AC 2007-2030: MENTORING OF GRADUATE STUDENTS IN STEM: PERCEPTIONS AND OUTCOMES

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Mentoring of Graduate Students in STEM: Perceptions and Outcomes

Abstract

A significant literature points to the importance of mentoring to ensure individuals' professional success. Although some research indicates that mentoring is critical to ensure the success of graduate students in STEM (Science, Technology, Engineering, and Mathematics) fields, little else is known about mentoring within academic settings. Since 1998, the University of Washington's Center for Workforce Development (CWD) has provided a mentoring program specifically for STEM graduate students. The mentoring program is unique in the amount of data that it collects about the participants in order to better understand the mentoring program's effects on retention and career outcomes. This paper discusses the evaluation and tracking of mentoring program participants and the findings of this assessment. Graduate students report both psychosocial and instrumental benefits from their mentoring relationships. In addition, most program participants complete their intended degree and continue to work in their field of study.

Introduction

Mentoring of graduate students in STEM (Science, Technology, Engineering and Mathematics) is one of the most effective ways to ensure student success¹⁻⁴. The University of Washington's Center for Workforce Development (CWD), formerly Women in Science and Engineering (WiSE), developed a mentoring program for STEM female graduate students interested in faculty careers in the 1990's. Subsequently, the mentoring program has evolved to reach out to underrepresented minorities interested in faculty careers and to all graduate students interested in careers in the field of nanotechnology. Students are matched with a faculty or industry mentor, based on their needs and interests. The program focuses on both the psychosocial and instrumental career development needs of graduate students. During the 2005-2006 academic year, the mentoring program served a total of 59 graduate students in 18 STEM departments, including Mechanical Engineering, Biology, Electrical Engineering, and Chemistry. Since its inception, CWD's mentoring program has served more than 180 students across science and engineering disciplines. Among the goals of the mentoring program are to provide students with personal and career guidance and to increase the retention of graduate students in STEM fields, particularly among women and students of color.

This graduate STEM mentoring program is unique in the amount of data that it collects for assessment. To evaluate whether the program is achieving its goals, CWD mentoring program staff collect data in three ways – through an annual evaluation, use of the university's student database, and a longitudinal tracking assessment. The annual evaluation has been an assessment fixture of the program since the mentoring program began in 1998. It asks participants questions about the frequency and type of contact between mentors and mentees, questions related to perceived impacts on retention and career planning, as well as others ways participants feel the program may have benefited them. The university's student database is used to follow the degree progress of mentoring students. The student database allows program staff to collect accurate enrollment data about graduate students. Additionally, it allows program staff to look at

retention of graduate students by determining when students leave their program or take a leave of absence from the university. The longitudinal tracking assessment is a newer addition to the data collection. In recent years, CWD program staff has informally contacted many former students to learn about their career outcomes. The mentoring program has formalized this tracking of students into a series of surveys that will be administered to student participants from now on. These surveys ask questions about how the student came to be interested in their field, their career goals and, for the post-program surveys, about the participant's job and career satisfaction.

This paper looks at the experiences of STEM graduate students during and after their participation in a mentoring program in an attempt to add to the literature on academic mentoring programs. This addition is important given that the literature on academic mentoring programs is more sparse than that on industry mentoring programs. In the paper, the authors look at how students experience the mentoring program and how they benefit from their participation. In addition, the paper looks at the career expectations of graduate students in the mentoring program and the actual career outcomes of past participants. Finally, this paper discusses the design of the new longitudinal tracking assessment and what CWD hopes to learn from this evaluation piece.

The large amount of assessment data collected enables a more in-depth analysis of the impact of graduate mentoring programs than is typically possible, which allows CWD to have a better understanding of how the mentoring program might influence career outcomes. Looking at the data that this mentoring program has collected about participants and their experiences during and after participation in the program helps generate information about graduate mentoring programs and their impacts.

Literature Review

Mentoring theory posits that mentoring is related to career success, and that the degree of career mentoring should be positively associated with the degree of career success⁵. Social learning theory⁶ is also used to explain why mentoring provides the benefits it does. Socialization is often described as one of the benefits of mentoring. It provides role-modeling opportunities and also a realistic picture of the norms and expectations of a particular field of study.

Theories discussed the positive effects of mentoring for years before quantitative data was available to support the propositions. Quantitative data on the effects of mentoring relationships has only more recently become available, enabling testing of mentoring theories⁷. Data on mentoring in industry has been more plentiful than data on academic mentoring, but each new study of mentoring in academe seems to lend support to the mentoring theories. For example, in educational settings, greater satisfaction^{4,8} and productivity³ have been found to be associated with mentoring.

