

MENTORNET: E-MENTORING FOR WOMEN STUDENTS IN ENGINEERING AND SCIENCE

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MentorNet (www.MentorNet.net), the E-Mentoring Network for Diversity in Engineering and Science, addresses the underrepresentation of women in science, technology, engineering, and mathematics (STEM). MentorNet offers a multi-institutional, structured, electronic mentoring (e-mentoring) program that pairs undergraduate and graduate students, primarily women, with professionals and supports them through e-mentoring relationships of specified lengths. The program evaluations established that over 90% of the participants would recommend MentorNet to a friend or colleague. The e-mentoring program allowed participants to establish satisfactory and beneficial e-mentoring relationships based on investments of approximately 20 minutes per week; in between more serious exchanges, email exchanges that included light-hearted social interactions and jokes were an important aspect of sustaining e-mentoring relationships. Participation in MentorNet increased the students' self-confidence in their fields; desire to obtain work in industry, national laboratories, or national agencies; and intent to pursue careers in their fields. Three years of evaluation results support the need for and efficacy of the program.

INTRODUCTION

Engineering has remained a field in which women are severely underrepresented. Over the last 30 years, the numbers of women and men have converged on many educational planes, including some science and math fields. As a career aspiration, however, engineering still shows the greatest divergence between undergraduate men and women (Astin, 1998). Nationwide data show that women earned 20.1% of the undergraduate engineering degrees, 21.2% of the master's degrees, and 16.9% of the doctoral degrees awarded in 2001 (National Science Foundation, 2004).

Consistently, research suggests that this discrepancy is not due to the lack of motivation, ability, or academic preparation on the part of female students (Felder, Felder,

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Mauney, Hamrin, & Dietz, 1995; Hawks & Spade, 1998). Instead, environmental and societal factors are primarily responsible for deterring women from entering or persisting in science, technology, engineering, and mathematics (STEM). These factors include the competitive and often unwelcoming classroom environments in college (Crawford & MacLeod, 1990; Seymour & Hewitt, 1997; Tobias, 1990), the lack of social relevance to their course of study (Mikic & Grasso, 2002; Seymour & Hewitt, 1997), enjoying the field but not considering it as a possible career choice (Creamer, Burger, & Meszaros, 2004), and the presence of male-dominated stereotypes and culture, both in the college classroom and in society as a whole, which may cause women to question their ability or commitment to a greater extent than their male counterparts (Margolis & Fisher, 2001; Steele, 1997). Mentoring, advising, and research experiences, identified as some of the most important predictors of academic persistence and success, are less readily available to women students, and their absence is detrimental to women students' persistence in STEM fields (Drew & Work, 1998; Seymour, 1995). Consequently, formalized women in science and engineering programs have become an important part of supporting and encouraging women students; mentoring is consistently a feature of these academic support programs for women (Knight & Cunningham, 2004; Wadsworth, 1992).

MentorNet¹ brings together structured mentoring programs and electronic communications to address the underrepresentation of women in STEM on a large scale. In this article, we introduce and explain MentorNet's One-on-One program and its various program features. Then, we present the results of three successive year-end program evaluations, describing results from the 1998–1999, 1999–2000, and 2000–2001 program years.

MENTORNET'S ONE-ON-ONE PROGRAM: A MULTI-INSTITUTIONAL STRUCTURED E-MENTORING PROGRAM

MentorNet (www.MentorNet.net) was founded in 1997 to address the underrepresentation of women in STEM fields by creating a large-scale structured electronic mentoring (e-mentoring) program (Muller, 1997) and is one of the earliest and largest e-mentoring programs (Single & Single, 2005a). MentorNet pairs students, primarily women, at undergraduate and graduate levels with male and female professionals working in industry, government, and higher education who serve as e-mentors. By recruiting e-mentors in industry or national laboratory/agency positions, MentorNet allows women students to

