AC 2010-1957: DESTINATION UNKNOWN: GENDER DIFFERENCES IN ATTRITION FROM GRADUATE STUDY IN ENGINEERING

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Destination Unknown:
Gender Differences in Attrition from Graduate Study in Engineering

Abstract: *Women continue to be underrepresented in engineering at all levels of education and in the U.S. workforce. Our paper looks at outcomes and experiences of students within a particular, federally-funded program that is meant to increase the number of minority doctoral degree recipients in the sciences and engineering. The program provides students with a generous stipend, travel and research funding, special programming and support to their mentors. The program seeks to increase the number of underrepresented minority students who complete master's degrees and then matriculate into doctoral degree programs. Thirty engineering students – 21 men and 9 women – moved through graduate school from 2003 through 2008. Women engineering students were three times as likely to leave graduate school without attaining a degree (33 percent compared to 9.5 percent), and women engineering graduates were less likely to matriculate into a PhD program than men (44 percent compared to 62 percent). Comparative case study analysis is used to describe the subtle ways that engineering graduate school at a particular large state university differs for students based on gender. Implications for future research are discussed.*

Introduction

Women continue to be underrepresented in engineering at all levels of education and in the U.S. workforce. For the past two decades, women have earned between 18-20 percent of undergraduate degrees in engineering, with approximately this same level of representation at the master's and doctoral levels[1]. In the U.S. workforce, women account for just 13.5 percent of all engineers and architects[1]. Women's underrepresentation, however, stems from lack of recruitment and enrollment in engineering programs rather than retention[2,5]. The rarity of women among engineering faculty is also cited as one of the many reasons for the continued underrepresentation of women in engineering schools[8,10]. Grounded in the framework that women seek role models that are like themselves, advocates of increasing women's participation in the engineering professoriate claim that more female engineering professors will provide a context in which more women will feel comfortable pursing engineering degrees.

Our paper looks at outcomes and experiences of students within a particular, federally-funded program that is meant to increase the number of minority doctoral degree recipients in the sciences and engineering. The program provides students with a generous ($30,000 annually) stipend, travel and research funding, special programming and support to their mentors. The program seeks to increase the number of underrepresented minority students who complete master's degrees and then matriculate into doctoral degree programs.

Four cohorts of students—49 students total, 30 males, 19 females—who moved through graduate school from 2003 through 2008 provide us with a window onto the graduate student experience. Of these 49 students, 30 were in engineering programs: 21 men and 9 women. Of these, three of the women (33.3 percent) and two men (9.5 percent) left graduate school and, despite comprehensive efforts, have been impossible to locate. Additionally, women engineering graduates were less likely into matriculate into a PhD program than men at 44 percent and 62 percent respectively.

Hence these data beg the question: why are women leaving graduate school without a master's degree at a rate much higher than that of men and why are female engineering graduates less likely to matriculate into a PhD program than men? Using comparative case study analysis of rich data about these students, we will describe the subtle ways that engineering graduate school at a particular large state university differs for students based on gender. For each student, pre- and post-program data were available via individual interviews, focus groups, transcripts, and students' writings related to career goals. Advisors' reports about student progress and post-program interviews with advisors provide additional information about each of the students who participated in the program. These rich data provide multiple insights about the students' graduate experiences from their own and their advisors' points of view. In addition, our analyses also examine experiences of female and male students and make comparisons of experiences between the sciences—where women are present in larger numbers—and engineering. The science-engineering comparison will enable us to see the extent to which "critical mass" might play a role in retention of female students.

The Program

The National Science Foundation (NSF) currently funds 41 Louis Stokes Alliances for Minority Participation nationwide, including the New Mexico Alliance for Minority Participation (NM AMP) and about half of these Alliances have received supplemental funding for a "Bridge to the Doctorate" (BD) program. The purpose of the program is to recruit talented minority students who had participated in an undergraduate AMP program to graduate school for a master's degree as a "bridge" to a doctoral degree. To date, at New Mexico State University (NMSU), there have been seven AMP-BD cohorts of between 8-13 students: in this paper, we examine outcomes associated with the first four of these cohorts and focus on those who were in engineering programs.

The program provides a generous stipend (currently $30,000) and tuition and fees to the students for two years of graduate study. In addition, students are provided with access to travel funds to attend conferences and are taken as a group during their first year in the program to Washington DC for the NSF Human Resources Directorate Joint Annual Meeting (know as "the JAM"). In the program's first year, too, students attend a weekly seminar run by the principal investigator that covers a range of topics related to graduate school. The students also, during their first semester, work on an application for the NSF Graduate Research Fellowship Program in their degree field.