It is widely accepted that there are two main functions of a mentoring relationship: one is to provide career and instrumental support, and the other is to provide psychosocial support^{5,9,10}. Psychosocial support has been found to be more highly associated with satisfaction with the mentoring relationship than instrumental support¹⁰. Additionally, Tenenbaum et al³ find that

instrumental mentoring has a positive effect on a graduate students' productivity, and that psychosocial mentoring impacts satisfaction with the mentor and satisfaction with graduate school. Instrumental mentoring is the type of mentoring typically concerned with professional development, while psychosocial mentoring involves more counseling and empathizing³. Interestingly, one study of 12 universities found that graduate students were more likely to report that their mentors provided them with psychosocial assistance more than instrumental assistance⁴. This result indicates that graduate students may be less likely to receive the type of mentoring which increases productivity.

Mentoring is a common strategy used by higher education institutions to provide socialization to their female graduate students, but also for the purposes of increasing retention and helping the students succeed^{11,12}. Recruitment, retention and advancement of female graduate students in STEM is essential to creating a strong and competitive future workforce. There is some evidence that formal mentoring programs in academic settings have positive effects on retention. Undergraduate students that are part of formal mentoring programs have higher graduation rates than their peers and higher rates of persistence from undergraduate to graduate degrees¹³. However, it is important not to forget that socialization is itself a positive outcome of mentoring. In their research on mentoring in academe, de Janasz and Sullivan¹⁴ describe the core competencies needed for academic careers as the development of beliefs and identities (knowing why), the knowledge and skills (knowing how) and networks (knowing whom). Other researchers discuss socialization as the process of exposure to discipline-based norms and career expectations through which graduate students gain these core competencies^{11,15-17}.

In addition, De Valero¹⁸ finds that in departments with high graduate student completion rates as well as short time to degree, students were more likely to describe their relationship with their advisor with positive, affectionate terms. It is not clear that these advisor relationships are truly mentoring relationships, but it is likely that they are at the very least providing some of the benefits of mentoring, such as socialization and networking. While this is not a causal association, it seems that advisor relationships which provide mentoring-like benefits can have some impact on retention to graduation. Ulku-Steiner, Kurtz-Costes, & Kinlaw¹⁹ found that the level of mentor support was positively associated with level of career commitment, regardless of gender of the mentee or mentor. While career commitment is a measure of student perceptions rather than actions, using this variable can yield interesting insight into the effects of mentoring.

Green and Bauer² studied the benefits of mentoring within a graduate student/advisor relationship. The student/advisor relationship is a formal one, which involves supervision of the subordinate by the advisor and is slightly different than other mentoring relationships with superiors without supervisory authority. There is some evidence that advisors put more energy and time into mentoring students who initially show high aptitude and motivation². The Tenenbaum et al³ study is one of the few quantitative studies of the academic milieu, and its findings mostly concur with previous findings from quantitative studies of mentoring in the business world.

For example, in work and industry settings, mentoring has been associated with increased pay, promotions, and increased commitment and satisfaction with one's career^{3,20,21}. Ragins and Cotton²² find that participation in formal mentoring in the workplace which also employs

elements of informal mentoring is associated with workers' positive attitudes regarding their career and job.

In a meta-analysis performed by Allen, Eby, Poteet, Lentz and Lima¹⁰ regarding the research on career benefits for mentees, they find that there is evidence for positive career effects from mentoring, but that in some cases, the strength of the effect depended on the type of mentoring provided. This meta-analysis is the first quantitative summarization of the literature on benefits for mentees, and it focuses on mentoring in the workplace. There is less research on the benefits of mentoring in academic settings, and it is possible that findings which are based upon workplace research will not completely apply to the academic setting.

Some researchers hypothesize the idea that socialization through mentoring is not enough, and that programs must develop and implement additional ways to help students learn what it means to be a professor¹¹. Additionally, other authors argue that traditional one-on-one mentoring may not provide all the benefits for women and people of color, and that other types of mentoring would be helpful in this regard. Chesler and Chesler¹² suggest that although traditional mentoring is effective, other forms of mentoring such as multiple or peer mentoring may be more helpful to women. In disciplines such as STEM, women may have a harder time with the construction and maintenance of a relationship in a traditional mentoring program¹².

Davidson & Foster-Johnson¹ argue that successful mentoring of graduate students by their professors is paramount for degree completion. This is problematic given that mentoring relationships are not often reported by graduate students of color. The authors suggest means for becoming a more competent cross-race mentor. Brown, Davis and McClendon²³ echo the lamentations of Davidson and Foster-Johnson regarding the dearth of both research on and actual mentoring of students of color.

As the literature shows, mentoring relationships can provide a number of benefits to participants. This includes both psychosocial and instrumental benefits and helping with overall satisfaction and self-confidence, in addition to increasing productivity and increased networking opportunities. These benefits can come from a traditional one-on-one mentoring relationship, but women and people of color may receive additional benefit from other types of mentoring such as peer and group mentoring.