¹MentorNet (www.MentorNet.net), the E-Mentoring Network for Diversity in Engineering and Science, is a 501(c)(3) educational organization headquartered in San José, CA. Its mission is to further the progress of women and others underrepresented in scientific and technical fields through the use of a dynamic, technology-supported mentoring network, and to advance individuals and society, and enhance engineering and related sciences, by promoting a diversified, expanded, and talented global workforce. MentorNet works in partnership with colleges and universities, corporations, government labs, and professional societies, and is international in scope, serving students and professionals all over the world. Since this data was collected and analyzed, there have been significant changes and enhancements in the programmatic infrastructure. In 2003, MentorNet's One-on-One programs moved to a new year-round patent-pending system of matching and coaching, providing the option for protégés to select their mentors and allowing mentors and protégés to be matched at any point across the year for 8-month-long mentoring relationships. An Academic Career E-mentoring (ACE) program matching graduate students and early career faculty with tenured faculty mentors began in 2003. In 2005, MentorNet formally expanded its initial mission focus on women to embrace its increasing service to men, particularly men of color.

interact with professionals in various fields and sectors, thereby allowing the students to make the college-to-work connection and understand how their current academic programs influence their future careers (Single, Muller, Cunningham, Single, & Carlsen, 2005). MentorNet then supports each pair through an e-mentoring relationship of specific length; during the years addressed in this article, these e-mentoring relationships lasted for one academic year at a time. By relying on email as the primary medium for establishing mentoring relationships, MentorNet can pair students with professionals, regardless of geography and time constraints.

Studies have shown that women and women's modes of communicating are often undervalued and belittled in academia, with the result being that women students are hesitant to speak up in classrooms, are more likely to be interrupted or discounted than male students, and males' comments are automatically accorded more authority (Crawford & MacLeod, 1990; Henes, Bland, Darby, & McDonald, 1995). These inequities are reduced in electronic settings (Smith & Balka, 1988; Sproull & Kiesler, 1992). For instance, McGuire, Kiesler, and Siegel (1987, cited in Sproull and Kiesler, 1992) found that when a face-to-face group of male and female executives met, the males were five times more likely to make the first proposal. When the same group met electronically, the women were as likely to make the first proposal as the men.

As a multi-institutional program, MentorNet allows for economies of scale in administration and opportunities for program growth because it can reach broader and deeper pools of professionals and students, and can provide mentoring at campuses where such opportunities might be limited. The size and structure of MentorNet allows for the concentration of staff expertise that permits the development of specialized systems and resources (such as a proprietary algorithm to optimize the matches between e-mentors and protégés). As a *structured* e-mentoring program, MentorNet provides training and ongoing coaching to participants throughout the program. Although structured mentoring programs require an additional investment in program staff, research on face-to-face mentoring programs confirms that training, coaching, and opportunities for group mentoring or community building facilitate the development of successful mentoring relationships and the benefits associated with mentoring (Boyle & Boice, 1998; Murray, 1991). Research on structured face-to-face mentoring programs influenced the programmatic features associated with structured e-mentoring programs (Single & Single, 2005b). A recent review of research supported the importance of training, coaching, and community building opportunities for e-mentoring programs (Single & Single, 2005a).

During the 3 years reported on in this article, prospective e-mentors were recruited by liaisons within corporations, government labs, and professional societies from among their employees, members, and affiliates and were also recruited by liaisons at institutions of higher education by tapping into alumni/ae networks. Students were eligible for participation as protégés only if they were enrolled at a college or university that formally agreed to participate in the MentorNet program; students typically heard about the opportunity through the efforts of the campus representative who served as a liaison to MentorNet. By working with a limited, though growing, number of campuses, MentorNet contained its growth while it developed systems to allow it to capitalize on economies of scale. MentorNet's design and development have been undertaken with the end goal of unlimited scale—or, at least eventually, to accommodate any female student interested in STEM fields. Since 1998, MentorNet has provided over 13,000 e-mentoring opportunities for women college and graduate students (MentorNet, 2005).

As part of the recruitment process, students and prospective e-mentors were directed to the MentorNet Web site, where they completed an online application indicating preferences for being matched by area of technical interest or major field of study, industrial sector, vocational interest, gender, ethnicity, with alumni/ae or students at a particular campus, and other factors. The information, submitted through the online applications, was automatically entered into a database and an algorithm-driven program identified the most suitable e-mentors for the protégés.

Mentors and protégés were expected to communicate via email *at least* twice a month. Some chose to supplement their email interactions with phone conversations and face-to-face visits, although doing so was not promoted. Each e-mentoring pair committed to the relationship for one academic year.

