

The Doctoral Program in Engineering and Computer Science: Is It the Same for Women and Men?

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Abstract— We are interested in learning why the completion rate of the doctoral degree in engineering and computer science is lower for women than for men and have been funded by a large NSF-funded study (#0634519) to discover the answers. As a part of this study, we wanted to know if women are experiencing different discouragers than men or do they react to the same discouragers in a different way? Do men receive more encouragers than women in their doctoral programs? We are interested, in particular, in the little encouragers and little discouragers that students encounter that can accumulate to the point of affecting the completion of the Ph.D.

To answer these questions, we held separate focus groups with domestic women, international women, domestic men, and international men to help determine the differences, if any, that women doctoral students in engineering and computer science experience. All of the students were enrolled in the Ira A. Fulton School of Engineering at Arizona State University. The Ph.D. students in the focus groups were in at least their second year of a doctoral program or had already completed a Master's degree if they were in their first year of a doctoral program. The focus groups were held with the same facilitator, same questions, and the same trained note takers. In addition, the 90-minute focus groups were recorded for accuracy and the students were identified by number only.

We asked all focus groups if graduate school was different for women, as well as the identification of encouragers and discouragers in their doctoral program. We also asked the students to rank these influences on their lives and to give possible solutions that they had tried and whether these solutions succeeded or failed to reduce the stress. The similarities and differences between women and men's groups will be discussed.

Introduction

Doctoral programs in all subjects are generally recognized as being challenging and difficult. Degrees in engineering and computer science are generally considered to be among the most difficult. The number of doctoral degrees in engineering earned each year in the United States is under 7,500 (7,276 in 2005); of that number women earn only 18% (1,322 in 2005) (Engineering Workforce Commission, 2005). Why aren't there more women earning their Ph.D.s in engineering and science? There is not a simple answer, but the answer includes the nature of doctoral education, the atmosphere, and largely unconscious attitudes and cultural biases in many graduate programs in engineering and science. In the American culture, boys are assumed to have been born with better math ability than girls, which may lead to a source of low self-esteem

in women and they assume that everyone, including men and international women, are better at math than they are (Lazarus, Ritter, & Ambrose, 2001).

The United States has only a very small part of its population choosing to study engineering. Bachelor's degrees in science and engineering make up sixty percent of the total degrees earned in China, while only five percent of degrees earned in the U.S. in 2004 were in science and engineering (Daggert, 2005). If we compare actual numbers, the U.S. shortage of engineers is even clearer. In 2005, China alone graduate 350,000 engineers (Daggert, 2005). By contrast, less than 125,000 engineering degrees were earned in the U.S. that year (Engineering Workforce Commission, 2005). Students admitted to PhD programs in engineering and computer science have already proved that they are capable students. Why do many of them not complete their doctoral program?

We are interested, in particular, in learning why the completion rate of the doctoral degree in engineering is lower for women than for men. Are women experiencing different discouragers than men or do they react to the same discouragers in a different way? Do men receive more encouragers than women in their doctoral programs? We are interested, in this study, in the little encouragers and little discouragers that students encounter daily that can accumulate to the point of affecting the completion of the Ph.D.

Prior Research on Women in Engineering Doctorate Programs

Researchers have identified important contributors to the experience of women in doctoral programs. These categories include the quality of mentoring and advising, the difficulties in balancing program demands with a family, and program climate issues (Anderson-Rowland, Bernstein & Russo, 2006). Women are relatively new to the scene of graduate schools and since there are few standard rules in graduate school, women often do not understand the rules and are not aware that there are hidden barriers. Three of these barriers are (1) finances, (2) stereotypes that presume women to be inferior, stressed-out, or just waiting to get married and have children, and (3) the greater demands on their personal time at home, especially if they are a wife, mother, or caretaker of an elderly parent (Lazarus, Ritter, & Ambrose, 2001).

