e-Technologies in Engineering Education Learning Outcomes Providing Future Possibilities

MentorNet:
Large Scale e-Mentoring for Women in Science, Engineering, and Technology (SET) Fields

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Abstract

MentorNet (www.MentorNet.net), the E-Mentoring Network for Women in Engineering and Science*, is a nonprofit organization which has created and implemented the organizational, educational, and technical infrastructures for a large-scale program to link women studying engineering and related sciences and professionals working in industry or government for structured, supported online mentoring relationships, and related networking and other learning opportunities. Using the user-friendly interfaces of the Web and e-mail, MentorNet has also created back-end systems to create a dynamic database, internal and external relationship management system, and a customized bi-directional matching algorithm to create optimal mentoring matches between students and professionals in the database. In 2001-02, nearly 3,200 students from more than 100 colleges and universities were matched with professionals from more than 800 employers; in addition to institutions of higher education, corporations, professional societies, and government sites provide MentorNet's programs with financial support and outreach to participants. MentorNet is beginning to expand outside the U.S.*

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I. Introduction

Because communications are an essential aspect of our lives and work, the emergence of the Internet is creating profound change and opportunities. As Internet access has reached homes, schools, and workplaces over the last decade, its technologies have been hailed as tools to access information, and in particular, at least briefly, for the ways in which new opportunities for commerce can be developed. The Internet has brought an increasing wealth of information available at one's fingertips and the continuing development of sophisticated tools to locate desired information quickly. It has also provided unprecedented opportunities for customers to reach and be reached by the sellers of goods and services. Beyond information, and beyond e-commerce, however, we need to consider how to encourage the Internet's potential as positive social technology to develop. Social technology helps to connect people to one another, building relationships and communities independent of physical geography, supported by a mix of synchronous and asynchronous communications.

Internet technologies have brought changes to the social interactions which define and support higher education and learning. Often, however, technologies have developed as solutions in search of problems, or in ways which overlook how people work with Internet media and electronic communications technologies in different ways than they do with other media, or in face-to-face interaction, or in physical settings. They also may develop in response to needs and opportunities, but without sufficient understanding of the complex interrelationships of people and community that support learning.

MentorNet (www.MentorNet.net) developed as one way of addressing a particular set of problems and solutions, by providing an array of activities for online co-curricular support for women in engineering and science revolving around building mentoring and networking relationships via electronic communications technologies. The relatively low numbers of women in engineering and related sciences have been a concern in higher education, as well as in industry, for well over a decade,[1] and their under-representation does not reflect lack of talent and ability [3]. Fewer women enter college with interests in science, math, and engineering, and then among those who do begin postsecondary studies in these fields, many switch out of these fields; women who switch to other majors typically have stronger academic achievement than the men who stay [5]. Because mentoring is a positive influence in retention of women in scientific and technical fields, numerous mentoring programs have been created on college campuses, but available resources have limited widespread implementation and effectiveness.

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[1] Although women represent 46 percent of the work force in the United States, they are barely 10 percent of the engineers and 30 percent of scientists in the work force; though more than half the students in higher education in the U.S. are women, women's enrollments in engineering programs nationwide average less than 20 percent, with some disciplines having even lower percentages. These low numbers suggest that talent is being lost for the technical work force and that women are less likely to be involved in many fast-growing, rewarding, and influential sectors of the economy.

In 1996, we began planning to create a multi-institutional partnership among colleges and universities, corporations, professional societies, and government to take advantage of Internet technologies to address the situation. The resulting nonprofit organization, MentorNet, offers a large-scale mentoring program developed to leverage electronic communications technology to provide links between thousands of women studying engineering and science and professionals working in industry. Through a structured program offering on-line information, applications, matching, training, coaching, and evaluation, MentorNet provides new and more extensive mentoring opportunities, complementing academic mentoring, and encouraging retention of women in fields where they have been traditionally under-represented. Undergraduate and graduate women students are paired with more experienced scientific and technical professionals working in industry or government for one-on-one e-mail-based mentoring relationships, which last for at least one academic year.

Although research to understand the full extent of human interactions with electronic communications is fairly new, it is evident from early findings that the Internet represents a social technology that connects and affiliates people [6,7]. There is good evidence that successful electronic communications lead to the development of strong ties among people who have never met face-to-face. People who don't know one another often exhibit remarkable kindness and helpfulness in providing information, support, and other assistance online. Electronic communication is not just an exchange of information, but leads to the development of virtual relationships and communities.

II. MentorNet – E-mail in Support of Mentoring

To address women's under-representation in engineering and related sciences, particularly in higher education, mentoring has become recognized as an effective strategy for improving retention. Students benefit from having experienced mentors who can help acquaint them with opportunities in these fields; offer guidance and advice based on experience; and provide support, encouragement, and access to professional networks for future career development [1]. Mentoring offers personal, one-on-one attention and assistance in decoding less obvious cultural and structural elements of a field.