Background

The University of Washington's Center for Workforce Development (CWD), formerly Women in Science and Engineering (WiSE), has been offering a mentoring program for graduate students since 1998. The Faculty and Graduate Student Mentoring Program (FacGrad) was developed at that time to work with female graduate students interested in faculty careers. Since that time, CWD has worked with various academic units on campus to accommodate other graduate students interested in either faculty careers or careers in industry. Starting in 2001, CWD formed a partnership with the UW Center for Nanotechnology to develop the Nanotechnology Mentoring Program for their students. In 2003 and lasting for two years, CWD developed a partnership with the UW Chemistry Department to develop the Chemistry Mentoring Program for their students. In addition, since 2005, CWD has had a partnership with

the UW Electrical Engineering Department that involves recruiting male and female students from their department to the FacGrad program. Furthermore, in recent years, the focus of the FacGrad program has expanded to include targeting underrepresented minorities working on STEM graduate degrees.

Although the mentoring program works with different populations of students and mentors, there are common goals. The goals of the mentoring program are to:

- Provide STEM graduate students with personal and career guidance,
- Encourage graduate students to pursue STEM fields,
- Enhance retention of students pursuing STEM graduate degrees,
- Prepare graduate students with a realistic viewpoint of faculty or industry experiences in their chosen field, and
- Utilize mentors' expertise for the professional and personal development of STEM graduate students.

The breadth of the goals of the program speaks to the breadth of issues dealt with within the mentoring relationships and in the programmatic information from the mentoring program staff.

Through the mentoring program, students are matched with a faculty or industry mentor, as appropriate, who can help them with their stated professional and personal needs. The program uses an updated version of the *Curriculum for Training Mentors and Mentees in Science and Engineering*²⁴ to help participants establish and facilitate successful mentoring relationships. The one-on-one mentoring matches are supplemented by emails and workshops on topics relevant to the professional and personal development of graduate students in STEM fields. Although all graduate students in science and engineering are invited to attend the workshops, special outreach is done to encourage mentoring program participants to attend. In this way, the mentoring program attempts to provide opportunities for more than traditional one-on-one mentoring, by bringing peers together who might realize they have commonalities and can help one another learn and succeed.

Mentoring program participants are recruited in various ways. In addition to advertising the mentoring program at academic departments' autumn orientation sessions, a large amount of advertising is done through emails to academic departments and graduate student clubs, as well as to female graduate students in science and engineering fields. Other participants hear about the program through word of mouth. Each student interested in the program completes an application that helps to illuminate their needs and interests. The form asks the student about her or his academic program status, research interests, professional goals, and the reasons that she or he is interested in the mentoring program. Using this information, CWD can identify an appropriate mentor from among existing identified faculty and industry mentors or will recruit a new mentor appropriate for the student. New mentors are identified through alumni networks, current mentors, faculty members, and college administrators. Potential mentors are sent a short biographical sketch of the unmatched mentee. Names, contact information, and other identifying information of students are kept confidential until mentors agree to participate.

Upon being matched, mentors and mentees are introduced over email and receive a packet with the mentoring handbook and other materials. They are encouraged to read the handbook, think

about their expectations of the mentoring relationship, and fill out a joint “Mentoring Agreement” to outline the parameters of their relationship. During the autumn quarter, program staff organizes an annual Welcome Session and Mentoring Training for all program participants in order to help them through this process. Mentees and mentors who have not previously attended a Mentoring Training are especially encouraged to attend. During the Mentoring Training, program staff talk to mentees and mentors about ways to develop and maintain successful mentoring relationships.

Participants receive regular communication from the program staff throughout the school year. Each quarter, program staff emails each mentoring pair to check on their status and any concerns or comments they might have. In addition, mentors and mentees receive three programmatic emails a month. Two of the emails include articles on professional and personal development issues for science and engineering graduate students from publications such as *Science*, *Nature*, *Chronicle of Higher Education*, and *Inside Higher Ed*. These emails touch on issues such as time management, finding post-doctoral positions, diversity in science and engineering fields, government careers for scientists and engineers, and communicating with advisors. The third monthly email addresses issues relevant to a mentoring relationship such as periodically evaluating whether the relationship is meeting the pair’s needs, giving advice on re-establishing contact with a mentor or mentee, and pointing to other resources on campus that can enrich the professional development of graduate students. Having regular and consistent communication with mentoring participants allows program staff to quickly learn when mentors and mentees need help connecting with each other or when a match is not working well. In addition, it provides mentors and mentees with ideas for conversation topics and reminds them to contact their mentor or mentee.

