Advancing Women on Engineering Faculties: MentorNet's Academic Career E-Mentoring Program

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Abstract— This paper presents the goals, objectives, and results to date of one recent nationwide initiative that deals with early stages of advancing women faculty in engineering – particularly focusing on a pilot program developed to provide external tenured faculty mentors for graduate students, postdoctoral fellows and early career faculty. MentorNet (www.MentorNet.net), the E-Mentoring Network for Women in Engineering and Science, is a nonprofit organization supporting large-scale, online mentoring programs. Its signature One-on-One program was expanded in 2003 through a grant from the National Science Foundation to undertake an experimental pilot project focused on Academic Career E-Mentoring. Through this initiative, graduate students, postdocs, and early career faculty pursuing academic careers are matched with tenured faculty mentors for one-on-one, structured, 8-month-long mentoring relationships conducted via email. During the first two years of the Academic Career E-Mentoring Program, over 161 mentoring pairs have been matched, and over 40 of those pairs have completed an e-mentoring relationship.

Introduction

In 2003, working first with WEPAN in the third year of a collaboration focused on "Faculty for the Future" and then through an ADVANCE Leadership grant from the National Science Foundation, MentorNet modified and extended its One-on-One mentoring program and other programmatic capacity in order to accommodate the participation of women pursuing academic careers in engineering and related sciences. The Academic Career E-Mentoring Program is a pilot program designed to link graduate students, postdocs, and pre-tenure faculty with tenured faculty in one-on-one e-mentoring relationships.

MentorNet (www.MentorNet.net), *the E-Mentoring Network for Women in Engineering and Science*, a nonprofit organization headquartered at San José State University (CA), offers a unique program designed to link large numbers of women studying engineering and science in one-on-one, email-based mentoring relationships with professionals in these fields. MentorNet's mission is to further women's progress in scientific and technical fields through a dynamic, technology-supported mentoring program and to advance women and society by developing a diversified, expanded and talented workforce. MentorNet leverages technology to build large-scale impact for its programs. Since its opening in 1998, well over 12,000 undergraduate and graduate women studying engineering and related sciences at more than 100 colleges and

universities across the U.S., and in several other nations, have been matched in structured email-based mentoring relationships with male[1] and female scientific and technical professionals working in industry and government. This innovative, award-winning[2] e-mentoring network provides mentoring opportunities that otherwise would not exist for women in engineering and science. MentorNet has developed the programmatic and information technology-based infrastructure to serve a large number of colleges and universities, corporations, professional societies, and government labs and agencies, and their respective students, employees, and members, all interested in advancing women in engineering and related sciences through mentoring. These organizations provide financial support for MentorNet programs and operations, and help to reach out to prospective participants. MentorNet uses research and evaluation in its design, in its continuous quality improvement, and to assess preliminary outcomes.

Prior to 2003, MentorNet concentrated its efforts on mentoring between students and professionals working in industry and government as a complement to academic mentoring. Yet, over the first five years of its existence, a variety of constituents requested that MentorNet's industry programs be expanded to include relationships for those aiming for academic careers. While initially, our presumption had been that those interested in academic careers could readily find mentors in their home settings on campuses, evaluation findings and conversations with various MentorNet community members helped us to realize that there are special qualities associated with *external* mentors that are particularly valued by women pursuing studies in engineering and science. One of the key early findings of our evaluation work showed that proteges were especially likely to cite their appreciation of having a mentor who was not serving in a capacity of judging or evaluating; they felt these external mentors were less driven by their own needs, agendas, or institutional interests as internal mentors may be, and more likely to be "objective" and have the best interests of the protégé at heart. Protégés therefore felt freer to voice doubts, fears, and quandaries with these mentors, in ways they were not as likely to do with mentors who were also serving as teachers, advisors, or others within their "home" environments (Ithaca Evaluation Group, 2001). Thus, in 2003, MentorNet developed its Academic Career E-Mentoring Program.

Present State of Knowledge in the Field

The under representation of women in science and engineering, both in industry and in higher education, has negative implications for the future technical work force, for equal opportunity,

[1] MentorNet intentionally encourages men as well as women to serve as mentors, for several reasons: 1) there are too few women to meet the need, 2) women are already more frequently called upon to serve mentoring functions to help develop the future generations of scientists and engineers, and even more importantly, 3) through serving as mentors, men can gain improved understanding of the obstacles women encounter and a vested interest in helping to change practices and policies that impede women's full participation in the professions, thus enhancing systemic change. The preferences of protégés to be matched with a mentor of a particular gender, however, will be accommodated.

