

Electronic Mentoring: Supporting Women Engineering and Science Students in the Crucial Early Years of College

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MentorNet is using electronic communications to address a persistent problem in engineering education: the underrepresentation of women. This paper in particular will focus on MentorNet's efforts to support women engineering, science, math, and technology students during the crucial first year of undergraduate education.

In this paper, we review the current situation of women students in engineering, identifying barriers and obstacles to their persistence in engineering majors. Then we will briefly explore why the first year of undergraduate education is a particularly important time for intervention programs for women in engineering. Next, we introduce MentorNet (www.mentornet.net), the Electronic Industrial Mentoring Network for Women in Engineering and Science, a large-scale project to support women studying engineering and related sciences. Finally, we present quantitative and qualitative results of year-end program evaluations focusing on both overall program results, and particularly on, the experiences of the first year undergraduate students. The qualitative aspects of the evaluation help bring richness and depth to our understanding of the benefits that first year students accrue from participating in MentorNet.

I. Women Students in Engineering and Early Experiences

Engineering has stubbornly remained a field where women continue to be severely underrepresented. Engineering is the career aspiration that still shows the greatest difference between the number of men and women as they begin their undergraduate years.¹ Nation-wide data show that women earned just 18.6% of undergraduate engineering degrees, 20.3 % of masters engineering degrees, and 12.3% of engineering doctoral degrees in 1998.²

Consistently, research shows that this discrepancy is not due to a lack of motivation, ability, or academic preparation of women students.^{3,4} Instead, it seems that environmental factors and societal factors are largely responsible for deterring women from entering or persisting in engineering. Competitive and unwelcoming classroom environments hinder women from persisting in their pursuit of engineering degrees^{5,6,7,8}. Because of the propensity of male dominated stereotypes and examples in society and the college classroom, women in engineering may question their ability or commitment more than their male counterparts⁹. Also, two highly important predictors of academic persistence and success -- mentoring and research experiences -- may be less readily available to women students¹⁰.

Formalized women in engineering programs, which often include mentoring components, have been become an important part of supporting and encouraging women students in engineering¹¹.

Intervention and support programs during the first year of undergraduate education may be particularly important for underrepresented students, such as women in engineering. Unfortunately, from the beginning, external and internal deterrents may hinder women from their pursuit of engineering degrees. Much like graduate students and new faculty members during their first year^{12, 13}, the first year of undergraduate education has important implications for socialization, achievement, and persistence. For undergraduate students, early academic and social experiences matter most during the first year of college and greatly influence persistence¹⁴. So, if women enter these programs at a disadvantage, not due to motivation, academic preparation, and support among first year students, but due to lower confidence in their abilities⁴ or if during the first year, they show a significant drop in self-confidence¹⁵, there could be negative consequences for retention.

For these reasons, programs that provide support to women engineering undergraduate students early in their academic careers may prove to be of particular importance. MentorNet provides e-mentoring opportunities to undergraduate, masters, doctoral, and post-doctoral women students; this paper focuses on the experiences of the students who participate during the early years of college.

II. MentorNet

MentorNet (www.mentornet.net), the Electronic Industrial Mentoring Network for Women in Engineering and Science, addresses the underrepresentation of women in engineering and related sciences by creating a large-scale structured electronic mentoring (e-mentoring) program. MentorNet pairs women students in engineering, engineering-related science, and math fields with industry professionals and supports them through a year-long e-mentoring relationship. MentorNet's multi-institutional focus allows for economies of scale, opportunities for growth, broader and deeper pools of mentors and students, and mentor opportunities with industry professionals at campuses where these opportunities either do not exist or are limited (See Table 1 for MentorNet's Actual and Projected Growth Plan).

Table 1: MentorNet's Actual and Projected Growth Plan

	-----Actual-----				Projected
	Pilot Semester 1998	Year 1 1998-99	Year 2 1999-2000	Year 3 2000-01	Year 4 2001-02
Students Matched	204	515	1,250	2,000	3,500
Mentors Matched	204	515	1,214	1,913	3,500
Participating Campuses	15	26	36	71	100
Companies Represented by Mentors	93	261	588	690	-

Literature about structured mentoring programs indicates that programs which provide features beyond the initial matching stage result in more frequent mentoring exchanges and benefits to the protégés^{16, 17}. Therefore, MentorNet includes multiple program features that support and enhance the e-mentoring relationships. MentorNet utilizes various features such as a web site, coaching curricula, electronic newsletters, and a group of electronic discussion lists to facilitate the one-on-one e-mentoring opportunities, and designated facilitators to assist pairs or groups in developing strong, mutually satisfactory, and productive relationships¹⁸.