The program rationale is situated in the reality that many underrepresented minority students are also from first-generation college families. When these students complete bachelor's degrees, especially in high-demand fields like engineering, the pull of labor market opportunities and the push of family members to take advantage of these opportunities can be strong. By offering a sizable stipend, though it is still lower than the usual market salaries for new engineers[3], the program seeks to retain strong students who have already engaged in research experiences in graduate school. Once there, with strong support for their research, access to national networks of minority scholars via specialized conferences like the JAM or others like the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS), and funding to attend

conferences within their own discipline, the program seeks to further retain these students in doctoral degree programs.

Special Challenges for Engineering

Engineering, unlike most of the science fields, has a strong grounding in "real world applications". As such, industry experience tends to be valued within the field. As indicated above, AMP-BD programs must work hard to recruit engineers due to the labor market situation for engineers, unlike some of the sciences in which the doctoral degree is, itself, considered the entrée credential. Once students complete a master's degree in engineering, though, there are continued "pulls" by industry, which offers still higher salaries to these highly-skilled graduates than those at the bachelor's degree level. For engineering, however, as described by one AMP-BD graduate, holding a professional engineering license, even if one plans to be a faculty member, can be an important credential. Therefore, at some point, in order to gain the work experience necessary to sit for the second part of the professional engineering licensure exam, engineers interested in this credential need to spend a period of time outside academia.

Literature

The literature is replete with anecdotal and more carefully gathered qualitative evidence of the sex gap in completion of graduate studies. In many cases, these accounts are often "buried" within larger treatises on leaving science[7] or are included in extended legal briefs[9]. Institutions that train large numbers of graduate students like the University of California at Berkeley, for example, have implemented policies that permit graduate students leave time for childbirth. Such institutions are setting the pace, as women's representation among graduate students has undergone vast growth in the past 30 years[1].

The lack of good mentoring is cited in much of the literature on graduate education, especially for women, as part of the additional burden women must face in graduate school[4,7,8]. Differential treatment based on gender also has a detrimental impact on women's persistence. Stone[10], Rosser[8], Preston[7], and Stark[9] all indicate that even though women are reluctant to discuss sexism, actions that are anti-female or anti-mother do have a cumulative and negative impact on women's success.

While some institutions or university systems have subjected the issues that confront female graduate students to quantitative analysis, there is no large-scale dataset that could provide similar information about engineering students in particular. Interestingly, it is difficult to get a reliable estimate of the number of people who enroll in graduate programs and then leave without degrees. The National Science Foundation's Scientists and Engineering Statistical Analysis System (SESTAT) is the leading source of data on scientists and engineers in the United States. SESTAT consists of three constituent surveys: the National Survey of College Graduates (NSCG), the National Survey of Recent College Graduates (NSRCG), and the Survey of Doctorate Recipients (SDR). The three instruments are administered to random samples, with the 2006 SESTAT dataset representing some 22.6 million U.S. scientists and engineers. While it would seem like these data would provide a window into the post-bachelor's degree educational lives of scientists and engineers, only information related to degree completion is available in these data.

The only other datasets that could be useful are those maintained by the National Center for Education Statistics, which has sponsored a series of panel studies dating to 1972 with the National Longitudinal Survey. Since that time, subsequent panels of young people have been followed in different survey programs to examine education and workforce outcomes. However, even though these are very large collections of multiple tens-of-thousands of individuals, by the time one controls for those with a bachelor's degree in engineering and then seeks to explore gender within that group, one quickly "runs out of 'n'."

Using the most recent available SESTAT data, collected in 2006, we examined the educational outcomes of respondents who indicated that they had graduated with a bachelor's degree in engineering in 2000 or later. Among underrepresented minorities, only 9.1 percent of women and 8.5 percent of men had obtained a graduate degree—either a master's or a doctoral degree—by 2006. These are only slightly lower than the rates for comparable non-Hispanic White recent engineering bachelor's degree recipients at 10.5 for women and 10.2 percent for men.

Methods

We used comparative case study analysis of files for 30 underrepresented minority (URM) engineering student participants in the NM AMP-BD program. For most students, pre- and post-program data were available via individual interviews, focus groups, transcripts, students' writings related to career goals, and interviews with their advisors. Structured intake and outtake interviews with the BD students were conducted upon entry and exit of the BD program by a former institution student close to their same age; structured advisor interviews were conducted by an institution professor upon students' completion of the BD program; focus groups were conducted to orientate incoming BD students; and essays and transcripts were part of the program application, with transcripts updated at the end of their program. Content analysis was chosen to examine students' experiences because similar types of data were collected across all 30 participants, thus elucidating themes and comparable responses across exact measures. The data sources were compared across gender, race, and field of study for similarities and differences. These rich data provide multiple insights about the students' undergraduate and graduate experiences as well as mentoring experiences and expectations of their mentors.