Structured mentoring programs, which attempt to replicate the relationships and effects of naturally occurring mentoring, have been created and studied in various work and educational settings. Programs are often created to serve those who are less likely to be included in naturally occurring mentoring relationships, and typically are designed to serve a large number of protégés, matching them with mentors. A program administrator who manages the program and regularly communicates with participants can significantly increase the number of successful mentoring relationships. Without such ongoing support, even

though mentors and protégés typically start with the best of intentions, many of these relationships are likely to fail [2,8].

Since the most common reason structured mentoring relationships fail is the inability of mentors and their protégés to meet due to constraints of time and location [8], e-mail in support of mentoring represents an obvious possible solution. There are some obvious benefits to using e-mail for communications between individuals involved in a mentoring relationship. It is user-friendly, readily available and easily accessed for nearly all members of most higher education communities and industrial sites. In addition, e-mail allows individuals to readily communicate with others regardless of their location or geographic proximity. The asynchronous quality of e-mail allows for less disruptive communications across time zones, and across lifestyle differences, so that a student can query a mentor at 2:00 a.m., and the working professional can respond early the next morning, at times convenient for both individuals.

There are advantages to e-mail for use in mentoring, however, that are less obvious than those noted above. In contrast to the more usual face-to-face conversation, e-mail allows mentoring communication to be thoughtful and deliberate. Mentors or protégés can take time to compose a message so that their query or response reflects just what they want to say. Furthermore, e-mail provides a record of the communications. A protégé inspired by a mentor's advice can return to it again and again; a mentor can review a previous e-mail message sent by a student to recall an exchange that may have taken place several weeks previously. The text-based nature of e-mail may also enhance mentoring communications, despite the inherent limitations of communication devoid of visual and auditory cues, including body language, facial expressions, and tone of voice. People focus attention more on the words in the message than on each other; they feel more anonymous, but also less concerned about how they are perceived by others [6], which in the context of mentoring can help open up honest and candid disclosures of concerns, questions, and insights.

Electronic communications also attenuate status differences. A student can easily communicate with a high-powered executive without being intimidated by direct confrontation and reminders of status differences, such as age, style of dress, office furnishings, security, and/or support staff screening. Knowing that initiating communication will not be interruptive also helps ease hesitation about approaching an individual of higher status.

The one-on-one communication helps to build relationships between individuals and gives those who otherwise are often on the margins of mainstream groups more opportunities to participate fully in conversational exchanges. For example, when a student is just one of a handful of women in an engineering or physics classroom, as frequently happens, she may feel isolated from her peers and may be less likely than her male

classmates to participate fully in discussions and exchanges. With e-mail, all students have an equal opportunity to participate.

III. MentorNet – Program Organization as "Partnership"

MentorNet was initially envisioned and intentionally developed as "partnership" or collaboration among an ever-increasing number of colleges and universities, corporations, government sites, and professional societies all interested in enhancing the retention of women in engineering and science, each contributing students or mentors to the program and supporting its educational and technical infrastructure financially. The centralized infrastructure created provides information, matching, training, coaching, and evaluation for the student and mentor participants, as well as information and reports for the organizational partners. This arrangement offers several benefits over programs created for one organization: a scale which provides deeper, richer pools of mentors and students, creating better matches; the opportunity to transcend the limited spheres of influence and acquaintance of any single organization in including program participants; and the opportunity to achieve cost-efficiencies through economies of scale in program administration.

Approaching its sixth year of operations in the fall of 2002, MentorNet's partners include more than 100 organizations – colleges and universities, corporations, government agencies and national laboratories, and professional societies. These organizations are critical to MentorNet's success and partner with MentorNet in many ways: providing financial support, mentor and student recruiting support, programmatic advice, and stakeholder accountability. The number of organizations involved has grown substantially each year since the program's inception (Table 1). This growth has been possible in part because of the base of support provided by the collaborations and partnerships it has developed and the design, assessment and improvement of its mentoring program.

Building such a large collaborative effort has not been accomplished without challenges. Participation in a multi-institutional program is a different experience for many administrators more used to competing than collaborating with peer institutions. Universities which have experimented with developing their own mentoring programs are often grateful to support a program which can eliminate time-consuming administration at their own site. Yet outsourcing a student service to a nonprofit organization is a new experience for some, and it can take time for a trusting relationship to develop. The economic downturn of 2000, extending into 2001 and beyond, has also reduced many organizations' resources, and in some cases, their interest in supporting a program which may assist long-term recruitment goals.

IV. MentorNet – Evaluation: Participant Satisfaction and Electronic Communications

In the spring of 2000, Ithaca Evaluation Group queried 1,089 students and their mentors in a year-end survey of the 1999-2000 MentorNet program. Overall response rates were 50.2 percent for protégés, and 46.3 percent for mentors; for the sample of 200 pairs particularly targeted for reminders and analysis, response rates were 57.5 percent for protégés and 56.1 percent of mentors. Students continued to report high satisfaction with one-on-one e-mentoring (response average 3.95 out of a possible 5), while 84 percent said they would recommend MentorNet to a friend.