Although many mentoring programs focus solely on the psychosocial or instrumental needs of mentees, CWD’s program focuses on both issues. Filling both of these needs is important for success in mentoring of graduate students. Furthermore, it allows CWD to attract more mentees to the program. On the initial application, some students indicate that they are coming to the mentoring program for assistance with psychosocial needs whereas others indicate an interest in using a mentoring relationship for more instrumental needs, such as furthering their career development. By offering both psychosocial- and instrumental-focused mentoring, students who may have only identified a need for one or the other type of help are able to get assistance of both types.

Methodology

As of December 2006, over 180 students have participated in the mentoring program. As seen in Table 1, the majority of all mentees, as well as the majority of the FacGrad and Chemistry mentoring program mentees, have been women. The Nanotechnology Mentoring Program targets all students involved with the UW Center for Nanotechnology, a group that is predominantly male; this helps explain the large difference in the gender composition of that program compared to the other programs.

Table 1. Frequencies of Mentoring Program Mentee Participants by Gender

Mentoring Program	Total	Male	Female	% Female
FacGrad	112	4	108	96.4%
Chemistry	24	7	17	70.8%
Nanotechnology	46	35	11	23.9%
Total	182	46	137	74.8%

Although more than a third of the mentees have been Asian or Pacific Islander, few participants are from ethnic groups that are underrepresented in STEM fields. As Table 2 shows, since 1998, there have been 4 Hispanic participants, 2 Native American participants, 4 Black or African American participants, and 3 participants who identified as other races or ethnicities. In addition, 16 students did not indicate a racial category. In the past year, the mentoring program has started to target students of color who are traditionally underrepresented in STEM fields. In the future, the program plans to do more focused recruitment of these students that will lead to an increase in diversity among mentoring program participants.

Almost one third of the participants have been international students, with the majority coming from Southeast Asian countries, such as China and Thailand. There have also been participants from a variety of other countries, including Ethiopia, Germany and Mexico.

Table 2. Frequencies of Mentoring Program Participants by Race and International Status

Race/Ethnicity	Domestic		International		Total	
	N	%	N	%	N	%
Caucasian	84	68.9%	6	10.0%	90	49.5%
Asian or Pacific Islander	24	19.7%	38	63.3%	62	34.1%
Black/African-American	3	2.5%	1	1.7%	4	2.2%
Hispanic	3	2.5%	1	1.7%	4	2.2%
Native American	2	1.6%	0	0.0%	2	1.1%
Other	0	0.0%	3	5.0%	3	1.6%
Not Indicated	6	4.9%	10	16.7%	16	8.8%
Total	122	100%	60	100%	182	100%

Note: The students who marked 'other' identified as: Black Pakistani, Turkish and Serbian.

The mentoring program is assessed in three different ways – with an annual evaluation, with information from the university's student database and through student longitudinal tracking. The annual evaluation and student database verification have been pieces of the program assessment since the mentoring program's inception. The longitudinal tracking piece has been added in the last year, and is expanding to collect even more information about current and future participant experiences.

Annual Evaluation

The mentoring program annual evaluation is administered at the end of every academic year to mentors and mentees as an online survey. Because this paper focuses on mentee experiences and career outcomes, only the results of the annual mentee evaluation are included here. The survey asks questions about the frequency and type of contact that is happening between mentors and mentees, as well as questions related to the perceived impact of the program on retention and professional development. Further, the evaluation asks questions related to participants' expectations and experiences with the program, and about the mentees' future career plans. Asking about these topics helps the mentoring program identify its successes, improve its activities, and can provide a measure for how well the program is retaining graduate students in science and engineering, one of the goals of the program.

Student Database Information

In addition to the assessment pieces, CWD's mentoring program maintains a dataset of enrollment and degree progress for all program participants. The enrollment and degree status of every student in the mentoring program is verified quarterly through a review of the university student database. Any information about degrees received is recorded in the student's file and compared against the degree the student indicated was their intended degree upon entering the mentoring program.

Student Longitudinal Tracking

In recent years, CWD has become increasingly interested in knowing about the career outcomes of past mentoring participants. Anecdotally, program staff knew where some former participants ended up taking jobs, but there had not been any formalized way of following up with past participants. Beginning in November of 2005, CWD program staff began to contact former participants in informal ways to find out where they ended up after leaving the university. For some former students, CWD had longer-term contact information, but for others, the program staff contacted former advisors or used other university and internet search resources to find contact information on former participants. Often, advisors will keep in touch with their former students, and can be a useful resource for the purposes of this evaluation. Since this follow-up of students was undertaken only in the last year, the program has had difficulty finding and contacting former students, especially amongst participants who left the university many years ago.

Future Student Longitudinal Tracking

The student longitudinal tracking piece described above has been an interesting and useful way to learn about the career outcomes of former students. However, CWD wanted to know more about the impacts of the mentoring program on retention and career outcomes and developed a more systematic way of tracking all students during and after their time in the mentoring program. CWD program staff suspect that this extensive data collection will make the mentoring program unique and help to answer important questions about the effects of mentoring programs on career outcomes and retention.

