

ASSESSMENT OF A LARGE-SCALE E-MENTORING NETWORK FOR WOMEN IN ENGINEERING AND SCIENCE: JUST HOW GOOD IS MENTORNET?

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Abstract — MentorNet (www.MentorNet.net), the e-mentoring network for women in engineering and science uses research and evaluation to inform program design and continuous quality improvement, and to assess preliminary outcomes. MentorNet has conducted year-end evaluations at the end of each program year since 1998. This paper provides a summary of the findings of data collected from student and professional participants in MentorNet's One-on-One mentoring program during the 2001-02 academic year. It also considers issues in measuring outcomes of mentoring programs.

Index Terms — collaborative projects, evaluation, large-scale, mentoring, mentoring program, MentorNet, outcome, results, women in engineering, women of color, measurement

INTRODUCTION

With the first pilot e-mentoring program at Dartmouth College initiated in 1995, there has been evaluation of industrial e-mentoring for women studying engineering and related sciences as undergraduates and graduate students to understand its effects, and to improve the experience of participants. Founded in 1997, MentorNet (www.MentorNet.net), the e-mentoring network for women in engineering and science, has conducted formative and summative evaluation, primarily through a survey of students and mentors participating in its One-on-One mentoring program.

OVERVIEW OF MENTORNET'S ONE-ON-ONE E-MENTORING PROGRAM

MentorNet's One-on-One mentoring program pairs undergraduate and graduate students, primarily women, studying engineering and related sciences in colleges and universities, with professionals working in industry or government, for year-long, structured, email-based mentoring relationships. The objective of these mentoring relationships is to provide support, encouragement, and information which will help students make good decisions about their future, and encourage them to pursue their

interests in engineering and science through completion of their degrees and entry into the workforce.

To be eligible to participate in the One-on-One program, students must be enrolled in a college or university which has joined MentorNet; in 2001-02, 116 institutions of higher education had formal agreements to participate in MentorNet. The majority of volunteer mentors come from MentorNet's sponsoring companies and government labs and agency, but a healthy portion of them are volunteers who work for other concerns, including themselves; in 2001-02, mentors represented more than 800 different employers.

Campus, corporate, and government representatives of MentorNet's partnering organizations use recruitment collateral provided by MentorNet to communicate with prospective participants in the One-on-One mentoring program, encouraging those interested to go to MentorNet's web site to sign up. MentorNet's web site provides online information, applications, and training materials, including a mentor's guide, a student's guide, and interactive case study-based training tutorials. In applying, students and mentors complete online applications which indicate both their backgrounds and interests, and their preferences in being matched with a mentor or protégé. This information, collected in a database, is then used to optimize matches across the pools of mentors and students, at several different points in time during the late summer and early fall.

Once matched, students receive ongoing instruction, in the form of email messages sent every 1-2 weeks, to help them form a strong mentoring relationship, and suggest topics of discussion. These "coaching" messages are designed to serve as reminders for students and mentors to communicate on a regular basis, to help them connect and deepen a relationship over time, and to provide them with a ready link to MentorNet staff should any questions or problems arise. The email messages include specific and practical information and suggestions, frequently with links to additional information and resources, and are tailored to mentors and students depending upon the student's level of study, so that community college students, lower division undergraduates, upper division undergraduates, masters and doctoral students, and their respective mentors, each receive somewhat different sets of coaching messages. Near the end of the academic year, coaching messages assist the participants in bringing closure to their relationship or

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establishing agreement about continuing in some form (approximately three-quarters of participants anticipate maintaining contact beyond the duration of the academic year), and participants are asked to complete an annual year-end online evaluation survey.