[2] In 2001, MentorNet was awarded the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring, and in 2004 was named the Grand Prize winner in the nonprofit category for the Cisco Growing With Technology Award.

for individuals, and for the disciplines and professions themselves. In academic science and engineering, women comprise less than 30% of faculty positions in 4-year colleges (National Science Foundation 2004). Only 26% of full-time senior faculty appointments in the life sciences are women, despite that field graduating the highest percentage of women among the science and engineering disciplines (excluding psychology and the social sciences) (National Science Foundation 2004). In many other fields, the percentages of women faculty are much lower. Though women enter the study of science and engineering just as or better prepared than their male counterparts, they are more likely to switch to other areas of study (Strenta *et al.* 1994; Seymour 1997).

Among the demonstrated educational obstacles to women's persistence in these fields are an academic climate where engineers and scientists are typically seen as male, where few women students have relationships with or even know women engineers and scientists (Char 1997; Leslie 1998; Yauch 1999), and classroom environments that are competitive and unwelcoming to women (Crawford 1990; Tobias 1990). As women enter graduate school and faculty positions, they face difficulties such as subtle and outright systematic discrimination (Massachusetts Institute of Technology 1999), competing family and career demands (particularly as women approach tenure), and feelings of isolation as they encounter fewer and fewer women colleagues (Ambrose 2001; Thom 2001). The situation leads to too few role models for would-be women faculty in engineering and the sciences, thus perpetuating the problem for future generations.

In contrast to the obstacles for academic women in engineering and science, noted above, mentoring, deliberate encouragement, and affiliation with a community have been shown to enhance women's retention, self-efficacy, confidence, and likelihood of remaining in these fields (Cunningham, Pavone et al. 1996; Goodman, Cunningham et al. 2002). For women of color, mentoring has been shown to be the only significant predictor of success (Faison 1995). Mentoring can also serve to counter the idea that science and engineering are not appropriate fields for women and people of color, and is a key to recruiting and retaining women and minorities in science, technology, engineering and mathematics fields (Shah 2001). A well-accepted strategy to improve retention of women students in science and engineering in higher education, mentoring helps expose students to the opportunities in their fields, offers guidance and advice based on experience, and provides support, encouragement, and access to professional networks for further career development (AWIS 1993). Mentoring can offer one-on-one attention and assistance in "de-coding" less obvious cultural and structural elements of a field, and allows students access to an impartial advisor who can provide personalized support and information (Thom 2001).

Mentoring has also been shown to be an effective tool for faculty and graduate students (Boice 1992; AWIS 1993; Boice 1993; Boyle and Boice 1998; Boyle and Boice 1998a). This recognition has led many institutions to create faculty and graduate student mentoring programs on their campuses, including some programs specifically for women faculty. Some professional societies and associations have created mentoring programs to encourage women to pursue academic careers in science and engineering. Informal mentoring networks for women in academic science and engineering such as the Committee for the Advancement of Women

Chemists (COACh) have also been developed. Women graduate students and faculty in science and engineering may also receive mentoring informally, or not at all. One reason mentoring programs are initiated is because women and people of color are thought to be less likely to be included in informal mentoring than are white males, who comprise the majority of senior leaders in higher education, including faculty. In informal mentoring relationships, individuals are very likely to choose someone like themselves, and frequently do not label the relationship "mentoring," but these relationship nonetheless take on the characteristics of mentoring relationships (Catalyst 2001).

The power of mentoring is sometimes poorly understood, and mentoring is not always effectively practiced (Zachary 2000); in particular, many well-meaning individuals have constructed mentoring programs without adequate knowledge and resources, leading some participants to conclude "mentoring doesn't work" or "mentoring programs don't work." While not every single mentoring relationship within a constructed program may end up being successful or valuable, there is ample evidence that mentoring programs provide considerable benefit to many participants (Murray 1991; Philip and Hendry 2000; Clutterbuck 2001; MentorNet Research Project 2002). At its weakest, mentoring is viewed as a somewhat offhand strategy to address deficits, providing some needed encouragement and advising of weaker and less confident individuals. At its strongest, however, mentoring is understood as a powerful learning process, which assures the intergenerational transfer of knowledge and "know-how" on an ongoing basis throughout one's life (Zachary 2000; Clutterbuck 2001). When mentoring is understood as a serious and powerful learning process, complete with the need to establish learning objectives, measures, and discipline to achieve results, its potential can be realized (Zachary 2000).

