in only one department, often working in a specific faculty member's laboratory.

Table 1. Trends in Graduate Degrees in Engineering, Selected Years

	Total Number	Percent Female	Percent URM*	Percent Non-Hispanic White	Percent Temporary Resident
Master's Degrees**					
1977	16,251	4.4	3.2	70.4	21.8
1990	23,985	13.6	3.6	53.6	30.2
2000	26,736	20.7	6.1	42.8	38.2
2004	33,872	21.1	6.1	34.7	46.1
Doctoral Degrees**					
1973	3,374	1.4	0.8	50.9	18.7
1980	2,479	3.6	1.9	46.1	34.5
1990	4,894	8.5	2.0	37.6	46.7
2000	5,321	15.7	3.2	35.5	46.1
2004	5,776	17.6	3.2	26.7	57.2

*Notes: *URM = Under Represented Minority: African Americans, American Indians and Alaska Natives, and Hispanics.*
*** Data are available for different years due to differences in reporting at the federal level.*
Source: Commission on Professionals in Science and Engineering, 2006. "Four Decades of STEM Degrees, 1966-2004: 'The Devil is in the Details'." STEM Workforce Data Project Report No. 6. Online data archives accessed at www.cpst.org.

In this paper, we use multiple sources to understand graduate student mentoring in engineering programs as compared to those in natural sciences programs. We assert that the context in which mentoring occurs impacts the qualitative experience of the mentoring relationship. In this case, the context is shaped by the structure of faculty members' work-lives including the structure of research and cultural norms within the discipline. In addition, the extent to which U.S. students work alongside non-U.S. students has a complicated impact upon the experiences of U.S. students. The paper will discuss findings from the interviews as well as suggestions for how engineering faculty can provide high-quality mentoring to students within the larger social context of demographic change in graduate-level engineering education.

Data and Methods

Our evidence is taken from two separate studies. In the first study, 43 tenured and tenure-track faculty members in science and engineering—junior and senior ranks—at a large public southwestern university were interviewed in semi-structured qualitative interviews with retrospective questions about graduate mentoring experiences. Gibson's[3] protocol formed the basis for the interviews, which were completed between July 2004 and September 2005. All interviews were fully transcribed[1] and memoed. Strauss and Corbin's grounded theory approach was used to study the themes that emerged from these faculty members' interviews concerning their experiences of mentoring as graduate students.

The study in which these faculty interviews were completed was an impact evaluation of a science and engineering (S/E) faculty mentoring program. Of the 43 interviews, 24 were conducted with mentors or mentees who had participated in the program. Purposive sampling was used to ensure that the interviewees included a mentor and mentee of both sexes (2 X 2) from each of the three campus units associated with the National Science Foundation-funded ADVANCE: Institutional Transformation program. Of the 24 participants, 3 were department heads (and were either full or associate professors), 6 were full professors, 4 were associate professors and 11 were assistant professors. There were no refusals, but one male mentee was not interviewed due to scheduling difficulties. The interviews on average were 51 minutes and ranged from 25 to 90 minutes.

Of the 24 non-ADVANCE mentoring program participants (hereafter, we refer to this group as "non-participants") originally selected as potential "matching cases" to the participants, five faculty refused to be interviewed (one was off campus for the semester). Potential respondents for this comparison group were chosen based on general disciplinary background, gender, rank, and approximate time at the institution to be as closely comparable to the ADVANCE mentoring program participants. There were few "ideal" cases where a participant in a particular department was able to be matched to another person of the same rank and tenure status within the same department. Because of the near-universal participation of science and engineering female faculty in the ADVANCE program, all but three of the non-participant interviews were with male faculty members. These interviews were generally of shorter duration, usually lasting from 20-30 minutes.

The second study is the principal study of interest here. We used case study analysis of files for 24 URM student participants in a National Science Foundation-funded program to encourage URM students to complete master's degrees and to transition into doctoral programs. The Louis Stokes Alliance for Minority Participation Program is now has a fourth cohort of students at New Mexico State University. For each student, pre- and post-program data were available via individual interviews, focus groups, transcripts, students' writings related to career goals, and interviews with their advisors. These rich data provide multiple insights about the students' mentoring experiences as well as the expectations of their mentors.