EVALUATION METHODOLOGY AND RESPONSE

During the spring of 2002, all mentors and students who had been matched in the One-on-One program were sent an email message, with a link to the web-based evaluation survey, requesting their completion of the survey. Students were sent up to five reminders if they didn't complete the survey; mentors were sent two reminders if they didn't complete the survey. The online surveys were derivative of survey instruments originally created by the Ithaca Evaluation Group, which conducted MentorNet's year-end evaluation for the first three years of the One-on-One program, and also of the previous year's instrument, which had been refined by MentorNet's mentoring specialist and senior research associate, Peg Boyle Single. The 2001-02 instruments were designed by Dr. Single, with revisions from previous years' surveys based on recommendations of the MentorNet Advisory Group on Research, Evaluation and Dissemination (MAGRED).

2,973 students and 2,749 mentors were sent email requesting them to complete the online survey (a few mentors are matched with two students). Of these, 1,101 students and 1,424 mentors responded for a response rate of 37% and 52%, respectively. Among students, 505 (17%) declined to complete the survey, 148 indicating they preferred not to fill it out, and 357 because they did not stay in contact with their mentor for the whole year. Email to 21 students "bounced back" and were evidently not received, while another 1,346 did not respond in any way to the request to complete the evaluation if they received the message. To generalize findings confidently to the full population of students, response rates ideally would be higher; interpretations of results should also consider that data are *self-reports* of student and mentor experiences and perceptions. Among mentors, 509 declined (19%) to complete the survey, 88 preferring not to fill it out, and 421 citing a relationship that did not continue for the whole year; email sent to 62 "bounced back," and 754 others did not respond at all.

Demographic and some other data were reported in online applications in the fall of 2001. Among those completing the year-end survey, students and mentors self-identified their ethnicity as follows:

African American:

Students – 8% (n=86)

Mentors – 4% (n=59)

Asian/Asian American:

Students – 25% (n=250)

Mentors – 11% (n=147)

Caucasian:

Students – 50% (n=555)

Mentors – 77% (n=1,047)

Hispanic:

Students – 5% (n=57)

Mentors – 4% (n=59)

Native American:

Students – 0.5% (n=5)

Multiracial:

Students – 3% (n=34)

Other:

Students – 2% (n=24)

Mentors – 8% (n=114)

Among students, 95 chose not to identify themselves by ethnicity. To a great extent, the greater ethnic diversity in the student population reflects demographics in higher education, while the more limited diversity among mentors reflects demographics of the workforce. In terms of ethnicity, percentages of students responding to the evaluation survey were similar to the percentages in the population of students participating in MentorNet.

Student citizenship among respondents was distributed as follows:

U.S. citizens – 72% (n=798)

China – 6% (n=64)

India – 3% (n=28)

Canada – 2% (n=21)

All other countries – 12% (n=136)

54 respondents did not identify their citizenship. Students' degree program level among respondents was as follows:

Community college students – 7% (n=74)

Undergraduate at four-year institutions – 70% (n=768)

Graduate students:

Masters' degree candidates – 10% (n=112)

Doctoral candidates – 13% (n=147)

94% of MentorNet students responding to the survey were women, comparable to their representation in the program. Students have their choice of being mentored by a woman or man (in 2001-02, approximately 30% of those who volunteered to serve as mentors were male). While more than half of the students express no preference for a mentor of a specific gender, more than one third said it would be nice to have a female e-mentor but it is not necessary, and the 7% that only wanted a female mentor were matched with a female.

STUDENT OUTCOMES

Measured outcomes for students based on their participation in MentorNet's One-on-One program and responses to the year-end survey were found in five general categories:

- Ongoing encouragement, reassurance, and moral support; boosting confidence
- Career information, alternatives and inspiration; learning about mentor's workplace
- Academic advice and support; relating academic work to the workplace

- Advice for women; female role models in engineering and science
- Options for balancing family and work

66% of respondents emphasized the value of the encouragement and moral support they received from their mentor. Sample comments included:

"The most valuable aspect is the inspiration from my mentor. Because there are times when you are so stressed out that you don't know what you should do next. My mentor always gives me the encouragement that I need... Sometimes those few words make a big difference to me."

"I have grown very comfortable sharing difficult issues with my mentor. My mentor is like a friend, except that she has wide knowledge about working and how to succeed."

"[The most valuable aspect of the MentorNet One-on-One relationship was] Just being able to confide in someone who seems to care, and that I didn't have to worry about 'sounding dumb.'"