Program Features

In offering a structured e-mentoring program, MentorNet used various features to facilitate one-on-one e-mentoring opportunities and to develop and understand the role of electronic networking and group/peer mentoring. These features included an interactive Web site with an underlying database, Web-based training, coaching curricula, electronic newsletters, and electronic discussion groups that provided opportunities for community building (Single & Muller, 2001). Online training materials were available on the MentorNet Web site. In addition, MentorNet provided e-training to both protégés and e-mentors via interactive Web-based case studies. In a study using experimental design, the protégés who were mandated to work through the e-training (experimental group), compared with the protégés for whom the e-training was voluntary (control group), experienced a higher frequency of email exchanges within their e-mentoring relationships (Kasprisin, Single, Single, & Muller, 2003); a higher frequency of email exchanges has been associated with increased satisfaction in their e-mentoring relationships (Ithaca Evaluation Group, 1999).

MentorNet provided on-going support and communications to the e-mentoring pairs through its coaching curriculum, which was a set of regularly delivered messages offering suggested topics for discussion throughout the course of an e-mentoring relationship. MentorNet used these “prompts” as coaching, educational, and administrative tools. These prompts allowed MentorNet to maintain communication between the program staff and participants, to coach the e-mentoring pairs through the stages of a mentoring relationship, to educate the professionals and students about issues pertinent to women in STEM, and to remind the participants to keep in contact. Research on this feature confirmed that more frequent coaching resulted in better outcomes for the participants (Single, Muller, & Carlsen, 2000a). In addition to these email “prompts,” all participants were sent monthly e-newsletters. This communications mechanism allowed MentorNet to keep the participants updated on MentorNet’s progress and development and, more importantly, was expected to help the participants feel a part not only of their one-on-one e-mentoring relationships but also of a larger MentorNet community (Single & Muller, 2001).

One additional feature of the MentorNet program was a group of topic-based electronic discussion groups (see Single, Muller, Cunningham, and Single [2000b] for an in-depth discussion of this feature). These discussion groups provided opportunities for the students and professionals to interact with others outside of their one-on-one e-mentoring relationship, thereby providing opportunities for peer mentoring to develop and for students and professionals to provide multiple and varying perspectives on certain topics. All participants were

offered the opportunity to participate in these groups. Although staff members did not facilitate the groups, research on the groups found that the professionals often informally took on the role of facilitators, by posting current events or issues of importance to them to the list and by soliciting discussion (Single et al., 2000b). Having explained the program features of MentorNet, we next describe the participants, and then report on the evaluation results and insights from the 1998–1999, 1999–2000, and 2000–2001 program years.

METHODS

On the basis of anticipated capacity, each year MentorNet established a targeted number of e-mentors and protégés to participate in the program. Then, on the basis of the results of the recruiting efforts, MentorNet matched as many e-mentoring pairs as possible. As a major feature of its program evaluation, MentorNet asked all protégés and e-mentors participating in the program to complete a year-end online survey instrument.

The evaluation results presented in this article are from the first few years of MentorNet's establishment. At that time, e-mentoring was still a very new concept, and research and evaluation on e-mentoring programs were minimal. Given this situation and the reliance on a new and different communications medium and delivery system for mentoring, it was important first to evaluate participant satisfaction with the program and participants' assessments of their e-mentoring experience. The evaluation results presented here focused on the participants' satisfaction with MentorNet and their self-assessment of the benefits they received from participation. In addition, the evaluation results identified the most common topics of discussion and the time investment on the part of the participants.

Participants

After the application deadline, MentorNet created matches between interested professionals and students. In 1998–1999, 973 students and 693 professionals applied. Of those who applied, 539 students were matched with 539 professionals to form e-mentoring dyads. In 1999–2000, 1,405 students and 1,521 professionals applied, and 1,250 students and 1,214 professionals were matched. Of these, 1,182 were matched in one-on-one e-mentoring pairs, and the rest were assigned to experimental mentoring groups. In this article, we report only on the participants in MentorNet's One-on-One mentoring program. In 2000–2001, 2,022 students and 2,360 professionals applied, of which MentorNet paired 2,000 students with 1,913 of the professionals; some of the professionals mentored two students. See Table 1 for applicants, participants, and response rates for each year.