Although the program is now working with its fourth cohort of students, the analyses in this paper are based upon results from just the first two cohorts. Almost all of the members of these two cohorts have transitioned out of the program. The cohorts differed in terms of the disciplines and ethnic backgrounds of the students. For example, all of the members of the first cohort were engineering majors, with the majority being Hispanic, while in the second cohort there were chemistry, physics, mathematics and agriculture majors with more African Americans and American Indians.

[1] Technical problems—in three cases relied upon interviewer notes in part. In one case, the respondent refused to be taped but consented to the interview. In this case, the interviewer's careful notes were used for analysis.

The Program participants were as follows:

	Female	Male
Science	5	4
Engineering	3	12

The 24 graduate students were spread across 9 academic departments: four in the college of engineering[2] and five science departments in the College of Arts and Sciences or in the College of Agriculture and Home Economics. The first "cohort" began the program in 2003 and consisted of all engineering students. The second cohort was recruited to the program in 2004, predominantly from the science areas with two engineering students. All but one of the engineering students were Hispanic (one was American Indian). Five of the 11 science students were Hispanic with an additional four African American and two American Indian science majors.

By late 2006, all but one member of the first cohort had completed their master's degree with half moving on to Ph.D. programs either at the same institution or elsewhere. Two members of the second cohort, both African American females who had moved to the institution after earning bachelor's degrees elsewhere had both left their respective programs. The institution is classified as a "Hispanic Serving Institution" (HSI) with a small percentage of African American students in a geographic area with a very modest African American community. Adjustment to the community and to the academic departments appears to have been difficult for these two students.

Findings

There are a number of interesting findings from these two studies. In this section we will first discuss how students' experiences differed due to features associated with academic science and engineering. Next, we compare students' and faculty members' assessments of their graduate advisor within a mentoring context. Next, we review how students' peers impact their experience of graduate school this section includes a discussion of how the relative size of the graduate program and the relative number of international students impacts URM students. Faculty in recent years have faced increasing pressure to do more work with fewer resources. From the standpoint of students, this faculty "time crunch" can have implications for the quality of interaction they can expect during graduate school.

Disciplinary Differences: Academic Science and Engineering

Norms associated with academic science and engineering markedly differ. Engineers who graduate with bachelor's degrees are able to command well-paying jobs with a bachelor's degree in the field as shown in Table 2, at which time they are also considered to be engineers. Conversely, bachelor's degree recipients in the natural and physical sciences have lower earnings. Indeed, master's degree holders who majored in the natural and physical sciences (except computer sciences and mathematics) reported lower earnings than engineering bachelor's degree holders as shown in Table 2.

[2] There were no students in the two earlier cohorts in the industrial engineering program.

While the master's degree is a common milestone in the progress of a student towards the doctoral degree in the engineering programs at this university, this was not the case for the students in the science programs, in which the master's degree was viewed in a more pejorative way. That is, in all but one of the science programs[3], students were expected to be moving towards a doctoral degree, were often already considered doctoral students, and for whom a master's degree was considered a "consolation" prize for those who were unable to perform to the level required by faculty for a doctoral degree. Some faculty in these science programs saw a master's degree, in fact, as a "waste of time" for students because the technical requirements of completing a thesis in accordance with the bureaucratic procedures of the graduate school distracted students from completing their lab work and studying for their qualification exams.

Table 2. Median Earnings of Full-Time Employed Scientists and Engineers by Sex, 1993-2002 Graduates with Bachelor's and Masters Degrees in Selected Fields

	Engineering		Computer and mathematical sciences		Physical and related sciences		Biological, agricultural, and environmental life sciences	
	Bachelor's	Masters	Bachelor's	Masters	Bachelor's	Masters	Bachelor's	Masters
Females	$58,000	$67,000	$50,000	$60,000	$42,000	$45,000	$36,000	$40,144
Males	$62,000	$72,000	$59,000	$75,000	$48,000	$55,000	$41,000	$47,000
Sex Gap	$0.94	$0.93	$0.85	$0.80	$0.88	$0.82	$0.88	$0.85

Notes: Sex gap is computed in the common way: the ratio of women's to men's median earnings.