Students who abruptly left the AMP-BD program without a degree have files with all but exit interview data. Of the five engineering "leavers" only two had an exit interview. Both students indicated they would be completing their master's programs within the year, and both intended to enroll in a PhD program at their current institution upon completion of the master's degree. To date, based on subsequent follow-ups, neither has completed their master's degrees, nor have they reported any intention of applying to PhD programs in the foreseeable future.

On an on-going basis, all of the program participants are re-contacted to determine their current status with respect to doctoral programs. That is, the ultimate goal of the program is not the mere production of master's degrees but the "bridging" of these students into doctoral programs. This "bridge" is meant to be multi-faceted: during the master's program, students were to have received professional development training that would provide them with a strong foundation for the new challenges of a doctoral program. The conference funding was to have provided them with access to their professional networks at an early career stage.

We have, however, found that some of the students have seemingly disappeared or seem unwilling to speak with program personnel, perhaps due to perceived failure at not completing this program. The program director emphasizes the goal of the program—transition to a doctoral program—during the seminar and in personal communications with the students. As we have reported earlier[4], the messages conveyed during these personal interactions need to be carefully crafted so that the student is not made to feel like a "failure" for not immediately matriculating into a doctoral program. As discussed, above, there are many reasons an engineering student would choose to complete a career segment in industry prior to completing the doctoral degree; the key, therefore, is to build an on-going connection with the students as a way to keep them focused on returning to graduate school.

Contact Attempts

Contact Information

Three of the five engineering students who left without degrees do not have current contact information on file, including working phone number, mailing address, and email address. Emergency contact numbers and "alternative" numbers were tried as well, to no avail. One of these students returned to his home state on the East Coast in 2008, but his whereabouts and educational endeavors since that time are unknown. It is unknown if the other two students (both female) have left the area or have only changed their contact information.

The fourth student, female, has a working phone number, but has not responded to repeated phone calls and messages. In fact, she has answered phone calls on several occasions, but immediately ended the phone call once the caller identified themselves as calling on behalf of the program.

The fifth student, male, did have accurate contact information and provided an annual update on his whereabouts and progress. This student has left the area in favor of employment, and is unsure when he will complete his master's degree or if he will enter a PhD program.

All of the students' last-known advisors have been contacted to determine if they have updated information on their former students. In all cases, the advisors have not had any contact with the students since they left their advisor's tutelage.

Social Networking Websites

It has become increasingly common for college student-oriented programs to make use of social networking websites, most notably FaceBook, MySpace and LinkedIn, to locate and contact students. Many programs now maintain Facebook profiles and students connect to them when they enter the program as a way to enable on-going contact with students. In the case of NM AMP-BD, these sites are being used post-hoc to attempt to track down students who have seemingly disappeared.

MySpace: None of the five students were definitively found on MySpace. Millions of people worldwide are on MySpace and many people have the same names as the "missing" students; indeed, one of the names had 63 matches, and another had over 500. In the cases where the names matched, it was unclear if they were one in the same without seeing pictures and educational history to confirm their identity. In one case, the person appeared to match the

identity of one of the students and was contacted on behalf of the program, with no response. In the cases where the student's names did not have a match, it is possible that they are under a different screenname or identity, or that the students did not have a MySpace account. MySpace is perceived to be a social networking site for adolescents and young adults, therefore it may not appeal to college students in general, and to the older students in particular.

FaceBook: Similar to MySpace, FaceBook has millions of users around the world. And, similar to MySpace, there were cases where there were many matches - up to 623 - and no matches. Again, it was impossible to definitively determine if the FaceBook users were the same as the "missing" students without seeing their profile and credentials. To date, messages sent to potentially former program students have not been met with a response. In the cases where no matches were found, it could be the case that the students' name is not associated with the account, or that they do not have an account with FaceBook. FaceBook is tailored to attract a slightly older, more mature audience than MySpace, but it is still incumbent upon the student to join if they are interested in social networking via the Internet.

LinkedIn: LinkedIn is designed to appeal to professionals interested in networking, but it has several of the same challenges faced in the previously discussed social networking sites, namely that there can be many people with the same name to choose from and it is difficult to be assured that the person is, in fact, the student being sought. Again, several of the students' names did not have any matches, which may indicate that the user information differs from the search inquiry or that they have not joined the site. One student had 258 matches, name-wise, yet none identified NMSU as their educational institution. Two students were found more definitively, but it is unclear of when their profiles were last updated, and most current entries appear to have been Spring 2009. Messages sent to both were not met with responses, to date.