Graduate school is difficult for all students: challenging classes to complete, qualifying exams to pass, a thesis to write and defend, and some time (maybe) for a life. Academic and social integration in the department, the quality of mentoring and advising, research productivity, difficulty in balancing program demands with the family, predictability of financial support, and program climate issues have all been identified as graduate school challenges (Lazarus, Ritter, & Ambrose, (2001); Lovitts, (2001); Tinto, (1993)). In addition, graduate students have to learn how to live and work in a politically charged university system, how to work on a largely independent basis, and how to deal with each other, faculty, and a department. Graduate students often have to learn to work with an advisor, teach, supervise other students, and find a place in the research world. In addition, women graduate students are challenged with the male environment, very few or no female role models and mentors, a lack of support and understanding, exclusion and hidden goals and objectives. There is often a general lack of inclusion for women in some departments, faculty, and graduate schools. All of this can make a woman graduate student feel that she is not good enough and this coupled with possible low self-

esteem can make graduate school an extremely harsh place to be (Lazarus, Ritter, & Ambrose, 2001).

Doubting yourself and your ability to be successful in graduate school is perfectly natural for both men and women, but women especially have potential areas in doctoral studies that can raise doubts of their ability to succeed: low self-esteem, feeling marginalized and alone, learning by critique (women are more likely than men to consider insistent questioning as harsh and negative or as a personal attack, when it is usually meant to be a way to think, analyze, and express findings to others), and balancing the competing needs, where others want your time outside of the academic setting (Lazarus, Ritter, & Ambrose, 2001).

A 1990 study showed that women are more concerned than men about the damage that an argument might cause in an interpersonal relationship. Women who argue are considered “disagreeable,” while men are considered “rational.” In fields where argument is important to the research process, women are at a disadvantage. Women are also at a disadvantage if the advisor is afraid to give proper feedback to a woman for fear she may become “emotional.” In this case, the female is denied an advantage over the male student, through no fault of her own (Mapstone, 1990).

We are concerned with the accumulation of these factors that affect women in doctoral programs.

Research through Focus Groups

The overall goal of this NSF-funded CareerBound research project (Award #0634519) is to understand and address the problems of retention for women in doctoral programs in engineering and computer science from the student viewpoint (Bernstein, Russo, & Anderson-Rowland, 2006). We are especially interested in the small discouragers that may accumulate to affect the decision whether or not to continue in the doctoral program. After identifying and understanding these discouragers, we want to be able to help women doctoral students overcome these discouragers through an on-line intervention and support system. We want to understand their individual experiences so that we can speak to these experiences directly.

Although the general reasons for women to become discouraged in doctoral programs have been researched, we believed that to be effective in our intervention, we had to understand the doctoral women’s experiences through the everyday encouragers and discouragers they encounter in their program now, today, and at Arizona State University. Therefore, we chose to use focus groups to identify the themes that emerge from the doctoral women’s discussions of their experiences. We would then further use the themes that emerge to contextualize our approach to development of the CareerBound curriculum for the Internet delivered resilience training. By also holding focus groups for men, domestic and international, from engineering and computer science, as well as the women, we expected to sharpen our understanding of how women, domestic and international, experience their doctoral program.

The role of the focus groups in our study is not to take the place of quantitative data (Bernard, 2006). We will get that type of data later in a national survey. By using focus groups (usually 5 or 6 students to 10 in number) we could verify the themes found in literature with concrete examples: How does it happen? What can be done about it? By talking with women doctoral

students, we can better understand how the women feel when they incur discouraging situations, what they have tried to do about the situation, and what has been the outcome.

We first defined the scope of the focus groups. In the Ira A. Fulton School of Engineering, we included all of the following departments: bioengineering, chemical engineering, civil/environmental engineering, computer science, electrical engineering, engineering science, industrial engineering, and mechanical/aerospace engineering. We identified our target population as graduate women and men who were in their second year or more of a doctoral program or were in the first year or more of a doctoral program, with a Master's degree already earned. We developed a recruitment plan that used multiple strategies, including phone, email, personal contact with students, advisor, and chairs, and professional contact through the IGERT (Integrative Graduate Education and Research Traineeship) programs and the PFF (Preparing Future Faculty) program, both NSF-sponsored programs on the ASU campus.