Source: Author's analysis of National Science Foundation public use datafile, National Survey of College Graduates, 2003 accessed via SESTAT online analysis system.

Another key difference between the science and engineering programs—as a general matter of culture—was that there was a stronger hierarchy of students within the science versus engineering programs. To some extent this was due to the relative size of the programs and the organization of work within science. The bench sciences—notably chemistry, physics and life sciences—involve large collaborative teams led by one or more faculty members. Students who had already been trained for a couple of years and had been advanced to doctoral candidacy (i.e., had completed their qualifiers) were expected to train the first- and second-year students in proper lab procedures. Any postdocs in these labs also played a key role in training students. The faculty member oversaw all of the research: as students moved through the advancement stages within the lab, their access to the faculty member increases.

While some engineering research groups are similarly structured, in the case of this particular institution, it was generally less common for the engineering graduate students to be members of collaborative teams in the same manner as that seen in the natural sciences. Faculty directed the research of multiple students, but from the student and faculty members' interviews, it seems that the faculty member more often played the role of a "point person," coordinating the work of several students who generally worked independently on pieces of the project.

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[3] The exception was the department without a doctoral program. In this case, students were trained to perform scientific work in the field with a master's degree but with a strong assumption that they would eventually pursue a doctoral degree at some appropriate future time.

Because it was normative for the engineering students to complete a master's degree en route to a doctoral degree, many of the engineers who completed their master's degree and then transitioned to a doctoral program chose to go to different universities rather than stay at their present institution. This was quite a different outcome than that for the science students, who were encouraged to stay at the same institution because they were already in the program. Students who chose to stay—and their faculty advisors in separate interviews—indicated that staying in the same program was a more efficient approach to completing their graduate studies. That is, if they went elsewhere, then they would have to learn to work with a new advisor and a new set of peers and potentially have additional coursework to complete prior to qualifiers. One faculty advisor, for example, felt that staying at the same institution would save his student about a year in time towards his Ph.D.

Assessment of Advisors as "Mentors"

The Program students completed an exit survey on which they were asked several items about their advisor. While these answers were part of a brief exit survey, they were then probed in the course of exit interviews to provide illustrations of the way in which they interacted with their advisors and whether, in fact, they considered their advisor to be a "mentor." In addition, their definition of the term "mentor" was probed to shed light on their expectations of the relationships with their advisor. Similar retrospective questions were posed to the 43 faculty members who completed interviews.

Both the faculty and the students had a high level of agreement on what differentiated an advisor from a mentor. Both students and faculty made reference to the notion that a mentor tended to be more proactive, providing guidance to students in anticipation of needs. One faculty member, for example, indicated that had he, himself, anticipated that he would actually end up in a faculty job, his impression was that his graduate advisor would have been able to more effectively mentor him for that role. Instead, he spoke with a little regret about his graduate advisor trying to get him up to speed on faculty life issues shortly after he had decided to accept a faculty position rather than pursue an industry position, which had been his original goal.

Female students, in particular, made note of the idea that their mentor was someone who was supportive that they "could ask him anything." Both male and female students stressed that what made their advisor really a mentor was that this was someone who went beyond academics and provided "personal and academic advice".

In all there were 17 students who addressed the issue about whether they considered their advisor to be a "mentor." All but three of these answered in the affirmative including all of the science majors. Three of the eight engineering men who answered this item reported that they saw their advisor as an advisor only and not as someone who went the "extra mile" to be a real mentor. When probed about why they did not feel this person was a mentor, two of these three men indicated that their advisor spoke to them only about schoolwork and not about personal issues while the third indicated that he and his advisor had significant differences in style.

When the faculty were asked about their experiences with mentoring, we found that we elicited more information when we reframed the query to focus on their graduate advisor in particular.

Many men recalled that they felt like a member of their faculty advisor's family: they were often invited to dinner, were included in holiday festivities, and indicated that their faculty advisor provided career supports. The provision of career and psychosocial supports reflected in these interviews is a hallmark of "mentoring," as opposed to advisement.

Many (but not all) women faculty[4], on the other hand, reported that they earned their doctoral degrees in spite of their advisors. Unlike the "family" relationship that their male colleagues reported, female faculty indicated that their faculty advisors often failed to provide guidance on their dissertation projects, let alone career guidance or psychosocial support during graduate school. The women indicated that they sought out post-graduate positions with little assistance from their mentors.