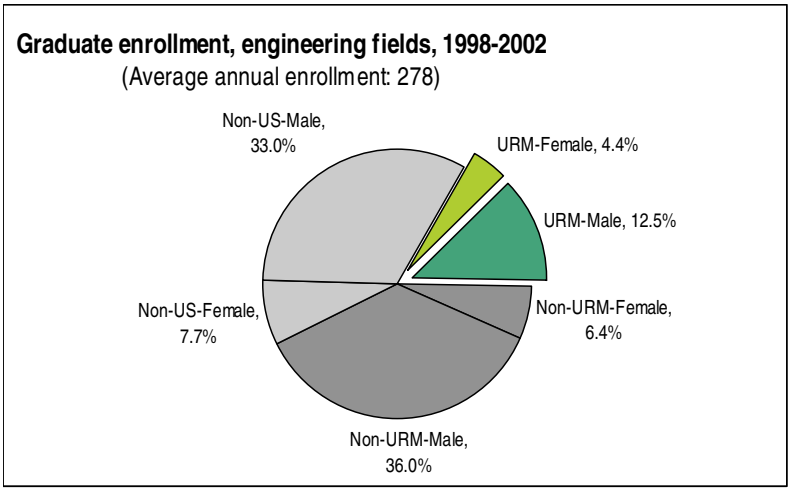
The Larger Context: Engineering Graduate Enrollment at NMSU, 1998-2007

In order to provide a better image of the context of graduate engineering education at NMSU, we worked with data available online via NSF's WebCASPAR database system from the "NSF-NIH Survey of Graduate Students and Postdocs in S&E". These data are collected from institutions (not individuals as the dataset name might imply), and often provided by the institutional research office, the same entity that completes many institutional data reports, including the (IPEDS) Integrated Postsecondary Education Data System reports for the National Center for Education Statistics (NCES). For the sake of simplicity, we present data separately by gender within three race-ethnicity and citizenship groups. The URM group consists of U.S. citizens and permanent residents who were members of three underrepresented minority groups: African Americans, American Indians and Alaska Natives, and Hispanics. At NMSU, the vast majority of URMs are of Hispanic descent with small numbers of American Indians and Alaska Natives and even smaller numbers of African Americans. The other two groups are then separated by citizenship: U.S. citizens and permanent residents versus temporary residents. The non-URM-US category, then, includes all U.S. citizens and permanent residents who were classified as White, Asian/Pacific Islander, or of unknown race-ethnicity.

Figure 1 shows the proportion of all graduate students enrolled during this five-year period - an average enrollment of 278 students - within the six groups defined by race-ethnicity, citizenship and gender. Figure 2 shows these same data for the three-year period 2003-2007, when the

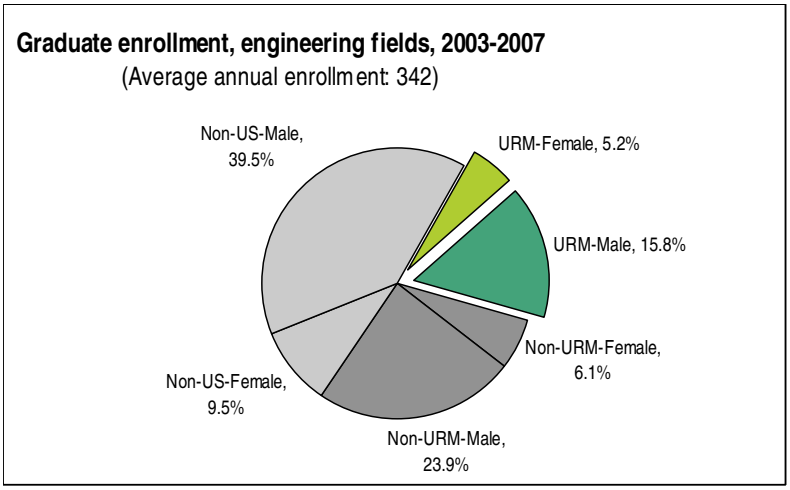
AMP-BD program had been put in place. A note of caution is in order: with the small numbers of engineering students in each cohort (ranging from 4 to 11), it is not reasonable to expect a program of such modest size to have a noticeable impact on overall graduate student enrollments of URMs.