"Just having someone listen to me and let me know about her life and what it's like. I'm the first in my family to go to college, so my parents can't help me there."

"Hearing that my worries of going into the 'real world' next year are not unique to me, and that everyone goes through them."

In terms of gains in information about careers and workplace reported by students:

- 75% of mentors suggested specific strategies for students to achieve their career aspirations
- 69% of students reported learning about their mentor's job and workplace
- 61% of students reported the experience affected their desire to pursue a job in their field
- 45% reported an increased understanding of skills used by engineering, science, or math professionals.

For example, students said:

"My mentor's helpful advice about working in industry, including the path he took and the experiences he gained along the way [was one of the most valuable aspects]."

"My mentor has helped me in many ways. She looked at my resume and provided useful tips to improve it. She also provided me with very useful career websites to look at for jobs in the biotechnical industry."

As students requested and/or benefited from their mentors' advice and insights on their academic experiences, 52% of students emphasized they had a better understanding of career and postgraduate opportunities available to them.

"My mentor gave me the opportunity to vent when school was stressful. She offered suggestions for scholarship searches. She gave me practical advice on classes, especially that the grade is not the most important thing."

"Knowing that I'm not the first person to screw up in Dynamics! [was valuable]."

"Being able to discuss my research and issues that concern me with someone that not only works in industry but has also been through the 'PhD' experience [was valuable]."

"Having an objective individual to ask questions about how the system works [was most valuable]. I didn't have to worry about pushing political buttons on campus by asking the wrong person the wrong question."

"The most valuable experience was to know that every engineer out there has been through what I'm going through right now, regardless of what they preach to you in school. It is also good to know that most engineers out there rely on common sense and communication skills rather than just the book. I feel that I enjoy learning more!"

Students also commented on the valuable perspective they gained from their mentors concerning issues for women in engineering and related sciences:

"Actually meeting a woman who has a physics PhD and is still working in the field has been extremely valuable. Previously, it almost seemed like no such women existed."

"Having someone in the field with whom I can communicate about things that only a female in computer science could truly understand and advise on."

"My mentor is a successful woman in industry. I see her achieving things that I hope to some day. She is a great role model and provides excellent feedback regarding my questions."

46% of students strongly felt they had a clearer perspective on balancing career and family, now or in the future, based on discussions with their mentor:

"My mentor has children, as do I. She helped me look at some difficult issues with dealing with working full-time, being a student part-time, and being a full-time mother and wife because she has been there."

Student feedback about MentorNet's One-on-One program indicates that it is useful and helps them with connecting with an individual as a mentor.

- 94% of students say they would recommend MentorNet to a friend;
- 77% expect to continue communicating with their e-mentor over the summer;
- 70% expect to continue being e-mentored another year.

In terms of indicators of retention, 89% of students indicated plans to remain the same field of study or employment for the following academic year, while 8% indicated plans to shift to a related scientific or technical field, and 3% planned to leave engineering or science for non-science fields.

Analyses of data designed to uncover statistically significant differences in responses based on level of study and ethnicity found the following:

- Community college students were most likely to report increases in self-confidence as a result of their MentorNet experience.

- Undergraduates were most apt to learn about their mentor's job and workplace environment and to report their e-mentor gave them advice about job hunting or internships.
- Upper division undergraduates (years 3, 4, and 5 of undergraduate study) (43%) and in doctoral programs (47%) were more apt to say they were "very satisfied" with their one-on-one mentoring experience compared to other MentorNet participants, averaging nearly 35% on this response.
- Higher proportions of students who are African American (76%) and Hispanic (79%) were satisfied overall with their MentorNet experience than those who are Asian (69%) or Caucasian (72%). The same pattern occurs when looking at respondents who say they are "very satisfied."