Interested students and prospective mentors complete an application online. Data about participants' area of technical interest or major field of study, industrial sector, vocational interest, gender, ethnicity, are collected and a computer-based sorting program identifies the most suitable potential mentors for a student. Matches are based on the educational field of the students and mentors (such as electrical engineering, biology), career sectors for mentors and of interest to students (such as telecommunications, hardware), and education level (a mentor's educational degree must equal or exceed that of a protégé.) After the computerized process is complete, MentorNet staff personally reviews each match and reviews the open-ended comments of applicants.

Mentors and protégés are expected to communicate *at least* twice a month. In addition, mentoring pairs may supplement their email interactions with phone conversations and face-to-face visits. The mentors and protégés are encouraged to contact the staff directly if they have any concerns or questions. Pairs are committed to a relationship for one academic year; following that year, participants may continue to maintain the relationship for another year, find a new partner, or leave the program.

On-line training materials are posted on the MentorNet web site. Even before they are paired with an e-mentoring partner, the applicants receive an email inviting them to review web-based training materials for information about the e-mentoring process. The Mentor and Student Guides provide information about mentoring, specific suggestions for establishing and developing a mentoring relationship, information about the use of electronic communication and "netiquette." These guides also include a list of questions for the students and for the mentors to use to initiate discussions with their e-mentoring partners. In addition, the web site includes general information about protégés' campuses for the professionals who will serve as mentors and information about the corporate, government agency and professional society partners for the student protégés.

MentorNet provides on-going support and communications to the e-mentoring pairs through regularly-delivered discussion suggestions and monthly on-line newsletters. The discussion suggestions serve a coaching function along four dimensions. First, they keep the lines of communication open between the MentorNet program staff and participants. At the end of each discussion suggestion we solicit responses from the participants if they are not in contact with their e-mentoring partner, if they are uncomfortable with any of the e-mentoring interactions, or if they have any questions or comments. 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 students 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 newsletters updating them on the activities of the MentorNet program.

The last element of the MentorNet program is the group of electronic discussion lists. The electronic discussion lists foster community among women (and men) in technical and scientific fields. The professionals participating in MentorNet seemed to appreciate the opportunity to interact with, solicit advice from, and provide support to one another in a safe and supportive on-line environment¹⁹.

III. Evaluation Results

At the end of the academic-year long program, all are asked to fill out a web-based survey to provide feedback about their experience in MentorNet. We report on data from 1998-99 because we conducted an extensive qualitative and quantitative evaluation that provided rich insights into student's experiences participating in MentorNet. The findings from this evaluation allowed us to streamline subsequent evaluations. In 1998-99, MentorNet paired 515 women students from 26 college campuses with industry professionals from 261 companies. That year, 80% of the mentors were women and 20% were men. Fifty-six percent of MentorNet's woman students and 75% of the mentors self-identified as Caucasian); the racial and ethnic backgrounds of the mentors were less diverse than those of the students, reflecting the underlying race-related workforce demographics. The response rate to the web-based survey was 67.6% for mentors and 50.9% for students.

The quantitative results from the full sample suggest that the participants were very positive about their experiences in the MentorNet program and that the e-mentoring format was a successful way to establish a mentoring relationship. One indication of satisfaction (or commitment) was that mentors reported high levels of interest in participating in MentorNet for the following year. On scale from 1 (Not at all) to 5 (Very), mentors very high interest in participating in MentorNet in the next year ($\bar{x} = 4.20$) and very high interest in promoting MentorNet to colleagues ($\bar{x} = 4.21$).

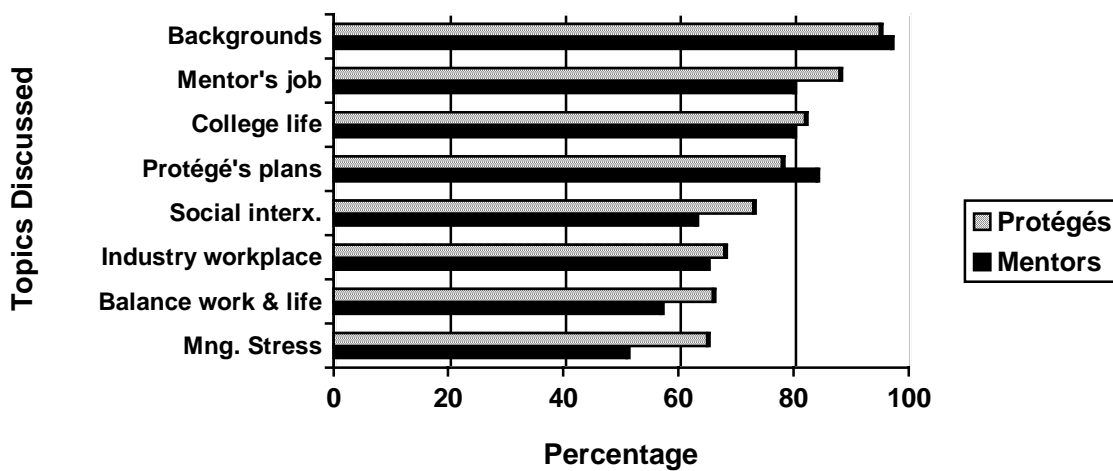
Using the same rating scale (1 = Not a all, 5 = Very), the protégés reported high levels of commitment to staying in their major ($\bar{x} = 3.49$) and interest in working in industry (4.17). Since knowledge of the opportunities in industry has been found to be indicative of an interest to continue in one's major^{20,21}, this may prove to be a very important outcome of this program.