Figure 1 NMSU Engineering Graduate Enrollment, 1998-2002, by Sex, Race-Ethnicity, and Citizenship Status



A few findings shown in Figures 1 and 2 are worth noting. First, the average annual graduate enrollment in engineering increased from 278 to 342 between these two five-year periods. Second, URMs accounted for a very slight increased share of graduate students enrolled: URM females' representation increased from just over 4 percent to just over 5 percent, while men's increased from 12.5 to 15.8 percent. Finally, growth was largely a result of the increased representation of international students, whose combined share of engineering enrollment at NMSU increased from 40.7 percent in the 1998-2002 period to 49 percent in the most recent five-year period ending in 2007.

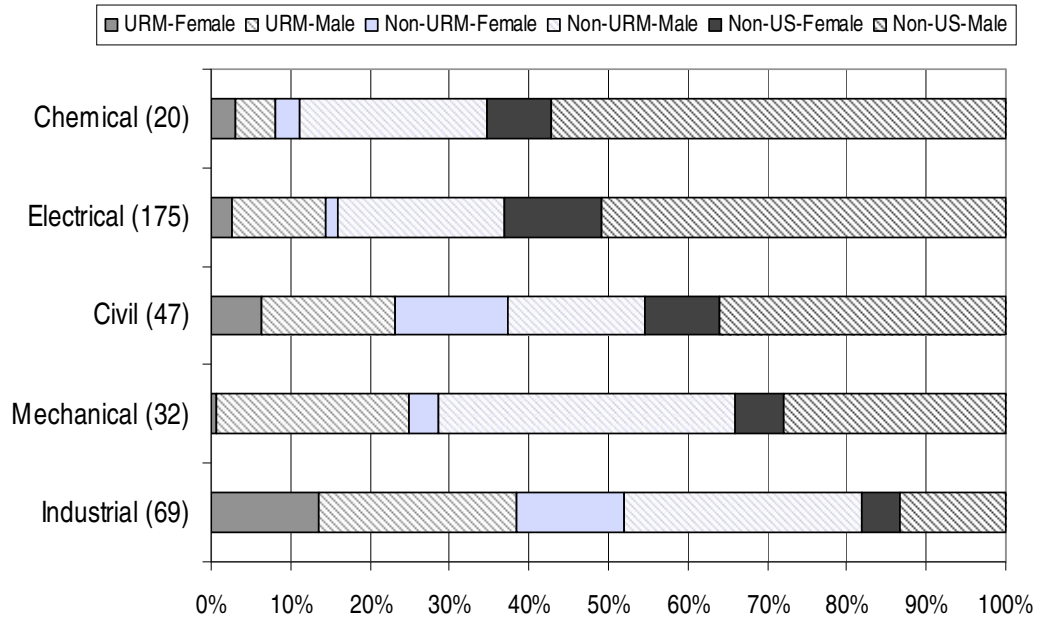
Figure 2 NMSU Engineering Graduate Enrollment, 2003-2007 by Sex, Race-Ethnicity, and Citizenship Status



In their intake interviews, students were asked to assess the relative percentages of international students, domestic minority students and women in their programs. Figure 3 shows the data from the "NSF-NIH Survey of Graduate Students and Postdocs in S&E" on enrollments by engineering program. The numbers in parentheses indicate the average annual enrollment within each department during the AMP-BD period of 2003-2007.

The students, for the most part are quite accurate in their assessments of the relative ratios of these groups. Approximately two-thirds of all chemical engineering and electrical engineering students were international men and women, with the number of men dwarfing that of women in both cases. The generally narrow solid-colored bars (of different shades) demonstrate the relatively low participation rate of women of all three major groups in contrast to men's greater representation, as shown by the striped bars in the chart.

Figure 3. Enrollment in Engineering, NMSU, 2003-2007, by Gender, Race-Ethnic Group, and Citizenship Status



Notes: numbers in parentheses are the average annual enrollment for the field. URM: Underrepresented minority, includes African Americans, Hispanics, and Ameircan Indians/Alaska Natives. Non-US: temporary residents. Non-URM includes whites, Asian/Pacific Islanders, and those with other or unknown race/ethnicities.
Source: CPST analysis of data derived from National Science Foundation's "NSF-NIH Survey of Graduate Students & Postdoctorates in S&E," accessed using WebCASPAR online December 30, 2009.

Results and Discussion

Tables 1 and 2 show the status, as of 2009, of the 30 engineering AMP-BD students by gender and department. There were three statuses: "left w/o a degree" are those students who had left the program and/or NMSU without attaining a master's degree; "completed MS" are those students who successfully finished their master's degree program and then did not, immediately, enter a doctoral program; and, finally, "enrolled in a PhD" are those students who had completed a master's degree and were currently enrolled in a doctoral program.

As illustrated in Table 1, below, women engineering graduates were less likely to matriculate into a PhD program upon receiving the master's degree than men at 44 percent and 62 percent respectively, and were three times as likely to leave without attaining a master's degree.