Structured mentoring programs provide matching, training, coaching, and facilitation for mentoring relationships (Murray 1991). Such programs are different from naturally occurring mentoring, where a mentor and protégé form their own relationship, without the benefit or intervention of a program. Structured mentoring programs, with training of mentors and protégés and facilitation or "coaching" of the relationships increase the likelihood of satisfying mentoring relationships (Brainard 1994; Boyle and Boice 1998; Zachary 2000; Clutterbuck 2001).

E-mentoring is mentoring conducted primarily via email. It builds on the Internet as a social technology that connects and affiliates people (Winter 1996). Email has the obvious advantages of convenience, efficiency, asynchronicity and facilitating distance communication. But mentoring via email and related electronic communications technologies also enable thoughtful, deliberate communication, provide a useful record of that communication, can use the power of writing as a reflective learning tool and as a strategy for socialization into a professional culture (Ivanic 1997), and limit status differences that might otherwise inhibit communication between protégés and mentors (Sproull 1992). In addition, the restricted channel of communication helps build relationships, especially for those who feel isolated (Smith 1988).

MentorNet's One-on-One E-Mentoring Programs

MentorNet's original One-on-One mentoring program pairs undergraduate and graduate students with female or male professionals working in industry or government agencies and laboratories for eight-month-long, structured one-on-one mentoring relationships conducted via email. Designated MentorNet liaisons within colleges and universities, corporations, government sites and professional societies inform professionals and students of the opportunity to participate in the MentorNet program, directing them to the MentorNet web site. Prospective participants get full information, complete online applications, and access training materials including tutorials from MentorNet's web site. MentorNet has developed and refined an interconnected relational database with systems and embedded algorithms to provide for bi-directional matching of students and mentors based on backgrounds, interests, and expressed preferences entered into a database via the online applications. Since 2004, protégés have had the option of selecting their mentor from among a group of up to the top five appropriate mentors, or having MentorNet select an appropriate match for them. We have designed online tools and messaging to provide direction and coaching to develop and sustain these e-mentoring relationships, using MentorNet's customized training and coaching curricula. These curricula are based on research related to mentoring, women's experiences in engineering and science, and electronic communications. At the end of the mentoring relationship, all participants are asked to complete online evaluations. In developing MentorNet, distinctions were made in providing coaching and training materials based on five possible educational levels of the students involved, as follows – 1) community college students, 2) first or second year undergraduates (lower division), 3) 3rd, 4th, or 5th year undergraduates (upper division), 4) masters students, and 5) doctoral students. To complement and enhance the One-on-One e-mentoring program, MentorNet also offers a community experience to its participants including such features as a monthly electronic newsletter and a series of online topic-based discussion groups focused on life/work balance, women's issues, job search, and similar themes. MentorNet's online community members may participate in these functions alone and/or in the One-on-One Mentoring Programs.

In offering external, cross-institutional e-mentoring for women who are interested in exploring, who are preparing for, or who are already pursuing academic careers, MentorNet's goal was to lay the groundwork and build the infrastructure for an extensive academic e-mentoring network to increase the likelihood that these individuals will successfully pursue academic careers. Our objectives were to build a set of systems to link tenured faculty, male and female, and students, postdoctoral fellows, and untenured faculty in productive online, ongoing discussions to enable valuable professional development through mentoring. We anticipated the mentoring needs of academic women in engineering and science, at different stages of their career preparation and progress, building on the research and empirical literature, and with the wise counsel of an advisory committee.[3]

[3] MentorNet's Academic Career E-mentoring Advisory Committee includes the following members: Susan Ambrose, Carnegie Mellon University; Denice Denton, University of Washington; Patricia Jones, Stanford University; Anne MacLachlan, University of California, Berkeley; Carolyn Meyers, North Carolina A&T; and Richard Reis, Stanford University.