The majority of students participating in MentorNet during these 3 years were undergraduate students: 82% in 1998–1999, 76% in 1999–2000, and 78% in 2000–2001. MentorNet attracted a large percentage of students and professionals in engineering and computer science fields: 83% in 1998–1999, 72% in 1999–2000, and 78% in 2000–2001. Students in other fields included those in life sciences, physical sciences, mathematics, applied math, statistics, and other sciences. The majority of the MentorNet students were Caucasian (44% in 1998–1999, 56% in 1999–2000, and 51% in 2000–2001), as were their e-mentors (75%, 79%, and 74%), reflecting current demographics of these fields in higher education and the workforce, with more students than mentors who identified themselves

Table 1. Participation in 1998-99, 1999-2000 and 2000-01 Program Years

	1998-1999		1999-2000		2000-2001 ^a	
	Students/ protégés	Professionals/ mentors	Students/ protégés	Professionals/ mentors	Students/ protégés	Professionals/ mentors
Total applied	973	693	1,405	1,521	2,022	2,360
Total matched	539	539	1,250	1,214	2,000	1,913
Total matched in one-on-one relationships	539	539	1,182	1,182	2,000	1,913
Participating campuses	26	--	36	--	70	--
Mentors' organizations	--	261	--	588	--	690
Response rates	51%	68%	58% ^b	56% ^b	52%	60%

^a In some instances, mentors were matched with more than one student.

^b Based on a sub-set of 200 e-mentoring pairs; see text for explanation of how subset was chosen.

as members of a minority group. In addition, the majority of the professionals who volunteered to serve as e-mentors were women, 80% in 1998–1999, 75% in 1999–2000, and 69% in 2000–2001. Table 2 summarizes the educational and demographic characteristics of participants.

Evaluation Procedure

The goals of the evaluation presented in this article were to obtain participants' assessments of their satisfaction and value associated with their e-mentoring experiences. All participants were invited via email to fill out an online survey, and, afterwards, a series of follow-up reminders were sent to nonrespondents. The surveys relied principally on questions that were rated on a 5-point scale. We also assessed the topics discussed between the e-mentoring pairs, to better understand the content of e-mentoring and, also, to influence the development of training and coaching curriculum. In addition, the evaluations assessed the time commitment invested on the part of the protégés and e-mentors.

In 1998–1999, the evaluation focused primarily on formative evaluation, with a focus on whether email was an effective medium for developing mentoring relationships. As such, the evaluation focused on questions such as, "How comfortable were you asking your mentor questions?" or "How comfortable were you responding to questions from your mentor?," rated on a 5-point scale from *not at all* (1) to *very* (5). The follow years' evaluations also focused on the protégés' changes in self-confidence, their interest in future careers, and their satisfaction with programmatic features. Examples of student questions included, "Has your MentorNet experience affected your self-confidence about your ability to succeed in your field?," ranging from *decreased* (1) to *increased* (5) and "How satisfied were you with your one-on-one e-mentoring relationship?," ranging from *not at all* (1) to *very* (5).

Mentors were also asked about their experiences participating in MentorNet. They were posed with questions similar to those posed to the protégés, and the questions also focused on comfort with email as a medium for mentoring and their satisfaction with MentorNet and its programmatic features. Examples of mentor questions included, for

instance, “Please rate how satisfied you have been with your MentorNet experience this year?,” ranging from *not at all* (1) to *very* (5).

To assess the time investment by the participants, both e-mentors and protégés were asked to report the number of minutes “spent writing and reading MentorNet email in a typical week.” We also asked them to report the number of emails sent and received per month.

In addition, a portion of the survey included a list of discussion topics from which the participants could check the topics they discussed with their e-mentoring partners. Topics included “Your backgrounds,” “Managing time, stress, or workplace demands,” and “Balancing a career and other interests, family, etc.” The list of topics was derived from previous research based on open-ended responses (Ithaca Evaluation Group, 1999).