The evaluation asked the mentors and the protégés to identify the topics that they discussed with their e-mentoring partners (see Figure 1 for a ranking of the issues discussed by the mentors and the students). As expected, they discussed their backgrounds, the mentor's job, the student's college experience, and the student's future plans. Of note is that the protégés' fifth most frequently chosen topic was social interaction, shared jokes, and discussions about non work- or school- related topics. These informal and lighthearted interactions may help protégés'

perceptions of mentors to evolve from seeming intimidating to being perceived as supportive advisors and friends. These social interactions also serve to sustain relationships so that important issues can be discussed when the need arises.

Mentors and students also discussed the industry workforce, issues pertaining to balancing career

Figure 1: Percentage of Mentors and Proteges who Reported Discussing Topics



and a personal life, time management, and stress management. In particular, time and stress management were important issues for students pursuing traditionally rigorous educational degrees. The fact that balancing career and a personal life was an important discussion topic for these pairs, especially since the majority of the students are traditional, college-aged students who do not currently have a family of their own, provides insight into the concerns of women engineering and science students. A prevailing societal view is that engineering and science careers are all consuming, and leave little time for developing a family life and having children. Having a forum for discussing the current beliefs related to work and family life may help these students persist in a field they feel passionately about but which they might perceive as conflicting with some of their other personal goals.

Analyses indicate that gender, race, and ethnicity seemed to play little role in the perception of the success of the e-mentoring. Comparisons between e-mentoring pairs with a male mentor versus a female mentor resulted in few differences; they reported similar frequency of email exchanges, comparable satisfaction with the match, and no differences between the other outcome measures reported above, with the exception that e-mentoring pairs with a female mentor were more likely than those with male mentors to discuss future career plans, treatment of women in the workplace, and balancing career and personal life.

Additional analyses focused on the experiences of the first year students and their comparative experiences compared with the whole sample. First we focus on the discussion topics of the first year students and how their choice of discussion topics compare to the full sample of the students.

Figure 2: Percentage of First Year Students and Full Sample of Students who Reported Discussing Topics

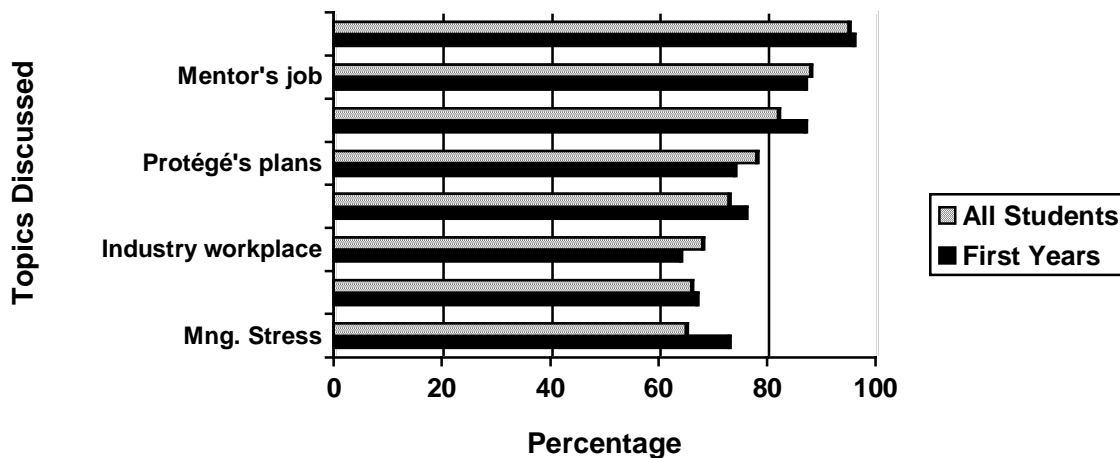


Figure 2 reports on the percentage of first year students who discussed a variety of topics with their mentors, compared with the percentage of the full sample of students. Overall and not surprisingly, the percentages are relatively equivalent and follow similar trends, with a few notable differences. First, more first year students discussed issues addressing college life with their mentors (87%) compared with the full sample (82%). Second, the first year students engaged in social interactions and lighthearted exchanges with their mentors more than the full sample, albeit not by much. Third, managing stress was an issue discussed more often by the first years with their mentors, and this was discussed more than issues concerning the industry workplace or issues concerning balancing personal and professional life.