Table 1: Status of Engineering Program Students as of 2009

	Females		Males	
	n	%	n	%
Enrolled in a PhD program	1	11.1%	5	23.8%
Completed MS, not in PhD	4	44.4%	13	61.9%
Still in MS Program	1	11.1%	1	4.7%
Left w/o MS	3	33.3%	2	9.5%
Total	9		21	

Table 2, below, illustrates the students' status by specific engineering field, which further delineates which students successfully completed their program. As seen in the table, all three of the women (100%) who enrolled in the institution's electrical engineering master's program left without a degree, as did the two men (100%) who were enrolled in the electrical engineering program. The remaining six women were enrolled in other engineering master's programs at the institution and completed the master's degree, with only one of the six (16.7%) matriculating into a PhD program.

Table 2. Status of the 30 Engineering AMP-BD Students as of 2009

	Left w/o Degree		**Completed MS**		**Enrolled in PhD**		**TOTAL**	
	Female	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**
Chemical	0	0	2	2	0	1	2	3
Civil	0	0	1	2	1	2	2	4
Electrical	3	2	0	5	0	1	3	9*
Industrial	0	0	1	1	0	0	1	1
Mechanical	0	0	1	2	0	2	1	4
TOTAL	**3**	**2**	**5**	**12**	**1**	**6**	**9**	**21***

**One male electrical engineer in cohort #1 was still enrolled in the master's program at NMSU.*

To what extent are the engineering matriculation rates to doctoral programs comparable to those of the science students who participated in the AMP-BD program? Table 3, below, provides similar enrollment status information for science majors who had participated in the AMP-BD Program. As seen in the table, three of the ten (33%) women in the sciences who had started a master's program left without a degree, as did one of the nine (11%) men. Additionally, three (33%) of the women who had completed a master's degree in a science field had matriculated into a PhD program, including one woman who directly entered the chemistry PhD program, compared to four (44%) of men, including one man who directly entered the chemistry PhD program and one who had successfully completed a PhD in chemistry.

Table 3. Status of the 19 Natural and Physical Science AMP-BD Students as of 2009

	Left w/o Degree		Completed MS		Enrolled in PhD		TOTAL	
	Female	Male	Female	Male	Female	Male	Female	Male
Agricultural Sciences	1	0	0	0	0	0	1	0
Animal Science	0	0	0	1	0	0	0	1
Astronomy	0	0	0	0	0	0	0	0
Biology	0	0	2	0	2	0	4	0
Chemistry	0	0	1	0	1**	2****	2	3***
Computer Science	0	0	0	0	0	0	0	0
Geology	0	0	0	1	0	0	0	1
Mathematics	2	0	0	0	0	1	2	1
Physics	0	1*	1	1	0	1**	1	3
TOTAL	**3**	**1**	**4**	**3**	**3**	**4**	**10**	**9*** **

**Completed coursework*
***No masters, straight to PhD*
****One male chemist in cohort #4 was still enrolled in the master's program at NMSU.*
*****One male chemist had completed a doctoral degree.*

In a nutshell, the gender gaps in outcomes for students in the sciences are similar to those in engineering - men are more likely to complete a degree and then to matriculate into a PhD program, which is the goal of the AMP-BD program - but the magnitude of the gender gap is much smaller. The stark differences in the engineering fields are important to study.

Case Study Analysis

In this section we provide an overview of each of the students who left the program without a degree and then compare and contrast them to students who were able to complete a master's degree. We use pseudonyms and have avoided use of too much identifying information to protect the confidentiality of the students. All five students who left without degrees had been enrolled in the electrical engineering program.

Three women attempted the engineering technology (ET) to electrical engineering (EE) transition and one man had made this transition early in the program. His case drew attention of the AMP-BD evaluation team and program staff to the significant preparation issues associated with this transition. Two of the women were unable, according to their transcripts, to successfully complete this transition. One was single and of "traditional" college age, while the other was divorced with children and "older". The EE faculty were well aware of the difficulties associated with the transition: one of the faculty members wrote in one such ET to EE student's application:

> ". . . with students transitioning into engineering from ET, it is extremely difficult to judge whether they have the ability to succeed or not. I have advised many ET students in the MSEE program. So far, I've only had one student that truly thrived. I recommend she begin taking courses in EE, monitor her progress, and re-apply."