Among respondents to the year-end survey, MentorNet received responses from 674 matched pairs of mentors and students, where both the mentor and student paired together responded to the survey. Interestingly, considering ongoing discussion about the relative value of same-ethnicity vs. cross-ethnicity matching in mentoring programs, the proportions of students in this group who had a mentor of the same ethnic background were:

- Asian – 16%
- African American – 8%
- Hispanic – 5%
- Caucasian – 82%

MENTOR OUTCOMES

Mentors also report benefiting from their experience with MentorNet, particularly commenting on the personal satisfaction of helping another person (74%), and appreciating the opportunity to pass along what they have learned to the next generation (81%):

"In my exchanges with my protege, I realize that the field of engineering has not dramatically changed for women since I was in school, over 15 years ago. If sharing my perspective encourages one more bright mind to stay in the technical field then I have made a difference."

"It has been wonderful to see my protege become more independent. I tried to give her enough information to help her make informed choices. I have really enjoyed watching her own decisions about her future."

"I think it's important for women in science to know that there are other women out there who feel like they do, and struggle with the same issues and survived it anyway."

69% of mentors strongly felt that serving as an e-mentor had led them to reflect on their own career:

"I came into this really wanting to help someone else (and hopefully I have). But what really intrigued me was the amount of self-introspection our dialogues have led to."

"I have developed stronger confidence in my own ability to make decisions by helping my protege to make important choices."

Mentors' rating of their own outcomes varied by racial/ethnic group:

- 40% of mentor respondents who were African American (n=64) said their experience as a MentorNet mentor improved their skills for recruiting new talent as compared to 22% of all other mentors.
- 48% of African American mentors said MentorNet experience gave them renewed commitment to their field as compared to 33% of all other mentors.
- 38% of mentors who are Hispanic (n=63) said the experience increased their own self-confidence as compared to 25% of all other mentors,
- 50% of Hispanic mentors said they experienced renewed commitment to their field as compared to 33% of all other.
- 36% of mentors who are Asian (n=160) said the experience improved their supervisory skills compared to 23% of all other mentors,
- 40% of Asian mentors reported increased self-confidence compared to 24% of all other mentors.

Mentors are highly satisfied with their experience of being an ementor, with 96% responding they would recommend to a colleague that s/he volunteers with MentorNet.

Mentors reported spending an average of 13.7 minutes a week writing and reading MentorNet email.

DISCUSSION

There are a number of challenges and limitations to analytic assessment of and research on mentoring and mentoring programs. These include self-reported data, observer effects, self-selection bias, challenges in establishing reliable control groups, variability in processes, too many variables which may affect measurements of mentoring outcomes, the usual challenges in research on social phenomena and interactions of isolating cause and effect even where correlations can be established, and of course, the cost of such research and assessment.

In most cases, data reflecting the actual process and content of communications that form the basis for a mentoring relationship are likely to be either limited to self-reported data from participants, or affected by observation. Self-reported data is limited to those effects noticed by participants which they are willing to report, potentially omitting some significant outcomes. If observers are present for communications between mentor and protege, their presence will influence the communications. (E-mentoring may provide an opportunity for less obtrusive monitoring of mentoring relationships, as long as the participants have consented to copy the evaluator on their correspondence,

because the evaluator's presence is less apparent during the course of the "conversations.")

Self-selection bias will also hamper the creation of ideal research protocol. Even in measuring outcomes for proteges being mentored with a control group of similar individuals not being mentored, the fact that certain individuals may be more likely to initiate or be selected for individual mentoring relationships, or more likely to elect to participate in a mentoring program might provide explanation for any differential outcomes between those being mentored and those not, rather than the process of being mentored itself.

When a mentoring program has been established, and the "control group" represents those who are not assigned to a mentor, or not assigned right away, in an effort to avoid this self-selection bias, two potential problems emerge. First, is the matching process one which might lead to greater likelihood of certain kinds of proteges being matched, and others not? If so, the "control" group may not represent a similar population across characteristics that would allow for assessing the outcomes of the mentoring experience. Second, the damaging effect of not being selected to participate in a program, or not being selected right away, may also alter the confidence, interest, or other characteristics of the "control group" such that again, they may not represent a similar enough group to ascribe outcomes differences to the effect of mentoring.