RESULTS

In this section, we present 3 years of evaluation data. Since these results represent the early years in an on-going program, the evaluation changed and evolved during the timeframe

Table 2. Participants by Educational and Demographic Characteristics for 1998-99, 1999-2000 and 2000-01^a

	1998-1999	1999-2000	2000-2001
Protégés’ degree program			
Undergraduate	82%	76%	78%
Master’s	8%	7%	8%
PhD/Post docs	10%	17%	11%
Protégés’ field of study			
Engineering & computer science	83%	72%	78%
Life sciences	10%	16%	10%
Physical sciences	5%	7%	7%
Math, applied math, statistics	3%	4%	4%
Other	--	1%	1%
Protégés’ Demographics			
Caucasian/Western European	44%	56%	51%
African American	8%	7%	7%
Latina/Hispanic	3%	3%	4%
Asian/Asian American	29%	25%	24%
Multiracial	4%	4%	3%
Other/no response	12%	5%	10%
Mentors’ Demographics			
Gender	80% women	75% women	69% women
Caucasian/Western European	75%	79%	74%
African American	3%	4%	4%
Latina/Hispanic	3%	3%	3%
Asian/Asian American	11%	9%	11%
Multiracial	1%	2%	3%
Other/no response	6%	3%	5%

^a Because of rounding off, some percentages do not add up to 100.

that is being presented in this article. The previous evaluations influenced future evaluation instruments and methods. As such, in some instances, comparisons could not be consistently made across all 3 years. Whenever possible, however, we did provide the opportunity to make comparisons across all 3 years.

Sample Size and Response Rates

In the 1998–1999 year, 539 e-mentoring pairs were matched, for a total of 1,078 participants. Fifty-one percent (51%) of the protégés and 68% of the e-mentors completed the on-line surveys. For the 2nd year, we sampled a subset of e-mentoring pairs to be included in the evaluation portion of the program. On the basis of responses to mass email solicitations requesting that participants engage in the evaluation, we decided to focus our efforts on a subset of 200 pairs so we could concentrate our follow-up efforts without inconveniencing all the e-mentors and protégés, who we hoped would sign up for the following year. Consequently, for the 1999–2000 year, although all participants were invited to complete the online evaluation, the analysis focused on a subsample of 200 e-mentoring pairs. The 200 e-mentoring pairs were randomly chosen from all the e-mentoring pairs, and 200 pairs (400 participants) were chosen as a large enough sample to represent the participants from the 1999–2000 program year. The response rates for this subsample were 58% for protégés and 56% for e-mentors.

Of the 2,000 protégés and 1,913 e-mentors paired in e-mentoring relationships in 2000–2001, the response rates to the year-end survey for participants were 52% for protégés and 60% for e-mentors. See Table 1 for the response rates for the 3 years of evaluation data.

Ratings of Email as a Medium for Mentoring

Since email was a new medium for conducting mentoring relationships, the evaluations first focused on whether the participants were comfortable both asking and answering questions over email. The responses to this construct were very high for the 1st year and remained high for the following 2 years. Both the e-mentors and the protégés felt very comfortable asking questions of and answering questions from their e-mentoring partners (all of the responses from the e-mentors and protégés to these questions were $M > 4.00$). The protégés rated their comfort asking or answering questions from a low of 4.31 to a high of 4.55. The e-mentors rated their comfort level from 4.11 to 4.64. See Table 3 for the participant ratings of using email as a medium for mentoring.

Table 3: Participant Ratings of Email as a Medium for Mentoring

Survey Questions	1998–1999		1999–2000		2000–2001	
	Protégés	Mentors	Protégés	Mentors	Protégés	Mentors
Comfort asking questions of my e-mentoring partner (1 = not at all to 5 = very)	4.45	4.32	4.32	4.11	4.31	4.32
Comfort answering questions from my e-mentoring partner (1 = not at all to 5 = very)	4.55	4.64	4.43	4.56	4.43	4.60

Satisfaction with One-on-One E-Mentoring, MentorNet, and Programmatic Features

After establishing that these technologically savvy protégés and e-mentors were using email effectively as a medium for establishing mentoring relationships, we next focused on participant satisfaction with the program. In 1999–2000 and 2000–2001, we asked the e-mentors and protégés to rate their satisfaction with the MentorNet program, as well as with specific aspects of the program. The protégés and e-mentors rated their satisfaction with their one-on-one e-mentoring highly ($M = 3.95$ and 3.44 in 1999–2000 and 3.83 and 3.42 in 2000–2001), along with giving high marks to the overall MentorNet program ($M = 3.75$ for protégés and 3.42 for e-mentors in 1999–2000 and 3.77 and 3.43 in 2000–2001). Rank order of satisfaction with various program features, from highest average ratings to lowest average ratings, were the MentorNet Web site, the coaching curriculum or discussion suggestions, the e-newsletter, and the electronic discussion groups. These results are reported in Table 4.