CWD has been tracking students involved with the nanotechnology center on campus since 2001, and the tracking assessment for the CWD mentoring program was developed based on this protocol. This tracking is broken into four pieces, administered to the student over their time in the program. Overall, the student longitudinal tracking asks questions related to their interest and satisfaction in their field, their career prospects and outcomes and their perceptions of the mentoring program.

There are four pieces of the expanded student longitudinal tracking:

- The initial survey is given to students following their entrance into the mentoring program. This survey asks questions about the student's background, how they came to be interested in their field and their satisfaction with their research facilities and coursework. In addition, the student is asked whether they feel their program of study has prepared them for an academic job, an industry job or both. Finally, the students are asked about barriers to their academic progress and positive influences that encourage them continue in their field.
- The continuing survey is given to students at the end of every academic year and asks similar questions regarding the students' satisfaction with their degree programs and facilities, how far they have progressed into their degree, and barriers and positive influences to their academic progression. This survey also asks if the student is still in contact with their mentor. Finally, the survey asks multiple questions about the students' career plans.
- The exit survey is given to students immediately following receipt of their degree or departure from the mentoring program. This survey asks students about their career prospects and plans and the impact that the mentoring program had on their graduate experience. If they have secured a job, the exit survey asks about their job search and the position they obtained. The survey asks all participants about work-family balance considerations that are important in their job search, such as access to childcare and availability of flexible work hours. Finally, the survey asks if the student plans to continue their mentoring relationship outside the confines of the university.
- The follow-up survey is given to students who have graduated or otherwise departed from the university. This survey is given to students once a year for five years after they have left the program. This survey tracks the professional progress of students, asking about job placement and whether they are using the skills and knowledge they learned in graduate school in their job. Finally, this survey also asks if the student is in contact with the mentor they had from the program.

With a more methodical tracking of students during and after their time in the mentoring program, CWD hopes to have a better understanding of how the mentoring program has impacted all of its mentee participants, as well as more information about students who choose to participate in formalized mentoring programs. Following students over time will help the program better understand how a mentoring relationship and participation in a mentoring program can affect academic retention and satisfaction as well as career outcomes. In addition, CWD mentoring program staff will be able to look at how students with different backgrounds are impacted by their participation in the mentoring program. By the end of the 2006-2007

academic year, CWD staff will have sent out initial, continuing and exit surveys to current mentee participants and contacted former participants with follow-up surveys.

Results

The following presents some of the relevant findings from the annual evaluation, the information from the university student database, and the student longitudinal tracking thus far. Overall, mentee participants have expressed satisfaction with the mentoring program, and felt that they had received both instrumental and psychosocial support. Most mentee participants are completing their intended degree and the past participants are working in a variety of positions in both academe and industry, most in jobs related to their field of study.

Annual Evaluation

In the past few years of annual evaluations, mentee participants have conveyed that they are generally satisfied with the mentoring program. The findings in this section present data from the most recent annual evaluation, conducted in Spring 2006. Of the 48 mentees actively participating in the mentoring program at that time, 30 completed the annual evaluation, a 62.5% response rate. Most mentees, 77% (n = 23), say that their mentoring match is a good one, and most (86.7%, n = 26) indicate that the amount of access that they had to their mentors was just about right. One mentee commented in the annual evaluation that “My mentor was an excellent match in terms of academic interest and outside interests both. We had a lot in common and it was great to share experiences about graduate school, teaching and women in academics.” This comment is one example of how a good mentoring match can bring a mentee both instrumental career development advice and psychosocial support.

**Table 3. Percentage of Mentees Indicated
Specific Expectations of Benefits (n = 30)**

Benefit	N	%
Receive career guidance	27	90.0%
Increase academic confidence	23	76.7%
Help with balance in life	21	70.0%
Receive academic support	20	66.7%

Mentees expect that the mentoring program will allow them to receive career guidance, will increase their academic confidence, will help with balance in their life and allow them to receive academic support (see Table 3). Some mentees also made comments of the benefits they were expecting – a few were hoping to develop friendship with their mentor, and one noted that she hoped to gain “useful information and emotional support during a challenging degree program.” Most mentee participants (57%, n = 17) also indicate that their expectations of the program had been met or exceeded, another 36.7% indicate that some of their expectations of the program had been met.