While additional analysis and evaluation will help illuminate these differences, they already suggest some distinct differences and needs of the first year students. First, the first year students are just beginning their postsecondary experiences and are entering new cultures and new milieus – which, may be very different from what these women have experienced in their past experience pursuing math and science. So it is not surprising that discussing issues pertaining to the college experience are relatively more important to this subset of the student population participating in MentorNet. In addition, as these students are just entering college and probably do not have the focus or the maturity of the more advanced students. Therefore, the mentors may be providing more psychosocial support as these women are negotiating, for the first time,

their college experiences. Therefore, the ability to engage in lighthearted exchanges, by sending jokes back and forth or by exchanging personal anecdotes and experiences, may be just what these students need to stay connected with their mentors. In contrast and based on anecdotal evidence, the more advanced students may have identified specific goals and questions for their e-mentoring experience. Therefore they may approach their e-mentoring relationships in a more pointed and focused manner, posing questions to their mentors and soliciting information support instead. The first year students also were more likely to discuss managing stress and time with their mentors and less likely to discuss balancing personal and professional aspects of their lives or different aspects of the workplace environment. These may be notable findings and certainly consider attention in the future – this notion that first year students are primarily looking for and in need of psychosocial benefits from their mentoring relationships and deriving informational benefits from their e-mentoring relationships is more in line with the needs of the more advanced students.

The qualitative analysis associated with the MentorNet evaluation helped to bring richness and depth to the benefits of participation for the first year students. Comparing the open-ended responses of the first year students to the remainder of the protégé sample, the first year students were more likely to find discussions of “school matters” useful. 40% of the first year students reported this to be the case, compared with 21% of the seniors. This is consistent with the earlier finding about discussing issues pertaining to college. This also suggests that mentors may also be serving as *academic* advisors, and may rival the usefulness or availability of on-campus advisors. In fact, one student reported that she found her e-mentor a more valuable resource than the on-campus advisor: “I was having some trouble picking some classes for next semester, but my mentor was more helpful than my guidance counselor.” As first year students are considering their majors, choosing majors, and wondering about the implications for their jobs, their industry mentors proved to provide valuable feedback about the process. Below are a few quotes from first year students that demonstrate how their industry e-mentor provided advice, support, and perspective on choosing a major. Through these quotes is woven the experience of receiving support and encouragement, and having a non-judgmental person with whom to discuss such important issues to a first year student:

“I really appreciate the advice she gave me regarding choosing a major and application of a major in a career. I enjoyed hearing about her experiences.”

“I am strongly considering changing my major and my mentor helped me to analyze this decision. She was very supportive.”

“I understand that choosing my major was not the biggest deal that I thought it would be. I realize that I can change majors and careers, and probably will change my career from what my major is at this point. Our correspondence really helped to alleviate the pressure of choosing a major.”

The personal relationships and encouragement that first year students gained from participating in MentorNet were notable and differed slightly from the benefits of the more advanced students. Overall, undergraduate students reported that conversations about personal issues were valuable aspects of the e-mentoring relationship. 32% of the first year students reported this to be the

case. The first years were more likely to report receiving encouragement from their mentor was one of the most valuable aspects of the program (11%) then were sophomores (4%) and juniors and seniors (0% for both). This quote by a first year student illustrates the encouragement she experienced through email interactions with her mentor:

“This [participating in MentorNet] reaffirmed my belief that I want to be an engineer. It helped me to decide that working in industry would be good, and when I was feeling based because of school or whatever she gave me encouragement.”

IV. Discussion

MentorNet represents the leveraging of electronic communications to connect women students with industry professionals to provide mentoring opportunities, support, and pre-professional development. The centralization of the application, matching, training, and coaching processes of MentorNet has allowed for considerable economies of scale and concentrations of expertise. MentorNet’s effectiveness is supported by the positive responses to the year-end evaluation.

In particular, responses from the first-year students support the need for and efficacy of the program, as participation in MentorNet benefits the students right when they need it, during the crucial early years. By comparing the topics discussed by and the issues identified as most valuable by the first year to the sample of the full students, we highlighted some notable differences in their needs and the benefits they receive from participation in MentorNet. The first year students, especially as they are entering a new and usually very stressful time in their lives, they are less in need of actual advice or direction. While the quotes above suggest they get both advice and direction nonetheless, what the students continue to identify as valuable is being in a relationship with a knowledgeable, yet non-judgmental, person. The first year students appreciate being able to exchange light-hearted stories and jokes with their mentors. As the first year experience appears to set the stage for the rest of the collegiate experience, being able to have a safe person with whom they can be themselves, receive encouragement and reaffirmation of their skills and desires, may prove to be a very valuable and have long-lasting benefits associated with participation in MentorNet.

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