Another way to assess the participants' satisfaction with the program was to ask them whether they would recommend participation in MentorNet to a friend, student, or colleague. The vast majority of the student respondents (94% in 1999–2000 and 92% in 2000–2001) said they would recommend MentorNet to a friend. In 2000–2001, the only year that this question was posed to the e-mentors, 94% said they would recommend MentorNet to a colleague.

Time Investment and Frequency of Email Exchanges

Since both students in STEM fields and professionals working in those fields tend to have very busy schedules, we wanted to determine what type of time commitment the participants were investing in MentorNet. In 1999–2000 and 2000–2001, we found that both the protégés and the e-mentors reported exchanging approximately four emails per month—that is, sending two per month and receiving two per month. In addition, the participants reported spending just under 20 minutes writing and reading MentorNet email in a typical week. In 2000–2001, the only year asked, on average the protégés spent 18.8 minutes per week and the e-mentors spent 17.5 minutes per week. For results, see Table 4 under “Participant-Reported Frequency of Email Communication.”

Effects of E-Mentoring on Protégés' Self-Confidence and Career Aspirations

Since self-confidence has been linked to persistence in STEM fields, in 1999–2000 and 2000–2001, the protégés were asked to rate how their MentorNet experience affected their self-confidence in their fields. The protégés responded that participation in MentorNet increased their self-confidence ($M = 3.57$ in 1999–2000 and 3.70 in 2000–2001). In addition, we examined how the protégés perceived that their participation in MentorNet influenced their commitment to pursuing jobs in the field they were studying. Their responses were favorable ($M = 3.74$ in 1999–2000 and 3.83 in 2000–2001), as was MentorNet's effect on their desire to work in industry or a government laboratory or agency ($M = 3.60$ and 3.73 , in 1999–2000 and 2000–2001, respectively). The averages are reported in Table 4 under “Effects on Protégés' Self-Confidence and Career Aspirations.”

Table 4. Participant Ratings of E-mentoring Relationships

Survey Questions	1999-2000		2000-2001	
	Protégés	Mentors	Protégés	Mentors
<i>Questions Posed to Protégés and Mentors</i>				
Would you recommend MentorNet to a friend/colleague (yes)	94%	(Not asked)	92%	94%
Overall satisfaction with MentorNet this year (1 = not at all to 5 = very)	3.75	3.42	3.77	3.43
Satisfaction with one-on-one mentoring (1 = not at all to 5 = very)	3.95	3.44	3.83	3.42
Overall quality of the e-mentoring match (1 = poor to 5 = excellent)	3.81	3.53	3.86	3.67
Satisfaction with the resources & info on the Web site (1 = not at all to 5 = very)	3.45	3.56	3.33	3.62
Satisfaction with group email discussion lists (1 = not at all to 5 = very)	3.14	3.24	3.07	2.97
Satisfaction with MentorNet discussion suggestions (i.e., coaching curriculum) (1 = not at all to 5 = very)	3.26	3.60	3.23	3.63
Satisfaction with MentorNet newsletter (1 = not at all to 5 = very)	3.17	3.46	3.08	3.45
<i>Participant-Reported Frequency of Email Communication</i>				
Number emails sent per month	2.15	2.09	2.44	2.42
Number email received per month	2.18	1.77	2.61	2.07
Time spent writing and reading MentorNet email in a typical week (minutes)	(Not asked)	(Not asked)	18.8	17.5
Felt part of a MentorNet community (1 = disagree to 5 = agree)	2.42	2.53	2.57	2.70
<i>Effects on Protégés' Self-Confidence and Career Aspirations</i>				
Effects of participating in MentorNet on your self-confidence in your ability to succeed in your field (1 = decreased to 5 = increased)	Protégés (average) 3.57	--	Protégés (average) 3.70	--
Effects of participating in MentorNet on desire to work in industry/national lab, etc. (1 = decreased to 5 = increased)	3.60	--	3.73	--
Effects on desire to pursue job in her field (1 = decreased to 5 = increased)	3.74	--	3.83	--