There are also ethical considerations to be considered in contemplating establishment of a control group for an intervention that already has strong indicators of positive effect, particularly when it is also apparent that not being selected is likely to have a negative, rather than a benign effect. In the case of MentorNet, for example, it's apparent that many participants who aren't matched frequently interpret that action as a negative reflection of their value, abilities, experiences, and/or interests, potentially damaging their confidence and diminishing the likelihood that they will pursue their interests in engineering and related sciences.

Since the most valuable mentoring by its nature is tailored to the individual, there are likely to be individualized learning outcomes for each relationship, resulting in non-standard outcomes measures. An intervention like MentorNet in psychological terms is necessarily limited, which isn't to say without strong positive value, but limited to about 15 minutes a week and not fundamentally changing the whole of a participant's educational experience. A myriad of variables which may affect outcomes measures related to retention and other learning, but which are difficult to capture in a research project of limited duration and resources include the specific student's academic curriculum program, co-curricular opportunities, fields of study, specific courses and faculty members, peer groups, family support systems.

With all these caveats, and the very real limitations of resources available for evaluation, MentorNet's assessment at this point is guided primarily by stakeholder interests,

including those of the MentorNet staff seeking to improve the value of the program for participants.

We are disappointed each year in not having a stronger response rate to the surveys, despite minor incentives, and follow-up reminders, yet acknowledge the "survey overload" as well as "email overload" experienced by participants that contributes to a lower response rate. We have begun to explore the nature of response bias, but have been hampered by difficulty in achieving 100% response from even a random sample of non-respondents, despite considerable efforts to contact them. Based on the numbers of participants who actively decline to complete the survey because their relationship did not last the full academic year, or never really got off the ground, it seems those not responding to the year-end survey are more likely to have experienced mentoring relationships that did not last the full academic year. As yet, however, due to resource limitations, we have no data to quantify what proportion of nonrespondents reflect failed relationships rather than just failure to complete the online survey.

On balance, however, we are happy to find strong evidence that the One-on-One mentoring experience has positive effects on confidence and interest, both of which contribute to retention in engineering and related sciences, and in many cases is clearly valued by participants.

In future evaluation projects, we will or would like to investigate more closely the differences in experiences by women of different ethnic backgrounds, as well as a variety of other factors that may contribute to differential experiences with the program, including mentor characteristics, socioeconomic backgrounds of students, field or discipline, type of institution the student attends, year of study, and other factors. We also would like to understand both the content and process of successful mentoring relationships to learn more clearly what might be passed along to others to help them form successful mentoring relationships. We are interested in the characteristics of students who select participation in MentorNet as an activity, in an effort to understand any characteristics within our student population that may be different from those in the student population at large. There are also opportunities to study mentor benefits more closely.

CONCLUSION

The 2001-02 MentorNet evaluation found continuing strong results and positive benefits from participation in the One-on-One program, for the majority of both students and mentors who responded to a year-end online survey. For the first time, there were sufficient numbers in the population of students served by the program and responding to the evaluation, to be able to measure statistically significant differences for students by ethnic background. We are pleased to see that those students from minority groups underrepresented in engineering and related sciences report even higher levels of satisfaction with their MentorNet

experiences, and we hope to have the opportunity to study these findings in greater depth.

ACKNOWLEDGMENT

MentorNet, headquartered at San José State University in San José, California, is a nonprofit 501(c)(3) organization working to further women's progress in scientific and technical fields through the use of a dynamic, technology-supported mentoring program. MentorNet aims to advance women and society, and enhance engineering and related sciences, by promoting a diversified, expanded and talented workforce. In partnership with colleges and universities, corporations, government labs and agencies and professional societies, MentorNet is international in scope, serving students from all over the world. Major funding is provided by Alcoa Foundation, AT&T Foundation, IBM and Intel Foundation. Additional funding is provided by the National Science Foundation and the U.S. Department of Transportation. This material is based upon work supported by the National Science Foundation under Grant No. HRD0001388. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.