The stories of two of the ET to EE transitioners who were unable to complete their degrees are instructive. "Jeannette" had a solid undergraduate ET GPA at 3.73, but that declined quickly once in graduate school as an EE. Indeed, her first graduate semester GPA was 2.80 likely due to taking 14 credit hours as a result of an advisor who told her to sign up for whatever classes she wanted. A conscientious advisor would have noted Jeanette's deficiencies and, even if she were a stellar student, would have been unlikely in any case to permit a 14-credit load. By the time she left the program, Jeannette's GPA had risen to 2.85 necessitating that she leave due to her academic status. In her intake interview, Jeannette indicated that she was having difficulty adjusting to the new program, stating, "it is difficult, because it's very different, especially how the classes are taught and everything". Jeannette relayed that in her undergraduate program, there were examples to assist in learning, whereas "in electrical, it's just lectures and lectures and lectures". Poor advising was clearly an issue, along with pedagogical differences between the more applied ET and more theoretical EE for Jeannette. She left the program and the institution with news that she would seek employment, possibly out-of-state.

"Maria", like Jeannette, attempted to transition from ET to the EE program for her graduate work. Maria's undergraduate GPA was 2.94. Her first semester as a graduate seemed promising, a 4.0 GPA, although she had an "Incomplete" that was not factored into the GPA. Her grades quickly deteriorated as she struggled with the new coursework, and, upon leaving the program, her GPA was a 0.75. This must have been exceedingly difficult on Maria as, when asked in her intake interview, she stated she expected to "do very well [in graduate school] because obviously that's the only thing I'm going to concentrate on, um, and I would love to do more research and learn". In addition, Maria prided herself on having "never dropped a class". Maria did have three young children, but had family support and expected to spend about 60 hours per week on coursework and research. Last contact with Maria indicated that she would not be returning to graduate school, but rather seeking employment in the area.

But three of the students who left were in rather good academic standing and seemingly making progress towards the degree. "Rachel" had appeared to make the ET to EE transition rather successfully, while the other two students were both African American males (a very small group in the NMSU College of Engineering) and had undergraduate degrees in electrical engineering; therefore, there were no deficiencies for these students. The most straight-forward among these three was "Michael," who had an undergraduate and graduate GPA of 3.7, hence he was a strong student. Michael had originally transferred to NMSU from an eastern university as an undergraduate and decided to return to his home in the East upon hearing that a close family member was ailing. Michael's plan, at the time of his departure, was to enter a university closer to home and resume his studies. Follow-up contact has not been successful.

"Rachel" was making good progress in completing deficiency classes and had a 3.6 GPA as a graduate student. She was working on a project that she found interesting and had even introduced another AMP-BD student to the project's faculty leader, with whom she was working closely. Her advisor, assigned by the department, was a person different from the faculty leader on the project and she had far less contact with this formal advisor in contrast to the nearly daily contact with the project leader. She had two children, but took being a graduate student seriously, reporting in her intake interview that she was on campus every day from about 8 am until 5 pm and often until as late as 7:00 or 7:30 pm. She also routinely came to campus on

weekends and worked with other students in study groups. She mentioned at one point in her intake interview that she felt that her children did sacrifice a bit in order for her to earn her bachelor's degree, so maybe she felt a well-paying job in the field that she had already chosen would be good from a "family" standpoint? We have no way of knowing this as, seemingly suddenly, Rachel dropped all of her classes and took a job in a field closely related to the research work that she had been completing and lost all touch with the AMP program. When the project director was contacted, he provided no additional information about her, saying, gruffly, that she had left the program.

Similarly, "Eric" was progressing along quite nicely in his graduate program, maintaining a 3.0 to 3.5 GPA every semester, when he also dropped all of his classes and relocated to take a job in a field related to his graduate studies. In one brief follow-up contact since he left, Eric stated he did not know when he would be completing his master's degree. Interestingly, Eric stated in his intake interview that he had decided to go straight from his bachelor's to master's because if he stayed out of school, the "likelihood of my coming back probably wasn't going to be that great". While he was a graduate student, Eric reported that he had a good working relationship with his professors, his advisor provided valuable assistance and mentorship on an almost-daily basis, and he knew the other students in his department well. Eric stated the coursework was challenging, but he was enjoying that it was applied and built on the foundation of his undergraduate studies. Eric stated he was persistent and liked to see projects through to completion. He did not anticipate any barriers or challenges other than meeting teachers' expectations and not over committing himself. Eric reported that his family was very supportive of his educational endeavors, and Eric was looking forward to doing new and interesting things in his field.

Of the students who successfully completed their master's degrees in engineering, all six women were spread across graduate departments other than electrical engineering in the NMSU College of Engineering. Nine of the twenty-one men were in electrical engineering; of these, 6 had completed master's degrees in electrical engineering by 2009, while all 17 of the men in the other departments had successfully completed a master's degree in their field by 2009. These results suggest that there needs to be more attention to issues that might be specific to the EE program as compared to the other four graduate programs in the College of Engineering at NMSU.