E-Mentoring Discussion Topics

The evaluation prompted the e-mentors and the protégés to identify the topics that they discussed with their e-mentoring partners. Table 5 provides a list of the topics and the percentages of respondents who discussed those topics. As would be expected, partners discussed their respective backgrounds, the mentor's job, the student's college and/or graduate school experience, and the student's future plans. One finding of note was that the

protégés' fifth most frequently chosen topic in 1999–2000, and sixth in 2000–2002, was social interaction, shared jokes, and discussions about non–work-related or non–school-related topics. These informal and lighthearted social interactions may help the professionals to evolve from being perceived as somewhat intimidating to being perceived as supportive advisors and may help to sustain a relationship so that important issues can be discussed when the need arises.

Mentors and protégés also discussed the industry workforce, issues pertaining to balancing a career and a personal life, time management, and stress management. In particular, time and stress management were important issues for students pursuing traditionally rigorous academic degrees. Balancing a career and a personal life was an important discussion topic for these pairs; women students continue to seek information and advice about these challenges from people, especially women, in the workforce.

DISCUSSION

MentorNet has taken advantage of the growth of email and the popularity and benefits of mentoring to develop and expand a large-scale program that provides support and information to women STEM undergraduate and graduate students by pairing them with industry professionals in their fields. By developing a centralized program, MentorNet used economies of scale to build an extensive infrastructure and concentration of expertise to allow for unprecedented growth for a structured e-mentoring program. Consequently, MentorNet is providing increasing opportunities for women students to be mentored by industry professionals, opportunities which otherwise might not exist on their campuses.

As MentorNet was one of the earliest and is one of the largest e-mentoring programs (Single & Single, 2005a), the evaluations presented here are from the first 3 full academic-length years of the program. Since, at that time, e-mentoring was a new communications medium for establishing mentoring relationships, it was important to

Table 5. Topics Discussed by Protégés and Mentors as part of the E-Mentoring Experience

Topics discussed (from checklist)	1999-2000		2000-2001	
	Protégés (%)	Mentors (%)	Protégés (%)	Mentors (%)
Your backgrounds	85	95	93	95
The mentor's job	68	82	82	85
The protégé's plans	66	79	77	83
College life	60	73	74	82
Social interactions, jokes	57	49	58	49
Balancing career, family, and life	48	57	55	57
Industry workplace	47	55	62	58
Managing time, and stress	43	59	57	46
Job hunting, interviewing	39	54	48	59
Differences between academia and industry	34	46	36	43
The mentor's plans	31	27	33	24
Women's experiences at mentor's company	25	26	30	30
E-mentoring logistics	24	32	33	38
Your reasons for participating in MentorNet	21	30	39	29

establish that participants were satisfied with the program and believed that they obtained value from participation.

The first goal of the evaluations presented here was to see if the program was embraced and believed worthwhile by the participants. The email-mediated mentoring worked well for this group of technologically comfortable professionals and students. E-mentors and protégés expressed strong interest in recommending MentorNet to a friend or colleague—which served as measure of the value of the program, and they rated their experience with MentorNet's One-on-One mentoring program, and with the whole organization, favorably. In addition, both e-mentors and protégés reported a high level of comfort with asking questions and developing a mentoring relationship over email, thus supporting the notion that relationships can be established and developed using electronic communications.

Researchers have suggested that e-mentoring should not serve as a replacement for face-to-face mentoring, but can extend mentoring opportunities where these opportunities would not otherwise exist (National Mentoring Center, 2002; O'Neill, Wagner, & Gomez, 1996; Single & Single, 2005a). In addition, researchers have posited the importance of meeting the expectations and needs of those volunteering to serve as e-mentors (Kasprisin & Single, 2005; O'Neill & Harris, 2004–2005). As such, in these evaluations for MentorNet we quantified the amount of time that the participants spent on the program. We found that the participants spent, on average, 20 minutes per week, or 80 minutes per month. On the basis of the asynchronous nature of the communication, the time was spent at the convenience of both the protégés and the e-mentors. In addition, 20 minutes per week may be easier to fit into the busy schedules of the professionals who participated in this program compared with less frequent but longer face-to-face meetings. The time investment was modest, convenient, and yet effective in terms of influencing female STEM students' knowledge and confidence about what their future careers may hold.