Components of the work to develop the Academic Career E-Mentoring Program have included:

- Developing effective recruiting strategies and channels to inform potential participants about the program
- Modifying MentorNet's existing One-on-One Mentoring Program applications and matching systems to allow graduate students, postdocs, and untenured faculty to be able to self-select tenured faculty members as mentors for "academic mentoring".
- Developing customized coaching curricula to be sent regularly to mentor and protégé pairs that contain information and resources on issues pertinent to the protégé's academic career stage.
- Developing resources such as links and guest chats on topics relevant to academic careers, such as grant writing strategies, balancing career and family, presentation skill development, and networking.

While we created parallel activities to match two populations – graduate students or postdocs with tenured faculty mentors and untenured faculty with faculty mentors – we realized that the issues facing these two protégé populations are very different. For example graduate students and postdocs are more focused on development of skills related to job searches and finding a career path, while early career faculty are focused on issues of tenure, time management and work/family balance. To that end, some of the resources, such as the coaching curricula, have been specifically tailored to address the different needs of these populations.

Once matched, mentors and protégés are expected to communicate on a regular basis, typically weekly or bi-weekly. Pairs are committed to a relationship for eight months; following that period, participants may continue to maintain the relationship for another eight months, find a new partner, or leave the program. MentorNet provides on-going support and communications to the e-mentoring pairs through "coaching prompts" – email sent on a regular bi-weekly schedule offering discussion suggestions. These discussion suggestions constitute the coaching "curriculum" for MentorNet and serve a coaching function along four dimensions. First, they keep the lines of communication open between the MentorNet program staff and participants. Second, the discussion suggestions help us to "coach" the e-mentoring pairs through the stages of a mentoring relationship. Early messages suggest that each pair agrees to an informal "mentoring contract" that lays out the frequency of the communication and their personal goals for the program. The final coaching messages prompt participants to reflect on their experiences and bring the program to a close. Third, the discussion suggestions are a means to educate mentors and the protégés about issues pertinent to women in engineering and science. Fourth, the suggestions serve as a reminder to keep in contact with their e-mentoring partner. In addition to the regularly delivered discussion suggestions, the participants are sent monthly e-newsletters updating them on the activities of the MentorNet program.

MentorNet's Academic program added to MentorNet's general coaching curricula by developing and deploying coaching tailored to the needs of women seeking academic careers in science and engineering, parallel to the approach used for protégés interested in industry careers. MentorNet's Academic program prompts cover issues typically encountered by women in academic careers, and by those engaged in academic careers in engineering and science. Examples of general training topics geared specifically for mentors and protégés include: the

importance of, and strategies for, networking among colleagues in one's disciplinary field, publishing, children and tenure, grant writing, curriculum vitae writing, the value and pitfalls of postdoctoral work, balancing the multi-faceted demands of an academic career, attention to departmental and institutional politics and policies, etc. Because MentorNet has the ability to specifically identify and email different constituents, we can target materials appropriately to protégés' specific career stages and provide them with the information that they might need to plan for a career that for some might seem far in the future, as well as information pertinent to their current situation

Results from the MentorNet Academic Career E-Mentoring Program

Evaluation of the first year of the Academic Career E-Mentoring Program has been largely formative, including background information and demographics about the protégé applicants. During the first year of the program (as of November 30, 2003; Barsion, 2004a) the protégé applicants were predominantly female (94%) and citizens of the United States (60%). Seventy-eight percent were PhD students, while 15% were masters students and 7% were postdocs. The majority were Caucasian (53%) and Asian (34%). Six percent were African American, and 6% were Hispanic. Top fields of study for the protégé applicants included computer science, biological sciences, physics, biomedical engineering, chemical engineering, and electrical engineering. The issue protégé applicants ranked highest as why they sought a MentorNet mentor was to "share concerns with a mentor who is a sounding board and shares experiences." Applicants also wanted to discuss issues of preparing for an academic career, life as a faculty member, and challenges/rewards of being a women engineer/scientist in academia.

A follow-up online survey was provided to the protégé applicants to further understand their mentoring objectives, and extend the basis for evaluating program outcomes. Evaluation of the survey responses (Barsion, 2004a) revealed that over three-quarters of the respondents were at least "reasonably certain" they would seek a faculty position after graduation. Almost 60 percent of respondents were "completely" or 'very" confident they will succeed as faculty members. Applicants were also asked to rate the importance of gaining information on specific aspects of academic careers. The three issues of the highest importance to respondents were: time management, grant writing, and publishing.