Interestingly, time seems to heal all wounds. For example, women who had an advisor for whom they gave a negative assessment were willing to "write off" the bad behavior by focusing, instead on a "bright side" outcome. That is, one faculty member indicated that she had a terrible advisor but that in some ways it may have been a good thing because it made her work hard to complete her doctoral degree in just three years. Another woman faculty member indicated that if one were to use a Myer's Briggs assessment, that one would discover that all faculty members share a number of important characteristics that tend to affect their interactions with other people.

Similarly, one male faculty member indicated that he had numerous personality conflicts with his advisor of such intensity that it impacted his experience of the relationship. He reported that over the years, he came to dwell more upon the positive aspects of the relationship with his advisor and was able to better appreciate the skills that his advisor conveyed to him and to downplay the negative personality difficulties.

Context: Peers

Peer relations are essential to success in science and engineering. In some bench sciences, work groups rely upon each member to possess the requisite technical, interpersonal, and communications skills to enable the group's project to progress. The individual's project as one component of the larger research direction needs to be completed in a timely manner in order for all to benefit.

In engineering, as discussed above, fewer of the Program students were involved in large research-labs akin to those of their peers in science. As undergraduates, engineering school tends to be characterized by the phrase "cooperate to graduate." With the persistent "weed out" mentality, students learn to collaborate on homework in order to master course technical content and develop the technical lab skills used in engineering research. The engineering departments at this institution had much space dedicated to common areas for the students, including separate graduate student lounges to enable students to get together for these collaborations.

In short, peers are important in graduate school in the sciences and engineering but relationships with peers are structured differently in these areas. In the sciences, these relationships derive from membership in a particular lab group, which is led by a faculty member who provides a

[4] There may be some important cohort differences among the women, which will be explored in other papers.

structure for interaction. In engineering, in contrast, at least at this particular institution, these relationships arise from courses that students take. A faculty member does not often provide the same sort of leadership as in the bench sciences and the work groups often form along lines of shared interests.

As illustrated in Table 3, the demographic profiles of master's degree recipients differ depending on the area of study. Although not shown here, it is clear that U.S. citizens and permanent residents comprise a much larger proportion of the master's degree than of the doctoral degree recipients from the departments shown here. Geology, which had a master's degree but not a Ph.D. program, had no international graduates between 1998 and 2005. Therefore, the data in this table is likely to overestimate the representation of U.S. students and underestimate the relative representation of temporary resident students in each of the programs, overall.

Table 3. Selected Characteristics of Master's Degrees Recipients at Institution

	URM Women	Women	URMs	Temporary Residents	Number of Master's Degrees
1998-2001					
Agronomy & horticulture	6.9%	41.7%	13.9%	13.9%	72
Chemistry	5.3%	26.3%	10.5%	63.2%	19
Geology	0.0%	33.3%	11.1%	0.0%	9
Mathematics	4.0%	56.0%	8.0%	40.0%	25
Physics	0.0%	33.3%	0.0%	16.7%	6
Arts & Sciences, Total	3.4%	40.7%	8.5%	39.0%	59
Civil & Geological	5.4%	27.0%	18.9%	18.9%	37
Chemical	11.8%	41.2%	11.8%	35.3%	17
Electrical	1.3%	10.0%	10.0%	50.0%	80
Industrial	2.8%	14.2%	13.2%	32.1%	106
Mechanical	0.0%	6.7%	26.7%	10.0%	30
Engineering, Total	3.0%	15.6%	14.4%	33.3%	270
2002-2005					
Agronomy & horticulture	8.5%	46.5%	15.5%	9.9%	71
Chemistry	0.0%	27.3%	0.0%	54.5%	11
Geology	0.0%	41.7%	0.0%	0.0%	12
Mathematics	6.5%	41.9%	9.7%	45.2%	31
Physics	0.0%	27.3%	0.0%	81.8%	11
Arts & Sciences, Total	3.1%	36.9%	4.6%	44.6%	65
Civil & Geological	4.3%	21.7%	21.7%	26.1%	23
Chemical	0.0%	10.0%	10.0%	30.0%	10
Electrical	3.1%	15.5%	13.4%	58.8%	97
Industrial	9.9%	21.8%	32.7%	13.9%	101
Mechanical	0.0%	5.9%	26.5%	17.6%	34
Engineering, Total	5.3%	17.0%	23.0%	32.5%	265

Source: Author's analysis of National Science Foundation WebCASPAR database.