The electronic communications technology supporting the program was an important aspect of MentorNet for many participants. Among students, 74 percent indicated that one reason they wanted to participate in MentorNet was because they were interested in being mentored by someone from industry; while some industrial mentoring programs are available to students, such opportunities are considerably more limited. Among mentors, 93 percent felt it was particularly important for students to hear from someone in industry. In addition, 66 percent of students, and 69 percent of mentors indicated they signed up because "e-mail is a convenient way for me to communicate," while 49 percent of students signed up because they could participate without having to schedule face-to-face meetings with a mentor.

Table 1. MentorNet Growth.

	Year 1 *98-99*	*Year 2* *99-00*	*Actual* *Year 3* *00-01*	*Year 4* *01-02*	*Year 5* *02-03*	*Projected* *Year 6* *03-04*
Students Matched	204	515	1,250	2,000	3,191	4,000
Mentors Matched	204	515	1214	1,913	2,953	4,000
Participating Campuses	15	26	36	71	116	85
Sponsoring Organizations	2	9	32	43	70	100
Companies Represented by Mentors	93	261	588	690	828	1,000

The year-end evaluations have also consistently showed that the e-mentoring format offers a successful way to establish a mentoring relationship. Both the mentors and the protégés feel very comfortable asking questions of and answering questions from their e-mentoring partners. They comment favorably on the quality of the e-mentoring partnership into which they were matched.

Topics discussed by more than 75 percent of participants include students' and mentors' backgrounds, the mentor's job, college life, and the student's career plans. Students particularly note the impartial quality of their mentors, appreciating that their mentors offer an objective sounding board, uncomplicated by passing judgment on the student's performance, decisions, motivations, or other factors. They also comment on the value of having a personal relationship and encouragement from a mentor with whom they can discuss school matters and course work, workplace skills, job hunting, future plans, and careers. Students repeatedly report that their own self-confidence increased as a result of communications with their mentor. This is an important outcome of the MentorNet program since low self-confidence consistently has been identified as one of the key factors that contribute to women's exodus from engineering and other scientific fields.

Highlights of findings from regular annual evaluations include improved self-confidence – 50% of student participants said MentorNet increased their confidence to succeed in science or engineering and 52% said MentorNet increased their desire to pursue a career in their field; increased interest in industry careers – 52% of student participants said participating in MentorNet increased their desire to work in industry or a government lab or agency, and enriching educational and personal experience – 92% of student participants would recommend MentorNet to a friend and 64% were satisfied or very satisfied with their MentorNet experience. Additional evaluation findings and detailed reports can be found on the Web site at <http://www.mentornet.net/Documents/Program/Results/Evaluation/>.

V. Conclusion

Electronic communications offer an innovative, and potentially powerful medium for mentoring, an ancient mechanism for helping those less experienced gain information and support to progress and achieve long-term goals. Though remaining questions abound – Does electronic mentoring support certain kinds of individuals better than others? What kind of training allows participants to be as effective as possible? How can mentors be prompted to externalize and communicate the tacit behaviors of a profession or discipline, an understanding of which will help protégés more successfully navigate professional opportunities and development? What are the short-term and long-term effects of electronic mentoring, and how do they compare to effects of face-to-face mentoring? What are appropriate expectations and measures for outcomes? Can electronic mentoring

programs prove cost-efficient enough to be sustainable once the novelty wears off? – it is still apparent that use of electronic communications to support mentoring offers many opportunities to extend mentoring and its benefits to those for whom it is currently not available, as well as a rich field for developing further research and understanding. MentorNet offers an interesting test-bed for exploring many of these questions and opportunities.

The Internet as social technology can be deliberately developed to enhance education or other social benefits for a population with access to the technologies. Electronic communications have qualities that may enable the development of certain kinds of relationships, as well as representing a convenient means of communication across time and distance. In the ways in which teaching is like mentoring, some of these findings may be helpful in other higher education settings.

Acknowledgments

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Author's Biography

Carol B. Muller is founder, president and CEO of MentorNet (www.MentorNet.net), a nonprofit organization based at San José State University; and consulting associate professor of mechanical engineering at Stanford University. An educator and social entrepreneur, she has spent 25 years in higher education, including work in academic administration; strategic planning and budget development; external relations; faculty recruitment; admissions; educational program development, implementation, and evaluation; and facilities program planning and development. A longstanding interest in gender equity in education and employment, coupled with professional work in engineering and science education beginning in 1987, supports her extensive experience in developing new initiatives to tap the women's talents in scientific and technical pursuits. Dr. Muller has authored numerous papers, is frequently an invited speaker, and has received grants for her work from private foundations, corporations, and the federal government. A.B., 1977, Dartmouth College; A.M. 1981, Ph.D. 1985, Stanford University; Management Development Program, 1990, Harvard University.