We identified the Institutional Review Board (IRB) issues: our target population, the recruitment methods, the focus group process, script, and demographic survey, and how we would give assurance of anonymity. We received the IRB approval to contact doctoral women in engineering and computer science, and later got approval to contact men. The students were recruited to four types of focus groups: domestic women, international women, domestic men, and international men. We quickly learned that emails were not an effective method for getting the attention of graduate students to attend a focus group. Personal contact proved to be the best method and the promise of refreshments did not seem to be much of an incentive. Most of the women who volunteered and actually participated in the focus groups had a story to tell. Some women appeared reluctant to participate in a focus group; some were explicitly fearful. Some were close to completing their degree and did not welcome any distraction. International women were more likely to volunteer after they learned that their focus group would all be international women. In this way, they were less conscious of their English speaking abilities. Only 50-75% of the students who committed to a focus group actually attended a focus group. The atmosphere of the women's focus groups was charged with personal struggles and a sense of relief that at last someone was interested in their problems and trying to do something to help them.

The men primarily volunteered out of curiosity. They did not understand how they could help a study about women doctoral students in engineering and computer science. However, they were curious and at least one man attended because he thought that his wife would want him to since she was interested in the general issue of doctoral women. The percentage of men who participated in the focus groups after a commitment was a little higher than the women. The general air of the men's focus groups was very relaxed.

Among the graduate women students in engineering and computer science, 118 women were identified in these fields that met our criterion. Of these 118 women, 49 were domestic students and 69 were international students. We talked with 10 domestic and 15 international women in engineering and computer science, and 11 domestic and 11 international men in the same areas. In the future we will talk with women who have left their doctoral programs in focus groups, if possible, or by individual interviews, since most would not be available to come to the campus.

The focus group was a 90-minute session of group discussion in response to scripted open questions. The session was taped, two trained staff note takers participated, and light refreshments were served. A project co-PI facilitated the engineering and computer science groups. The three primary questions asked were:

- How does being a woman (man) play a role in your progress through the doctoral program? (For men only: How do you think that your doctoral program is for a woman?)
- What types of things happen in your day that encourages you to keep going in your program?
- What types of things happen in your day that discourages you from continuing in your program?

In addition the students were asked if they had personal factors that hindered them in their successful completion of a doctoral degree. The focus group script had standard probes to make sure that the students covered all of the areas important to them or to help clarify responses. The general results of the focus groups with the domestic and international women have already been described (Anderson-Rowland, Bernstein, & Russo, 2007). However, those results will be highlighted here so that a contrast can be drawn with the results from the male doctoral students.

Does Being a Woman (Man) Play a Role?

The majority of engineering and computer science students within the Ira A. Fulton School of Engineering are international students. In fall 2006, there were a total of 1,797 graduate students in engineering and computer science, with 52.8% international students and 47.2% domestic students. Only 22.2% of these graduate students were female. See Table 1 for the 21st day enrollment in fall 2006. For Fall 2006, there were 659 students, 547 men (83%) and 112 women (17%). Of the 112 women, 68 (60.7%) were international. Six of the women that we identified for our study were not on the 21st day enrollment for fall 2006. The majority of the international students in engineering and computer science are from China and India. The next largest, but decidedly smaller, groups are from South Korea and Mexico (Anderson-Rowland, Bernstein, & Russo, 2007).