Among the ways that mentees indicate that the mentoring program most benefits them are that it: 1) helps them better prepare for their career; 2) provides an alternative support network; and 3) increases their confidence or self-esteem (see Table 4). Many mentees also felt that the

mentoring program helped them with their academic progress, gave them networking opportunities in their field, and was a contributing factor to helping them continue in their field of study. As Table 5 shows, though there is only limited data, mentees that indicated that they had good access to their mentor and a good quality match generally receive more benefits from the program. A mentee participant commented that, through the mentoring program, she received “useful information and emotional support during a challenging degree program.” Comments such as these and the data shown in Table 5 underline that mentees are more likely to feel they benefited from the program if they have a mentor whom they feel they are compatible with and also if they interact with that mentor more often.

Table 4. Percentage of Mentees Indicating Specific Benefits from Program (n = 30)

Benefit	N	%
Helps better prepare for career	21	70.0%
Provides and alternative support network	20	66.7%
Increase confidence/self-esteem	15	50.0%
Helped with academic progress	12	40.0%
Helped networking in field	10	33.3%
Helped student decide to continue in field	10	33.3%

Table 5. Average Number of Mentoring Program Benefits Received by Mentees, Associated with Quality of Match and Amount of Access to Mentor (n = 30)

Amount of Access to Mentor	Quality of Match			Total Average
	Good	Unsure	Bad	
Too little interaction	2.0 (n = 1)	--	0.0 (n = 2)	.67 (n = 3)
Just enough interaction	4.4 (n = 22)	2.8 (n = 5)	--	4.0 (n = 27)
Too much interaction	--	--	--	--
Total Average	4.3 (n = 23)	2.8 (n = 5)	0.0 (n = 2)	3.7 (n = 30)

The annual evaluation is also a chance for CWD to learn what mentoring pairs discuss together. Many mentees answered that career options and opportunities (70%, n = 12), their relationship with advisors (63.3%, n = 19), publishing opportunities (43.3%, n = 13), and conferences (40%, n = 12) are popular topics of conversation with the mentor. One mentee was enthusiastic about her mentoring relationship and the ease of discussion, commenting on the annual evaluation that “We’ve been in a mentee-mentor relations for over 3 years... We have chatted about all kinds of work and family/personal-related subjects.” Mentees are able to talk about both instrumental development issues such as publishing opportunities, but also use the relationship as a way to gain psychosocial benefit.

**Table 6. Mentee Career Plans
(n = 30)**

	N	%
Academia	6	20.0%
Industry	9	30.0%
Government	1	3.3%
Other	3	10.0%
Undecided	11	36.7%

The annual evaluation asks mentees about their career goals and if the mentoring program has had any effect on those plans. Twenty-two mentee participants responded that they are planning on taking jobs in their field of study following graduation (73.3%), while another six are unsure (20.0%). Table 6 shows the expected career plans of the mentee participants after leaving the university. There is a slight leaning amongst the mentee participants to careers in industry, but the plurality of participants is undecided about their future plans. Only 23.3% of mentees replied that they plan to take a post-doctoral fellow position after graduate school (n = 7), while another 36.7% were unsure (n = 11). Many mentee participants responded that the mentoring program has made an industry career seem more achievable (36.7%, n = 11), as well as a faculty career. (36.7%, n = 11). Further, many answered that the mentoring program helps them think about the practical applications of their degrees (46.7%, n = 14).

Student Database Information

The information from the university student database on mentee enrollment and degree progress provides an effective way to track student retention and degree completion. The dataset collected from this resource includes information on the 183 students who have participated in the mentoring program since its inception. Of these, 93 have either graduated or left the university without a degree and 90 are currently enrolled, as of Autumn 2006.

As Figure 1 shows, of those mentee participants who have left the university, seven left without a degree, thirty-three left with a master's degree and fifty-three left with a doctoral degree. When applying to the mentoring program, student participants are asked what his or her intended degree is, and this intended degree is compared to the actual degree he or she receives when leaving the university to create a completion rate. Of these 93 students, 76 left the university with their intended degree or a higher degree, which is more than an 80% completion rate.

Figure 1. Degrees Earned by Mentee Participants

Figures 2 and 3 show the completion rates of intended degrees amongst different demographic groups in the mentoring program. Amongst international students who have left the university, more have completed their intended degrees than domestic students – 88.6% of international students (31 of 35), compared to 77.5% of domestic students (45 of 58). Amongst male students who have left the university, more – 18 of 20 – have completed their intended degree than female students, though the completion rate for women is still high (58 of 74). Seven underrepresented minorities have left the program, with five completing their intended degree (71.4%).

Figure 2. International v. Domestic Degree Completion Rates

Figure 3. Male v. Female Degree Completion Rates

Student Longitudinal Tracking

As the student tracking is a relatively new piece of the assessment process, there is less data than from other parts of the program assessment. Since the mentoring program has started contacting past participants, post-graduate school employment data is available for 53 of the 93 participants who have left the university, a 57% response rate. Of those who were contacted, 22 former participants report that they are employed in academe and 27 are in industry. Two others are continuing their education at other universities and another two are seeking additional non-STEM degrees at the University of Washington. Past mentee participants have been gone from the university for, on average, three years, with some having left as long as seven years ago. Table 7 shows the gender breakdown of past mentee participants who are now in the workforce.