As a structured e-mentoring program, MentorNet provided facilitation and support throughout the program, going beyond simply matching e-mentors with protégés. This system worked well for these participants. Along with rating the program favorably, the two aspects of the program that they ranked as first and second were the Web site and the coaching curriculum (i.e., discussion suggestions). Both of these program features enhanced program engagement not only within the e-mentoring pairs but also with the program as a whole. In particular, the biweekly coaching messages provided discussion topics appropriate to the academic level of the protégés. The coaching not only served to deliver information that could fuel e-mentoring exchanges and bolster the e-mentoring relationship but also served as a prompt for the pairs to keep in contact and provided an avenue by which the program staff maintained contact with the participants (Single & Muller, 2001). As such, the participants appreciated the additional structure and facilitation provided by the program.

A notable outcome of participation in MentorNet: The protégés reported that participation in MentorNet helped to increase their academic self-confidence and their interest in pursuing careers in STEM fields. By being exposed to the individual stories and experiences of the e-mentors, the protégés identified with the e-mentors' previous academic struggles and ascertained that they were not alone and that they could become successful engineers and scientists, even if they experienced academic setbacks. This finding is notable, since the decline in academic self-confidence, lower self-confidence compared with their male counterparts, and women questioning their ability to succeed in STEM fields has been reported in the research literature (Brainard & Carlin, 1998; Margolis & Fisher, 2001; Seymour & Hewitt, 1997).

In addition, participation in MentorNet not only resulted in increased self-confidence for protégés but also increased their career aspirations in STEM fields. Although the abilities of men and women have converged, women are still less likely to pursue these interests as part of their future careers (Creamer et al., 2004). The interactions with e-mentors in professional STEM careers influenced the undergraduate and graduate students positively in terms of encouraging their interests and aspirations in pursuing careers in these fields. The students had access to academic engineers and scientists on campus but did not have ready access to professionals in industry, unless they have relatives in these fields. The e-mentors served as role models to the protégés. By having an individualized relationship with a professional in her field, the student had the opportunity to discuss the mentor's job and related experiences and gather insights and information about the industry workplace, as well as visualize the options and opportunities following graduation.

Involvement in a virtual community increased the students' self-confidence and career aspirations in STEM. Although the evaluation results presented in this study, which assessed the first years of MentorNet, were not designed to assess persistence in fields of study, MentorNet is specifically designed to create a virtual STEM community for its participants. E-mentoring provides mentoring opportunities and engagement in STEM communities where these opportunities would not otherwise exist (Single & Single, 2005a). In a large-scale, nationwide study of women engineering students, the one variable that was consistently related to persistence was involvement in a STEM-related community (Goodman et al., 2002). As such, it is likely that participation in MentorNet could contribute to persistence.

The content of the mentoring relationships, as gauged by the most frequent topics that the e-mentors and protégés discussed, offered insights into how e-mentoring relationships were developed and maintained. The most frequently mentioned topic discussed was their backgrounds, which served as a way for the newly paired students and professionals to establish a mentoring relationship. Next, both identified discussing the mentor's job as the most frequently discussed topic. That the mentor's employment was the second most frequently discussed topic was notable, since it may be one of the few opportunities students get to experience, albeit vicariously, their future work experiences. These findings underscored the value of connecting students with professionals working in their fields of study.

Along with the expected topics of discussion, such as exchanging emails about their backgrounds, the e-mentors' jobs, or the protégés' college plans and experiences, the sharing of social and personal information, and even jokes, was the fifth highest ranked discussion topic. While mentoring and e-mentoring research often focuses on the relevant exchange of information, this finding is a good reminder that e-mentoring, like mentoring, is about developing and sustaining a relationship. Just as in face-to-face mentoring relationships (Boyle & Boice, 1998), light-hearted exchanges served to build trust and kept the lines of communication open so that the e-mentoring relationships were primed when topics of import arose.

The results from this article suggest that MentorNet's One-on-One Mentoring Program supported female students in STEM by providing them with opportunities to interact with industry professionals and by providing a training and coaching curriculum that supported the establishment of e-mentoring relationships. The benefits to students focused on their opportunities to learn about the workplace, to increase their academic self-confidence, and to advance their STEM-related career aspirations. These opportunities may prove invaluable to students as they persist in fields where women remain underrepresented.

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