ASU Engineering and Computer Science Graduate Students Enrolled Fall 2006				
	All Graduate Students		All Doctoral Students	
	Total	%	Total	%
All	1,797	100	659	100
Men	1,398	77.8	547	83.0
International Men	734	52.5	352	64.4
Domestic Men	664	47.5	195	35.6
Women	399	22.2	112	17.0
International Women	215	53.9	68	60.7
Domestic Women	184	46.1	44	39.3

Table 1. ASU Engineering and Computer Science Graduate and Students by Total, Doctoral Students, Gender, and Citizenship (Arizona State University Summary Enrollment, 2006, Data Warehouse, 2006)

Although a few women said that there were no differences, most women, both domestic and international cited two common problems: their additional responsibilities as caregivers and the physical problems that are inherent in a lab. The most common additional responsibilities as caregivers were with a husband and children. The women mentioned physical problems in the lab such as heavy lifting of equipment or carrying water. The women do not want to be seen as incapable and so are afraid to complain and therefore go home at night with a backache. Pregnancy is a problem for women working in labs with chemicals, since pregnant women are not allowed in the labs. Women are advised to be out of the lab with chemicals for at least nine months before becoming pregnant, placing an additional strain on marriage. Some women fear that by the time they have completed their degree and marry and are ready to have children, it may be too late for them. Women with menstrual pain are not comfortable telling their male advisor or post-doc that they are not able to perform well that day.

A few women had a very supportive female advisor, but most reported the advisors (mostly male) were friendlier with the men in the program. The women felt that they could not easily discuss their research with their advisor. As the only woman in the research group, the women were put in awkward situations on a field trip or excursion. The men share a room, while the woman is alone. Also, the advisor may invite all of the male students to go with him to a bar. The woman is either not included or, if she tries to fit in, is not interested in drinking beer or talking sports.

Both domestic and international women feel putdown by male peers from cultures that devalue women. These men expect them to be lab “maids” cleaning up the lab for them or Xeroxing copies. The women also report that men in the lab control the equipment and often are not willing to share, even for a short period of time.

In general, the women felt stressed to constantly prove that they were as good as the male graduate students with whom they worked. The women reported that men, in general, are not very good about working in a team or helping anyone else.

The male students acknowledged that most advisors and doctoral students are men, making it easier to be part of a group. Some noted that none of the post docs with whom they had worked was a woman. Three men who had spent years in industry and had become very dissatisfied with industry, felt that they had an advantage because they were not in graduate school for the money but for the fun of learning. In general, the men reported that they had selected their advisor carefully. The male students felt that the faculty took the men more seriously than the women. The men considered themselves more competitive and therefore sought more approval from their advisor than women.

Domestic men observed that the lack of females in their doctoral programs meant that the women had less support. However, at the same time, they felt that some faculty had a soft spot for women and therefore the women tended to get a better deal. They acknowledged that women are nicer to others than men and not as confrontational. They also thought that women take comments more personally than men and women are more stressed than men.

They felt that women are more naturally motivated, by who they are, having come from a stressful place. Since women are more motivated than men, they do the brunt of the work. Some of the domestic men acknowledged that they were not as motivated and thought that the lab work is ok, but they don't want to analyze and write up the results. These domestic men thought that women are more apt to put in more hours to get the job done, while men will spend more time figuring out how to do the job with less effort.

The international men gave a rather different view of the women in their doctoral programs. In general, their first evaluation was that a doctoral program for a woman was no different than for a man. However, they felt that women have decided advantages. They feel that it is easier for a woman to find a job and that it is easier for a woman doctoral student to get help from peers and that they have better files of old exams to help them. They believe that the male professors give women more attention outside of class and that many professors view women as more fragile. At the same time, an international male doctoral student stated that math was harder for women and in general they were not as persistent in engineering as men.

One international man, who had done undergraduate work in the states, noted that women in engineering were seen as "geeky" or "nerdy" and that starting in high school a woman in engineering is not a socially positive choice. He and others agreed that if a woman married then she needed to devote her time to her husband and family. Another student remarked that if a doctoral woman joins a research group, she is kept on the periphery because she might leave at any time.

An international man suggested that there might be a department policy (quota) that more women need to get their doctorate and so getting the doctorate is made easier for women. The other international men did not dispute this assessment. The men thought that women do tend to be more friendly and easier to approach; men don't want to talk too much.