Table 7. Breakdown of Career Outcomes by Gender (n = 49)

	Academe		Industry	
	N	%	N	%
Male	6	60.0 %	4	40.0 %
Female	16	41.0 %	23	59.0 %
Total	22	44.9 %	27	55.1 %

The former mentees working in academe have taken positions in labs and as faculty at universities around the country and world, including Harvard University, Stanford University and Japan University. Of the 22 students working the academic sector, 11 are post-doctoral fellows in research groups, 8 are in faculty positions and 3 work in other capacities, such as researchers or as staff. Many of the post-doctoral fellows are from the fields of chemistry and chemical engineering, though a few are in materials science and engineering or civil engineering. Those in faculty capacities are almost all in the fields of computer science and industrial engineering. Of those who left with a doctoral degree, 54.5% are in academe.

A number of mentoring program participants now work in private industry or in governmental labs after completing graduate work at the university. Thus far, 27 former students are in positions in industry, mostly with science and engineering related companies, such as

Honeywell, Ford Motor Company and Zilog, Inc. Of those who left with a master's degree, almost all (80.0%) are in the industry sector.

Discussion

Overall, the assessment data collected by CWD's mentoring program indicate that efforts to provide an effective mentoring program for STEM graduate students are succeeding. Students currently involved with the program indicate that they are satisfied with the program and that they are receiving psychosocial and career development benefits from being in a mentoring relationship. In addition, mentoring program participants have a high likelihood of retention within their degree program and complete their intended degrees. Finally, many of the former mentee participants are now working in industry and faculty jobs related to their field of study. All of these are indicators of the success of the mentoring program.

Much of the small body of literature on the mentoring of graduate students indicates that mentoring has positive effects for students^{3,4,8}. The fact that the majority of the mentee participants indicate receiving multiple benefits from the program, both instrumental and psychosocial, fits with the literature on mentoring benefits. Furthermore, a large proportion of mentees complete their intended degrees and many go on to work within their fields of study. This indicates that the program has been successful in retaining students within their fields of study.

In the annual evaluation, a majority of mentees indicated that the mentoring program better prepared them for their career and increased their confidence or self-esteem. Furthermore, both mentees and mentors indicated in the evaluation that the program has a positive effect on the mentees' lives. Anecdotally, most mentees seem to be looking for either psychosocial or instrumental support when they enter CWD's program. The annual evaluation indicates, however, that regardless of their stated needs, students are receiving both instrumental and psychosocial support. Given the literature that points to the importance of both aspects of mentoring^{3,10}, these results suggest that CWD's mentoring program is successful. It may be that students who are only looking for one or the other form of mentoring receive both forms because of the way that the mentoring program is structured. For example, the semi-monthly topical emails that are sent out to participants touch on both psychosocial and instrumental issues. By doing this, mentoring program participants are encouraged to talk about both sets of issues within the context of their mentoring relationships.

The annual evaluation continues to have many practical effects on the program, as the program continues to evolve based on these evaluations. For example, in the 2005-2006 mentoring program evaluation, a mentor suggested the need for further training about how to be effective with her mentee. The monthly mentoring training emails were developed and implemented based on discussions spurred by this comment. Previously, the semi-monthly topical emails also grew out of a comment on the annual evaluation from a mentee who said she would like suggestions for topics to talk about with her mentor.

In the annual evaluation, CWD asks a number of questions about career plans and how the mentoring relationship and program may have impacted those plans. A large proportion of

mentoring participants indicated that they were unsure about whether or not they would pursue a post-doctoral fellow position after graduation. This result is interesting given the increase of post-doctoral positions across STEM fields in recent years. Overall, mentees in this program are interested in many career paths such as industry and government, and most are interested in pursuing a job in their field of study. Many also answered that the mentoring program has made both faculty and industry careers seem more achievable, an indicator of success.

The information gathered from the university student database shows that more than 80% of mentee participants are completing the degree they intended to receive when they entered the mentoring program, which is a high completion rate. Further, almost 60% of mentee participants received their doctorate degrees, and only seven of the ninety-four participants left without any graduate degree at all. The high rates of degree attainment support the literature that says that mentoring encourages retention and productivity^{1,3,18,20,21} – mentee participants may feel a renewed commitment to their degree when interacting with a mentor who can act as a role model.