URM students, and especially URM women are quite likely to find themselves to be “solos” in almost any graduate program. In addition the representation of URM women at both points in time show no dramatic difference. Between the two time periods, however, there was a marked increase in the representation of URMs among master’s degree recipients in the engineering fields (from 14.4% to 23.0% of all master’s degrees) largely as a result of an increase in URM representation in industrial engineering (which also showed an increase in URM women’s representation over the two time points). It is notable that within the science disciplines that are part of the institution’s arts and sciences unit that there was actually a decrease during the latter period compared to the earlier period in the representation of URM master’s degree recipients.

Temporary residents accounted for about a third of master’s degree recipients in engineering largely as a result of their majority position in the electrical engineering program in that academic unit. Temporary residents’ representation among master’s recipients increased between the two time points in the science disciplines (except in agronomy and horticulture, which is within a different academic unit than the other four science fields shown in the table).

Students’ experiences with other graduate students in their home departments varied substantially from those who felt they were able to interact well with others to those who suggested that the large number of international students resulted in strained relations with their peers. One student complained in an exit interview that the more highly-trained international students made classes difficult for U.S. students who had received lesser quality prior training than their international peers.

A seminar that was part of the Program provided a space for the first cohort to establish strong connections with each other but was less effective with the second cohort. This was especially the case with one of the only two women in the first cohort. While one woman was in a program where there were other female graduate students, the other was in a program with fewer women and in which there were more international students, who may harbor more traditional views about women and their role in engineering. Both the woman and her advisor reported that the Bridge cohort provided a good peer group in the absence of such a group within the woman’s home department.

The second cohort students varied greatly in terms of their current stage of the graduate process. A few students had started participating in the Program as undergraduates, while others were close to the time when they planned to complete their qualifying exams. This heterogeneity, combined with the Program Director’s basis in engineering, made it more difficult for the seminar to fulfill the same role as it had with the first cohort. Furthermore, the bench science majors in the second cohort already had support groups in the form of their lab groups. The students who lacked this support—such as the lone African American woman in the mathematics department, a program in which students often work in solitude—were subsequently unable to rely on the seminar in the same way as the lone engineering woman in the first cohort.

The Time-Crunch: Faculty Availability to Students

Faculty in recent years have been asked to do more with less, especially at state-funded educational institutions, many of which have been faced with budget cuts, hiring freezes, and other financial exigencies. Science and engineering faculty have come under greater pressure to generate external research funds[1]. In addition, some of the students in the Program as well as faculty members in their interviews reported that their graduate advisor also served as a department chair/head. In these cases, the administrative duties often took time away from the lab, and subsequently, the students who worked in that lab.

The table, below, shows per faculty graduate degree production in each of the departments in which Program students were located. The total number of masters degrees awarded for 2002-2004 and doctoral degrees from 2002-2005 are shown. There are wide variations in the number of degrees produced by each program and, as seen earlier, in the demographic characteristics of the students who earn those degrees. The department of Chemistry and Biochemistry has the lowest such ratio, producing just 1.3 masters or doctoral graduates for each of its 19 faculty members during the past four years, while the department of industrial engineering somehow managed to graduate 21.7 students per faculty member in the same time period.

The electrical engineering and agronomy and horticulture departments also reported fairly high ratios in comparison to those of the other departments shown in Table 4. Electrical engineering has fairly high numbers of international students: in electrical engineering, temporary residents accounted for 63 of these degrees (59%). Agronomy and horticulture's graduate programs serve a diverse clientele: about one-third were women earning master's degrees, another one-fourth were international students, and a noteworthy 14.3% were URM students.