They thought that it was more likely for a man to stay focused since the women have pressure on them to have a family around age 27. When this pressure was mentioned, others acknowledged that grad school was harder on women with children, but noted that it was better for her to have children in graduate school than as an Assistant Professor. A married international male student, whose wife is also a doctoral student, added that women do have more problems than men. While he could excitedly tell others that they are expecting a baby in four months, his wife had not yet told her advisor because she is afraid. Another international man then acknowledged that women do have a tougher time in graduate school if they are married, because they would have to be home by 6 p.m. each evening to make dinner for her husband. He also noted that women are not as focused on their doctoral program after they have children.

The men believed that, in general, men choose a field of study because they like it, while women choose a field that promises jobs and money. These men concluded that women drop out of doctoral programs in engineering and computer science because they are not as dedicated as men to their field.

It is interesting to note that mistreatment in the labs by peers, a post doc, or an advisor was never mentioned in the four male focus groups, while this was a common issue for all of the women

students. All of the focus group students were encouraged to let us know after the focus group meeting if they thought of any additional pertinent information. After the focus meetings, an international student emailed that in his lab, the two males were always asked to clean up the chemicals in the lab and that he, in particular, was asked to clean up chemicals more than the other male student, while the women students in the lab were never asked to do this chore.

Encouragers

All of the women agreed that if their research is going well, they are encouraged, especially if a short-term goal is reached. Also high on the list of encouragers is the recognition of their advisor that the research is progressing and they are complimented for the good job that they have done. The women describe an encouraging advisor as one who responds to emails, gives regular constructive feedback and guidance, gives help when needed, maintains a friendly, cooperative research group, and has confidence in them and their work.

The women also cherished encouragement from peers, role models, or their family. International women are encouraged by being with other students from their homeland in their leisure time. This interaction gave the international women a sense of belonging. Being able to move toward a clear goal of the degree and the career they want and expect to have because of the degree is a significant encourager to women. The women mentioned that making small goals helped with this encouragement.

The domestic men most often said that their wife was their most important encourager. Other common themes were: seeing progress in your work, the fun competition in their research group, the lab post doc, their advisor, and their family, parents, and friends. The determination that “you don’t quit” was the strongest encouragement for others. The fun competition included discussions such as “What is the best way to wash your car?” Each member of the research group would propose a solution and the group evaluated the merits of the each solution. For a doctoral male student, it was as much fun to have your solution selected as the best, as to have made significant progress on the research. These fun game sessions often turned into discussions about the research at hand (leaving out the women because they usually would not be included in such a game). Several of the domestic men mentioned that they had complete freedom in their lab because their advisor trusted them completely and had assured them that they had complete confidence in their ability to accomplish good results and finish a PhD. This type of encouragement was never mentioned in any of the women’s focus groups.

The encouragers for the international men were somewhat different. Their encouragement list was topped with family and friends. The men felt that their own achievement was a big encourager. For many of these students, the PhD is a dream and a commitment. The PhD dream “since they were young” was by far the strongest encourager for the international men as compared with the other three groups. Several men mentioned that “finish what you start.” was their primary encouragement. Although the groups of international men did not mention their wife as their primary encouragement, wife and family did pay a part in a slightly different way. The man who felt that he was doing his PhD for his family since his wife had left graduate school to have children and to stay at home with them exemplifies this focus.

For the international students who are earning a doctorate to become a professor, the main encouragement was that they needed a PhD in order to get to a good university and a good future career. Another expressed that he wanted to be a *good* professor and so was going through a difficult program so that he would be able to make a difference in the education in his country.

The international men also said that “to know more” was a major encouragement to them.

Discouragers

All student focus groups had much more to say about discouragers than encouragers, as might be expected. The two major categories presented by the women were academic interactions and personal interactions and responsibilities. A major discourager for all students is the “bad” advisor: critical, demeaning, too busy to pay attention to the student, gives no feedback, cares only about getting another publication, has harsh expectations, and is a poor match with the student’s work style. All four groups mentioned research failures and no progress as discouragers. Uncertain finances were not a major factor. The students in the focus groups did not have financial worries, but some did have to “sweat it out” at the beginning of each semester before being told that their assistantship and funding was continued. Uncertain finances are a worry especially for women who dependent on child care for their continuation in their program. A constant worry is not having adequate resources to pay for childcare.

