Information Sheet: Mentoring and Women in Engineering

By Catherine T. Amelink, Ph.D.
Virginia Tech

Mentoring is identified as an important element of educational environments that are designed to facilitate the success and retention of females in STEM disciplines. Consider the following two quotes from representatives in STEM fields who have participated in a mentoring program:

> *"When I was in high school, I received zero support for studying math and science. As a consequence, I floundered a lot when I got into college and started my hard engineering classes. If it weren't for a good support system of other women in the department with me, encouraging me to stick it out, and my father who was also very supportive, I would have left science after my first semester (MentorNet, 2008, p. 32)."*

> *"The single most important thing people need to realize and hear is that their field will not seem to scary or intimidating once they talk with someone else who has already done it and overcame it. It is through that person (a mentor) that one finds solutions to obstacles/concerns (MentorNet, 2008, p. 35)."*

This information sheet summarizes pertinent research for instructional professionals in K-16 to design mentoring programs within the disciplines of Science, Technology, Engineering and Math (STEM):

- Positive socialization to the field helps reduce gender role barriers and can increase the success and retention of women in STEM fields. Mentoring is one programmatic initiative that provides women in STEM fields with exposure to role models, a support network, and personal interaction with experienced professionals (Frestedt, 1995).

- Benefits associated with mentoring have been seen among protégés, mentors, and institutions and businesses that provide formal mentoring programs (Aryee, Chay, & Chew, 1996; Fagenson, 1989; Wright & Wright, 1987). These benefits are also found among mentoring programs specifically developed for women in STEM fields (Chesler, Boyle Single, & Mikic, 2003).

- Effective mentoring programs are well-planned, starting with clear goals. Programs should have a well-informed management team who will be responsible for implementation (for examples of good mentoring practices see http://www.mentoring.org/find_resources/elements_of_effective_practice/). An orientation to the parameters of any formal mentoring program and expectations of the parties involved has been shown to benefit both the mentors and protégés. Ideally, mentoring programs take into consideration the needs of the population they are designed to address and they provide appropriate levels of both challenge and support (Wadsworth, 2002).

- Identifying specified outcomes and selecting appropriate methods of assessment should be part of the program design (Rhodes, 2002). The type and quality of assessment tools vary. Most

assessment tools available are surveys and are discussed in more detail in the ARP Resource companion document, *Mentoring and Women in Engineering Literature Overview.*

- Mentoring can take place through conversations, collaboration, and participation in an online or virtual community as well as through opportunities for the protégé to observe their mentor (Rhodes, 2002; Wright & Wright, 1987). Coupled with other programmatic initiatives, mentoring relationships are a key element in encouraging retention and success of women in STEM fields.

    - Mentoring has been shown to increase self-confidence and enhance communication skills among women in STEM careers. Mentoring relationships provide role models and present opportunities to discuss work-life balance issues (Brainard & Ailes-Sengers, 1994; Chesler, Boyle Single, & Mikic, 2003).

    - Exposure to women who are well-established in the field helps break down the gender barriers that work against women's persistence in STEM disciplines (Clewell & Campbell, 2002). Women engineers report that mentoring relationships provided them with a better understanding of the educational climate and a clearer picture of expectations for performance and other elements of the professional work environment (Brainard & Ailes-Sengers, 1994; Brainard & Carlin, 1998; Frestedt, 1995; Kahveci, Southerland, & Gilmer, 2006).

    - Increased retention rates among undergraduate women pursuing STEM majors are associated with mentoring relationships that provide academic and social support (Wasburn & Miller, 2004). Participating in a formal mentoring program where students meet regularly with faculty members has been shown to improve the retention of undergraduate STEM women. (Kahveci, Southerland, & Gilmer, 2006).

    - In K-12 education, mentoring programs that paired female students with women scientists in an after-school program found that female students were more likely to indicate an interest in pursuing a STEM career following the experience (McLaughlin, 2005).

- Research indicates that cross-gender mentoring relationships can provide similar or additional benefits. Mixed gender mentoring relationships may help females ally themselves within a male-dominated organization (Burke & McKeen, 1996; Ensher & Murphy, 1997; Ragins, Townsend, & Mattis, 1998; Scandura & Williams, 2001). Other studies highlight that length of the mentoring relationship is more influential than whether the mentoring relationship is formed between females or is a mixed gender relationship (Turban, Dougherty, & Lee; 2002).

- Elements of consistency and a vested interest on the part of the mentor in the vocational and personal development of the protégé are key aspects in positive mentoring (Kram, 1985; Fagenson, 1989; Paglis, Green, & Bauer, 2006).