Interviews with some of the participants were pursued to gather more in-depth information and elaborate upon the findings of the online survey. These interviews provided information about the following topics: participant recruitment; the nature of the program's mentoring relationship; how mentoring in this academic program compared to the MentorNet Industry mentoring program; and how the relationships compared to those with campus faculty advisors to determine what was successful and what needed improvement (Barsion, 2004b).

Interviews with mentors provided information about how the mentors benefited from the program. The comments about being a mentor in the Academic program were similar to those reported for MentorNet's Industry program. The greatest benefit was that mentors gained insight about their own careers and career choices. Mentors also reported that they found the program to

be convenient and not a large time commitment. This latter point is particularly important for faculty recruitment since many faculty members already feel they do not have time for additional mentoring commitments.

Interviews with protégés revealed that the two most popular reasons for seeking a MentorNet mentor were 1) to find a female mentor and role model and 2) to receive advice from an external faculty member who could be a more objective advisor than those in one's own department/school. One of the most striking findings from the interview study was the significance of having female faculty mentors. For many of the female protégés, having a female mentor was more important than having a mentor in one's field of study. In the interviews, both male mentors and female protégés paired with male mentors expressed dissatisfaction with the mentoring relationship. The protégés reported that their male mentors did not provide support and perspective about the topics they most wanted advice from a MentorNet mentor regarding. While this finding may not be particularly surprising, it emphasizes the need to encourage as many female faculty members as possible to participate as mentors in the program.

Recruiting tenured faculty members, especially female faculty, has been particularly challenging for this program. Protégés and mentors in the interview study indicated that there were two major barriers to mentor recruitment. First, they suggested that MentorNet needs to increase the visibility of the Academic Career E-Mentoring Program. Second, they observed that faculty may perceive they would not have time to commit to another mentoring relationship. Suggestions for addressing these concerns were incorporated into development of a new faculty recruiting flyer and subsequent recruiting efforts.

During its first year, the MentorNet Academic Career E-Mentoring Program matched 43 mentor and protégé pairs. As of this report, 41 of these pairs had completed their 8-month-long relationship. MentorNet is in the process of collecting and analyzing data describing their experiences and satisfaction with the program, as well as how the program may have changed their perspectives on academic careers.

During the second year of the program (as of February 2005), more than 100 protégés have been matched with mentors. This also reflects the expansion of the program to include early career faculty in the protégé pool. Of the total pool of current protégés (279), 16% are masters students, 63% are doctoral students, 15% are postdocs, and 6% are early career faculty. The most popular fields of study for matched protégés include: computer science, electrical/electronics engineering, physics, biological sciences, and mechanical engineering.

One of the greatest challenges facing the MentorNet Academic Career E-Mentoring Program is providing sufficient numbers of mentors to meet the protégé applicant need. As of February 2005, more than 90 protégés remain unmatched with mentors. Fields of study in which mentors are most needed are the same as in the general protégé pool (described above). MentorNet has been actively trying to recruit additional tenured faculty mentors in a variety of ways, including developing a new faculty recruitment brochure for distribution to campus representatives and at

professional meetings, as well as asking professional societies to contact their membership about MentorNet.

Conclusions

For protégés, the value of participating in electronic mentoring via MentorNet lies in obtaining personalized advice, encouragement, and support to help overcome obstacles related to their career goals. In the MentorNet Academic Career E-Mentoring Program, protégés specifically benefit from the electronic mentoring of a woman faculty member who serves as a role model and can offer realistic guidance towards a successful career in academia. The value for mentors lies in the knowledge that they have helped someone, gaining mentoring skills that they can apply to their own students and younger colleagues, and in learning about the issues encountered by women in academic science and engineering careers. By building on the solid base of MentorNet's established Industry program, and expanding to include women in academic science and engineering careers, we have the opportunity to leverage a modest strategy to make a considerable difference in transforming the gender composition of the fields of science and engineering. MentorNet's development has drawn upon extensive past research, ongoing evaluation, and the considerable knowledge of a broad group of experts in the fields bearing on our work. MentorNet has pioneered design, implementation, and testing of structured e-mentoring, and continues to set the standard in this relatively new practice. Evaluation results indicate that graduate students and their mentors in particular report high levels of satisfaction with MentorNet, with increased confidence, and other predictors of improved retention and enhanced self-efficacy for the protégés.

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