In the academic setting, the women reported feeling: invisible, marginalized, alone, isolated, gender stereotyped, in a hostile environment with peers, they had inadequate research group oversight, their ideas were not given consideration, ignorant of problematic practices in how to pass an oral defense, and a lack of fit with the doctoral program culture of competition, male interests, and a hierarchy in the lab.

In the personal discouragers category (Anderson-Rowland, Bernstein, & Russo, 2007), the women felt they: were alone, had no emotional support, worried that they will be too old to have a husband and family by the time they finish their degree, were conflicted with commitments to family and to career, were burdened with cooking, cleaning, and child care physical strains that left little time for sleep, and on top of this the heavy lifting and cramps, which made them weep and ask “Is this really worth it?” This last question was often asked in the context of knowing women without a doctorate who were doing very well financially in industry. Some of the male doctoral students also mentioned being bothered with this comparison.

The women recognized that there were personal characteristics that contribute to being discouraged: low self-esteem, the imposter syndrome, oversensitivity, poor time management, perfectionism, guilt over conflicting roles, loss of commitment to the goal, and the lack of “having a life.”

In general (Anderson-Rowland, Bernstein, & Russo, 2007), the domestic and international women had similar experiences, including issues with international males expecting them to clean up the labs. However, the international women have different major discouragers not experienced by domestic women. The international women agreed on their top three discouragers which all relate to their being *international* women. Topping their list was the extra effort needed with language, both speaking and writing. Some women reported that they spent

hours and hours going over their reports before they dared to give it to their advisor. A second common discourager was homesickness. Even though they found some comfort in meeting with other students from their homeland, the new land, harsh academic climate, and the language made the women feel alone and lonely for their home. Some women admitted making almost daily phone calls to their mother. The third common discourager was the cultural expectation that women should be married and begin having children by some age around 20. These women fear they may be too old to bear children after they complete their degree and do not receive strong encouragement from the family back home to continue in their degree because of this cultural expectation.

The domestic men cited somewhat different discouragers. Their discouragers included: a lack of control of the lab situation such as broken equipment; process failure; department chaos; busy, boring work; the need to be political to get your degree; health problems; and an absent advisor. The department chaos centered on the uncertainty of requirements: students need to jump through certain hoops to get a doctoral degree, but they do not know what hoop would appear, when it would appear, or where it would appear. The personal hindrances mentioned by the men included that academia was a different game than being in industry, being too egotistical, and procrastination. After understanding what “imposter syndrome” meant, some of the men admitted that they may have had the syndrome when they first started their doctoral program, but that was no longer a problem for any of them.

The primary discouragers for the international men were not as well defined as for the international women. The international men mentioned six discouragement themes. These themes were the advisor who doesn’t recognize the work put in, the degree is taking more time than expected, communication skills (mostly oral), failure in research and not solving a problem, spending a year on a topic and then learning the problem was already solved, and finances. None of the students had direct financial problems, but some students on restricted scholarships from their country are having a difficult time. Although the scholarship pays the basics, half of the stipend each month may go for rent. The student is not allowed to earn any extra income and therefore there is no money for the theatre, a social life, or even buying fruit. An example of a discouraged international student is one turning 30, with no money to his name, and no feedback from his advisor in the last couple of months.

When asked about personal hindrances, the international men mentioned that they need a good advisor and a field in which they are interested. One student felt that his lack of confidence in his own ability was the reason that he did not apply to more schools for graduate work. Perfectionism was also mentioned as a personal hindrance. A personal hindrance mentioned by some of the students is actually a personal driver to complete their degree: “better no PhD than an incomplete PhD”.

Several men from both the domestic and international groups mentioned that their advisors were not readily available and did not seem to appreciate their successes, but none seemed as discouraged by their advisor as the women in general.