Academically, the women were described as "knowledgeable", "motivated to succeed", "stellar student", and as having "excellent academic potential" by faculty members. The women from ET had additional notes encouraging them to build math and engineering research skills. The women's undergraduate GPA's ranged from 2.9 to 4.0, with an average of 3.4. Their first semesters in graduate school indicated continued success as well, with a range from 2.8 to 4.0, and an average of 3.5. Of the women who did not complete their master's degree programs, all of them withdrew from and/or failed multiple electrical engineering courses. Conversely, of the women who gained their master's degrees, only one withdrew from one course, and received an "incomplete" for another. Eight of the nine women had active and involved advisors, and provided guidance and support as expected. The exception was Jeannette, whose advisor failed to adequately guide her in course selection.

Recent research emphasizes that "the classroom environment is a particularly powerful determinant of persistence in engineering, especially for women students"[6]. In light of this, the women who transferred departments between their undergraduate and graduate programs may not have had the cohesiveness or familiarity with the program, staff, faculty, and fellow students necessary for them to be able to thrive, as they had in their previous program. Osborne[6] discusses faculty development programs and external support as ways to increase student achievement. Indeed, if the three women new to the electrical engineering program had felt integrated and supported by the program, they may have been more successful in classes and with obtaining their master's degree. Finally, it may just be the sad fact that "while women engineering students perform as well or better than men students on objective measures of performance, they are still less likely to complete their engineering programs"[6]; these women may have been the norm rather than the exception when compared to their two counterparts.

Conclusions

Although it is impossible for us to determine with any degree of certainty exactly why these students left the AMP-BD program without their master's degrees, it is clear that those who can be potentially located are not interested in sharing their stories with us. Students who, for all intents and purposes, appeared to be very much on track to complete their master's degree somehow failed to do so, even when they had every intention of finishing those requirements within mere months of their exit interview. Although they had received very generous support from the program, these students refused to allow the program to access them at a later time, possibly due to feelings of failing the program and/or personnel.

While all three women who did not complete a master's degree had switched from engineering technology to electrical engineering, this is not a satisfactory explanation for their inability to complete the degree. Such students had successfully made up "deficiencies" that, according to some students, appeared to vary for no apparent reason and were not specified in graduate program documentation. Earlier, one of the AMP-BD program's first cohort students had also been an ET undergraduate who switched to EE as a graduate student. In his case, according to his exit interview, he was frustrated by what appeared to him to have been capricious changes in the deficiencies that he was required to make up. Rachel, one of the ET to EE women who left without a degree mentioned that there appeared to be wide variations in the courses other ET students were being told to take by their advisors. The NMSU electrical engineering page indicates a table that clearly lays out the courses that could be required by non-EE bachelor's degree holders. According to this table, there are only three classes for which there is no ET-equivalent course but, given the pre-requisites and co-requisites for these classes, it is possible that students could be given different advice by different advisors. That is, some advisors might tell a student (s)he has to take the co-requisites while others may not. Of course, the presence of a table does not necessarily mean it will be used by advisors and students; all too often, information that is placed on the web is assumed to be "freely available," yet, without proper training of advisors, they may not be aware of the resources that are available. Related, graduate training is more individual-specific than is undergraduate training. Thus, it is possible that a student wishes to move in a particular research direction and then is told by her/his advisor that additional courses - and related deficiencies - will be necessary. Students who are the first in their family to go to graduate school may be less attuned to this aspect of the graduate

educational process and view the advisor's recommendation as capricious rather than as a functional necessity.

Finally, gender does appear to have been a factor associated with attrition from engineering. The women's inability to successfully complete the master's program could have been the result of many factors converging simultaneously: age, parenting responsibilities, difficult courses, ineffective advising, and the like. Women who leave professional jobs - or in this case, graduate school - for apparent family/work balance issues, are not merely pulled by the demands of motherhood, but they are pushed, often quite harshly, by biased attitudes and actions in the workplace that provide them with no support for combining motherhood and employment[8,9,10]. Conclusions that family issues, themselves, influence leaving must be taken within the context of a growing literature that questions the extent to which women are "opting out"[10]. Unfortunately, in the case of this particular program, the occasional "heavy-handedness" with students who left had negative ramifications for the ability to then follow-up with the students at a later date to monitor their progress, so that some of these students' destinations remain unknown. Further research is necessary to delve into the issues faced by men and women throughout the graduate school experience, in general, and in male-dominated fields, in particular. However, efforts to recruit and retain and graduate women in engineering would be advanced if current practices were better informed by recommendations from the research literature[6].

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