Table 4. Science and Engineering Graduate Program Departments at Institution

	Program Students	**Number of Graduate Degrees, 2002-2004**	**Faculty* Fall 2006**	**Ratio: Degrees/ Faculty**
Chemical Engineering	3	16	7	2.3
Civil Engineering	5	27	15	1.8
Electrical Engineering	4	106	18	5.9
Industrial Engineering	0	107	5	21.4
Mechanical Engineering	1	39	15	2.6
Agronomy & Horticulture	1	105	16	6.6
Chemistry & Biochemistry	4	24	19	1.3
Geological Sciences**	1	12	6	2.0
Mathematics	1	42	29	1.4
Physics	4	33	16	2.1

*Notes: *Includes tenured and tenure-track faculty only.*

*** Geological sciences does not offer a doctoral degree, therefore, all degrees shown here for this program are masters degrees.*

One of the Program students lamented that because her advisor was the department chair, his time availability in the lab was reduced. She was grateful to have any time with this scholar, but will pursue a doctoral degree elsewhere instead of remaining at the institution. Another student who had changed majors between his undergraduate and graduate program complained in a very frank way about his advisor. In this case, his advisor was supervising even more than the average number of students in the department and, in her interview, reported that she simply did not have time to deal with the kind of hand-holding that the student required. The particular student had actually alienated himself from the other faculty members in the department and, according to the advisor, was so unfocused in lab, that other graduate students stopped coming to the lab and, instead, did their work at home to avoid interactions with this student.

Another structural feature that played a role in limited students' access to their advisors was the faculty member's career stage. In the faculty interviews, several faculty members indicated that their graduate advisors had been close to retirement and, therefore, not very motivated to pursue new lines of research or, in at least one case, to even do the basic level of advisement necessary for a graduate student. Other faculty indicated that their advisors were simply more self-interested, therefore, they would spend less time with students. A few students in the Program indicated that their advisors were not yet tenured and that their time was dedicated to completing the work necessary to earn tenure. In all of these cases, the ultimate assessment of the relationship relied upon the individuals involved. Some of the mentees in these cases tended to be more optimistic about their advisor's time crunch, seeing it as a way to "push" themselves to complete their program of study or as providing them with more freedom to pursue their own creative ideas. Other students who wanted more direction from their advisors had a more negative interpretation of the time-crunch, seeing the advisor as entirely self-serving at their expense.

Conclusions

Communication is an integral part of mentor-mentee relationships. In the past, very little guidance was provided to graduate students about how to interact with their advisors and very little training was available to mentors about how best to guide budding scholars. The two NSF-funded programs within which the interviews were completed sought to provide: (1) advice to mentees about communicating with their mentors; (2) assistance to mentors on how to be more effective. The faculty program (ADVANCE) was lauded by its participants in the interviews for these training features while the graduate student Program was less effective in working with students' mentors.

The heterogeneity of students' disciplines and stages in graduate school posed barriers to the Program in working with students' advisors. As discussed earlier, the Program's seminar was more effective with helping the first cohort—all engineers—to forge bonds as a cohort than it was with the second, more heterogeneous group of students. In addition, as was discussed by one faculty respondent, time can heal many of the apparent "wounds" associated with working with a difficult mentor in graduate school. That is, even is a second or third-year student feels that his/her advisor was not an effective mentor, as the years pass and the student continues to mature as a scholar, (s)he may, as the faculty member did, come to see the wisdom in their mentor's approach.

Many of the disagreements were rooted in miscommunication. That is, students complained that their advisor gave "vague instructions," sent "mixed messages" or was a poor communicator. Advisors, on the other hand, complained that students lacked initiative or required too much "hand holding." It was clear from the interviews that the experience of mentoring is very much in the eye of the beholder: "hand holding" to one person might be seen as important psychosocial support to another. One person might welcome this behavior, while another would feel overly constrained.

Because of the key role of communication, we suggest using mentoring agreements, along with more communication about Program expectations to faculty advisors. Mentoring is essential to students' success. As we have shown here, contextual factors can impact the kind of mentoring students need. Programs like the ones discussed in this paper can provide important pro-active assistance by helping mentees better identify mentors who are less likely, for example, to be under specific kinds of "time-crunches," such as the tenure track or heavier administrative duties. Graduate students are often drawn to junior faculty who are often engaged in cutting-edge projects and work hard on research because they are on the tenure track. But these faculty can often have too many students or may be less familiar with the norms associated with graduate school.

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