- Among women in STEM fields, co-mentoring relationships that allow for an equal exchange of ideas are valuable as women mentors and protégés benefit from increased self-esteem. When there is shared power, both the mentor and mentee have an opportunity to be the learner or the teacher, sharing input and validating the other's contribution (McGuire & Reger, 2003). Mentoring

relationships that address both personal concerns (i.e., issues at home, family) and academic issues helped mitigate feelings of isolation (Liang, Tracy, Taylor, & Williams, 2002; McGuire & Reger, 2003). Attention should be given to shared discussion and ideas within mentoring relationships among women rather than serving as simply a source for information and skill building (Grant & Ward, 2000; Liang, Tracy, Taylor, & Williams, 2002).

- While benefits associated with mentoring have been documented, other studies have proved inconclusive with regard to the benefits associated with mentoring in STEM fields, particularly in relation to the protégés commitment to pursuing a research career (Green & Bauer, 1995; Paglis, Green, & Bauer, 2006).

- More research is needed on the role of gender in STEM mentoring, particularly whether cross-gender mentoring relationships encourage positive socialization and retention in the field in the same manner as within gender mentoring relationships. Future research should explore the role of gender in different types of mentoring models. For instance, studies could examine whether males and females in STEM fields receive the same benefits through mentoring programs that emphasize the use of technology such as e-mentoring (mentoring conducted via the Internet). Longitudinal research designs that follow a cohort of students and explore whether formal or informal mentoring is linked to outcomes such as time to degree, persistence, and advancement are needed (George & Neale, 2006). Qualitative studies that explore in more depth the elements of successful mentoring relationships formed by women in STEM disciplines would provide a more holistic picture of what factors need to be included in the design of mentoring programs in order to reap maximum benefits.

(For a practice-oriented guide on this topic or other ARP Resources, go to: http://www.AWEonline.org/ARPResources.aspx)

Short list of Recommended Readings

Brainard, S., & Carlin, L. (1998). A six-year longitudinal study of undergraduate women in engineering and science. *Journal of Engineering Education, 87*(4), 369–375.

Brainard, S. G., & Ailes-Sengers, L. (1994). Mentoring female engineering students: A model program at the University of Washington. *Journal of Women and Minorities in Science and Engineering, 1*(2), 123–135.

Chesler, N. C., Boyle Single, P., & Mikic, B. (2003). On belay: Peer mentoring and adventure education for women faculty in engineering. *Journal of Engineering Education, 92*(3), 257–262.

Fagenson, E. A. (1989). The mentor advantage: Perceived career/job experiences of protégés versus non-protégés. *Journal of Organizational Behavior, 10*(4), 309–320.

Frestedt, J. L. (1995). Mentoring women graduate students: Experience of the coalition of women graduate students at the University of Minnesota, 1993–1995. *Journal of Women and Minorities in Science and Engineering, 2*(3), 151–170.

Kahveci, A., Southerland, S. A., & Gilmer, P. J. (2006). Retaining undergraduate women in science, mathematics, and engineering. *Journal of College Science Teaching, 36*(Nov-Dec), 34.

Kalbfleisch, P. J. (1997). Appeasing the mentor. *Aggressive Behavior, 23*, 389–403.

Kram, K. E. (1985). *Mentoring at work: Developmental relationships in organizational life*. Glenview, IL: Scott, Foresman and Company.

Liang, B., Tracy, A. J., Taylor, C. A., Williams, L. M., Jordan, J. V., & Miller, J. B. (2002). The relational health indices: A study of women's relationships. *Psychology of Women Quarterly, 26*, 25–35.

McGuire, G. M., & Reger, J. (2003). Feminist co-mentoring: A model for academic professional development. *National Women's Studies Association Journal, 15,* 54–72.

MentorNet (2008). Students' Perceptions of the Value and Need for Mentors As They Progress Through Academic Studies in Engineering and Science. San Jose, CA: MentorNet. Retrieved September 28, 2008 http://www.mentornet.net/documents/files/evaluation/studentperceptions.completereport.pdf

Paglis, L. L., Green, S. G., & Bauer, T. N. (2006). Does adviser mentoring add value? A longitudinal study of mentoring and doctoral student outcomes. *Research in Higher Education, 47*(4), 451.

Riordan, C., Manning, L., Daniel, A., Murray, S., Thompson, P., & Cummins, E. (1999). If I knew then what I know now: A portable mentor for women beginning professorial careers in science and engineering. *Journal of Women and Minorities in Science and Engineering*, *5*(1), 29–52.

Wallace, D., Abel, R., & Ropers-Huilman, B. (2000). Clearing a path for success: Deconstructing borders through undergraduate mentoring. *The Review of Higher Education, 24*(1), 87–102

Wasburn, M., & Miller, S. (2004). Retaining undergraduate women in science, engineering, and technology: A survey of a student organization. *Journal of College Student Retention Research Theory and Practice*, *6*(2), 155.