Conclusions and Advice from the Students

The primary conclusions from the women were: choose your advisor carefully, very carefully; the advisor or post-doc needs to set the tone for the lab, become involved with an organization or some support system, and take short breaks from the intense academic situation for good mental health. The domestic men advised: choose your advisor well, know what you want to do in the next 30 to 40 years, choose a topic quickly, and choose a topic that's interesting enough to know all of it. Their advice to women in electrical engineering is that they need to know that their peer group will be international women

The international men had several pieces of advice to other international men considering pursuing their doctoral degree. For married men, responsible for a family, they advise that the degree will be worth it. They also advise that the kids be put to bed by 9 pm so you can study. They suggest that you need to dedicate time to research and be prepared to endure hardship. They also suggest that it is a good idea to get married before coming to the US, that the wife is a great support while earning a doctorate degree.

The international men also had specific advice to international women thinking about getting a doctorate degree in the states. They advise that women need to be more convinced of getting a PhD because the process will be more discouraging for her. Both men and women need to study hard, but women can do better at studying. This group of international men thought that women should not be in chemical engineering; they thought that women should be in a nicer, cleaner lab.

Analysis

As reported (Anderson-Rowland, Bernstein, & Russo, 2007), we were surprised to find very few differences between the encouragers and the discouragers of the domestic and international women. The international women identified their status as a doctoral student primarily how they were treated differently as a woman, not as a majority international student. Their primary discouragers though, language, homesickness, and cultural expectations were all about being an international student. The general atmosphere for all of the women's groups was that they were being stressed unnecessarily as women beyond the general stresses of being a graduate student. The advisor and post doc play very large roles in the general atmosphere of a doctoral program, especially for women. Clearly, we want to use our findings to develop faculty workshops to make faculty aware of the intense impressions and discouragement they can give to a doctoral student, especially a woman. In many cases, just a few words of encouragement could make a big difference in the student's disposition. Even if an advisor was not supportive, women who had a supportive spouse or significant other could clearly handle the situation easier knowing that they had a sounding board and support at the end of the day. Women in the focus groups seemed to find comfort in just talking with other doctoral women who are going through similar experiences. We intend to develop training on approaches that a student can take to improve the relationship between herself and her advisor. These approaches will include help with decision making (when do I choose another advisor), problem solving and conflict resolution (Anderson-Rowland, Bernstein, & Russo, 2007).

The atmosphere of the men's focus groups was entirely different. The men were very relaxed; they did not seem to have major issues; and were mostly curious as to why they had been invited to a focus group for a research study on women. Several men reported that they had never been

asked by any faculty member for their opinions and were pleased to be able to do so. Some of the men were a little suspicious and wondered at the beginning of the focus group if they were now going to be asked “to spill their guts”. All of the men seemed to enjoy the focus group and the last group of international men students at the end of the session thanked us for inviting them.

The women reported feeling: invisible, marginalized, alone, isolated, gender stereotyped, in a hostile environment with peers, they had inadequate research group oversight, their ideas were not given consideration, ignorant of problematic practices, and a lack of fit with the doctoral program culture. In general, the men, domestic and international, did not report these problems. The primary concerns of the domestic men were broken lab equipment, process failure, departmental chaos, the need to be political to get your degree, being too egotistical, and procrastination. None of the men, domestic or international, felt they had an imposter syndrome, maybe at the beginning of their program, but not now. The international male discouragers were an advisor who doesn’t recognize the work put in, the degree is taking more time than expected, communication skills (mostly oral), failure in research and not solving a problem, spending a year on a topic and then learning the problem was already solved, and restricted finances. The women are primarily discouraged because of how they feel due to unpleasant incidences and the men are discouraged because of unpleasant incidences.

The “put downs,” experienced by both domestic and international women from international men whose cultures do not value women as equal to men, were evident in the focus groups with international men. The international men felt that women were given preferential treatment by the professors to the point of granting doctoral degrees easily to women in order to fill a quota of more women PhDs. They also believe that women choose to pursue a doctorate primarily in an area that has lots of jobs and pays good money, not due to a love of learning or real interest in a field of study. In general, they expect that if a doctoral woman becomes pregnant, she will quit her program and stay at home to take care of the children. At the least, even if there are no children, the doctoral student wife needs to be home early in order to make dinner for her husband. Clearly some general training for new graduate students is needed, for both domestic and international students, on the respect that one should have for their peers, male or female.