After mentee participants leave the university, the mentoring program is no longer an active part of their lives. Anecdotally, however, mentoring program staff know that some mentoring pairs continue the relationship, and CWD believes that the effects of the mentoring program continue after the student leaves the university. From the follow-up surveys completed so far, it seems that slightly more participants are taking industry positions rather than academic positions. However, the type of jobs that they take is also related to the level of degree they receive – almost all participants with master's degrees have taken industry jobs, while a majority of doctorates have taken faculty and other academic positions. Given the qualifications needed for most academic careers, it makes sense that the students with master's degrees are not pursuing these opportunities. The fact that so many of the student participants with doctoral degrees pursue academic careers is an indicator of the mentoring program's success.

As noted in an earlier section, CWD's mentoring program is particularly interested in working with women and underrepresented minorities in STEM fields. Almost 80% of the female mentees who have left the university have received their intended degrees, and of the former female mentees contacted, 41.0% are working in academe and 59.0% are working in industry. Although the literature on women and mentoring suggests that women may benefit more from non-traditional mentoring than traditional mentoring programs¹², it appears that the women in this program are benefiting. This may be because of the peer mentoring that exists through the professional and personal development workshops that CWD's program offers or because of the highly structured nature of the one-on-one mentoring relationships. It may be that the frequent emails and advice from program staff helps women have successful one-on-one mentoring relationships. The mentoring program has had only seven students leave the university who are considered underrepresented minorities, but five of them left with their intended degree. Despite the small sample size, CWD believes that this result is an indication that students are succeeding in their degree programs and are receiving help from the mentoring program. It is particularly important that students of color have access to mentoring programs like this one because they are more often in need of mentoring^{1,23}. Davidson and Foster-Johnson¹ point to the need to train mentors for cross-race mentoring because many mentees of color are paired with white mentors.

By addressing cross-race mentoring in the mentoring curriculum, the CWD mentoring program is helping mentors and mentees with these issues.

The mentoring program also serves international students in STEM fields. Because international students are a large proportion of graduate students in STEM fields at the University of Washington, it is important to serve this population. Collected data from the mentoring program shows that a very high proportion of the international students in the mentoring program are leaving with their intended degrees, indicating that the program may be helping them reach their goals.

However, there are some limitations to the research presented here. One clear limitation is that the program does not have a control group with which to compare findings. Although a large proportion of student participants are completing their intended degree and finding work within their fields, it is difficult to say to what extent this result is based on their experiences within the mentoring program. Furthermore, with regard to tracking students after they leave the university, the program has only been able to contact just over half thus far. In the future, with more systematic tracking, the mentoring program should be able to follow a greater proportion of our students through their graduate careers and beyond.

In the coming years, the mentoring program intends to further the longitudinal tracking of graduate student mentoring program participants. The initial findings that suggest that the mentoring program may be successful in retaining graduate students in STEM fields also suggest that further research may be valuable for understanding the effects that the mentoring program has on retention rates, career outcomes and satisfaction with graduate education. Learning more about mentoring program participants will allow the program to better understand the complex issues surrounding who succeeds in mentoring relationships and ways that the relationships benefit graduate students. The types of questions that the longitudinal tracking will be asking will allow the program to learn about, for example, how a graduate student's satisfaction with their academic program changes over time in relation to the quality of their mentoring relationship.

Conclusion

The University of Washington Center for Workforce Development (CWD) offers a mentoring program for graduate students in STEM fields that has served more than 180 students since its inception in the 1990's. This mentoring program is unique in the amount of data it collects to evaluate its program and to better understand the effects of the program on its students' retention and career outcomes. There are three parts to the program assessment: an annual evaluation, use of the university student database and longitudinal tracking. The annual evaluation asks participants about their general perceptions of the program, perceived benefits of the mentoring program and their relationship, and how the program may have affected their career planning and development. Use of the student database helps the mentoring program track enrollment and degree status of students involved in the program. The longitudinal tracking piece is a newer piece of the assessment that will allow CWD to follow students throughout their time in the program and better understand the effects of a mentoring program on career outcome and retention.

From the data collected thus far, it seems that participants are gaining both instrumental and psychosocial benefits from the mentoring program, and that most students are completing their intended degree and working within their field. In the most recent annual evaluation, most mentees answered that the mentoring program had helped them better prepare for a career, had provided them with an alternate support network and had helped increase their self-esteem and confidence. Use of the student database shows that more than 80% of students are leaving the mentoring program with their intended degree or higher. Finally, the beginnings of the longitudinal tracking assessment show that former mentee students are working in both academe and industry, with most continuing to work in their field of study, regardless of the sector. In the future, with more longitudinal data, CWD will be better able to understand the effects of a graduate mentoring program on student satisfaction, retention and career outcomes.

Through providing a mentoring program for STEM graduate students at the University of Washington, CWD is able to help a handful of students, but through increasing the knowledge base and available data about mentoring of graduate students, CWD hopes to be able to help more STEM graduate students both at this university and at other universities.

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