The results of our focus groups show that some of the graduate stressors occur for both men and women, such as unresponsive or discouraging advisors. However, the male students themselves believe that they have an easier time with advisors and post docs because most of them are men. Other areas of discouragement are uniquely borne by women: being a minority in the research group or lab, heavy lifting, menstrual pain, family and childcare demands, pregnancy and chemicals, and the pressure of the ticking clock for childbearing years. In addition, some men from cultures that devalue women treat both domestic and international women as “lab maids”.

Conclusions and Further Research

This study is part of a larger study funded by the National Science Foundation to develop an ongoing, interactive program that will provide support and interventions to women already in or contemplating engineering and science doctoral programs. The themes that we have discovered in our focus groups fit very well with those reported in the literature. We now have a much better understanding of how discouragers can happen every day with women doctoral students. We also have a better understanding of the methods that can be used to cope with them in a way

to help the student recognize the source of the discouragement and some practical ways of handling the situation. We will also be speaking with women who have discontinued their doctoral studies to make sure that we have not missed any major areas of discouragement.

The research project still has many areas to develop. We plan to survey women doctoral students across the nation to make sure that the discouragers that we have identified are consistent with those to be identified at other universities. We are using the concrete examples from the focus groups to develop Psycho-educational, Herstories, Case Studies, and Resource components that will map onto the resilience-training matrix organized into thematic areas. Our ultimate goal is to help increase the retention of women in engineering and computer science doctoral programs and to help ease the unnecessary stresses experienced by these women.

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References

Anderson-Rowland, M.R., Bernstein, B.L. and Russo, N.F. (2007), Encouragers and Discouragers for Domestic and International Women in Doctoral Programs in Engineering and Computer Science, *2007 ASEE Annual Conference Proceedings*, Chicago, Honolulu, Hawaii 2007, CD-ROM, 8 pages.

Arizona State University Enrollment Summary, Fall Semester 2006 (2006), Office of Institutional Analysis, Arizona State University, Tempe, Arizona.

Bernard, H.R., (2006), *Research Methods in Anthropology: Qualitative and Quantitative Approaches*. AltaMira Press, Oxford, UK.

Bernstein, B.L., Russo, N.F., and Anderson-Rowland, M.R., (2006) Everyday discouragers and supports for Women in STEM PhD Programs. In Bernstein, B.L. (symposium organizer), Predictors of Science and Engineering Involvement: Three NSF-Funded Studies. Annual Meeting of the American Psychological Association, San Francisco, CA, August 2006.

Daggert, W.R. (2005), *Preparing Students for Their Future*, Presented at June 2005 Model School Conference.

Data Warehouse (2006), Arizona State University, Tempe, Arizona.

Engineering Workforce Commission of the American Association of Engineering Societies, Inc. (2005), *Engineering and Technology Degrees 2005*, Washington, DC, American Association of Engineering Societies, Inc.,

Lazarus, B., Ritter, L. & Ambrose, S. (2001) *The Woman's Guide to Navigating the Ph.D. in Engineering & Science*. New York: The Institute of Electrical and Electronic Engineers, Inc.

Lovitts, B.E. (2001), *Leaving the ivory tower: The causes and consequences of departures from doctoral study*, New York: Rowman & Littlefield.

Mapstone, E.R. (1990), "Rational Men and Disagreeable Women---The social Construction of Argument: Women Argue Differently from Men." Paper given at the British Psychological Society Conference, City University, London (as cited in Phillips and Pugh in *How to Get a Ph.D.*).

Tinto, V. (1993), *Leaving college: Rethinking the causes and cures of student attrition* (2nd ed.) Chicago: University of Chicago Press.

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