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Overview: Mentoring and Women in Engineering

By Catherine T. Amelink, Ph.D.
Virginia Tech
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Mentoring can facilitate positive socialization among women to STEM fields by encouraging interaction with successful individuals and by providing career and psychosocial (i.e., combining aspects of psychological and social behaviors) support. This support helps women overcome perceived gender role barriers. There are a variety of mentoring models on which to base programmatic initiatives for the specified target group. Assessment tools are also available to evaluate the effectiveness of mentoring programs. Coupled with other programmatic initiatives, mentoring relationships are a key element in encouraging retention and success of women in STEM fields.

Definitions and Theoretical Constructs Associated with Mentoring

Mentoring is typically viewed as a series of meaningful interactions between a more experienced person, identified as the mentor, and a protégé that enhances the protégé's personal growth and professional advancement (Fagenson, 1989; Kram, 1985; Paglis, Green, & Bauer, 2006). The mentor may serve as a role model, teacher, sponsor, coach, friend or counselor (Anderson & Shannon, 1988; Fagenson, 1989). The key element in a mentoring relationship is a consistent interest on the part of the mentor in the protégé's progress (Collins, 1983; Rhodes, 2002). An ethic of care enacted by mentors as they monitor their protégé's progress is found in many mentoring relationships (Buell, 2004; Young, Alvermann, Kaste, Henderson, & Many, 2004). 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 his or her mentor (Rhodes, 2002; Wright & Wright, 1987).

Kram's (1985) mentor role theory has provided the basis for much of the research conducted on the topic. In the theory espoused by Kram, mentoring can be categorized as career or psychosocial. Career mentoring functions include sponsoring professional advancements and overseeing career preparation within an academic setting, coaching the protégé, protecting the protégé from opposing forces, presenting challenging assignments, and increasing the protégé's exposure and visibility (Kram, 1985). Psychosocial mentoring functions include helping the protégé develop a sense of self through acceptance and affirmation, providing counseling, establishing friendly rapport, and serving as a role model (Kram, 1985). The emphasis placed on fulfilling each of these functions varies by mentoring relationship.

Kram (1985) also developed a theory on the phases of mentoring that includes:

- Initiation is the beginning of the relationship. Goals become more concrete and opportunities for interaction around work tasks are realized.
- Cultivation is the phase in which the individuals learn more about each other's talents. The emotional bond deepens, intimacy increases, and opportunities for meaningful interaction increase.
- Separation happens when a structural or emotional separation occurs. During separation, the protégé works more autonomously and the mentor is less available to serve in mentoring functions.

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- Redefinition transpires as the relationship takes on a new dimension or terminates. Here the tensions from the separation phase disappear and a new relationship is formed. The mentor relationship is no longer necessary in its previous form and takes on a new form.

Research has focused on the terms associated with the development of mentoring relationships, classifying the type of relationship that develops, and drawing conclusions about the benefits of mentoring. Studies have also investigated the role that gender plays in mentoring relationships.

Terms Associated with the Development of Mentoring Relationships

Mentoring relationships can develop through both formal and informal terms (Cobb et al., 2006). In formal mentoring relationships, mentor and protégé are brought together through a formalized program or series of activities. This does not necessarily mean that the relationship is assigned; it is still possible that one chooses the other (Armstrong, Allinson, & Hayes, 2002; Morzinsky & Fischer, 1996). In informal mentoring, the mentor and protégé are brought together spontaneously through mutual interests (Pollock, 1995; Ragins & Cotton, 1999). Regardless of the terms associated with the formation of the mentoring relationship, participation is voluntary, with either party being able to disengage (Wallace & Wang, 2006).

Models of Mentoring

Research has sought to examine the nature of relationships between mentor and protégé. This can include how information is shared, what topics are discussed, and whether the protégé or mentor is seen as the primary beneficiary of the mentoring relationship (Buell, 2004; Touchton, 2003; McGuire & Reger, 2003). Traditionally, mentoring has taken place by mentors choosing and preparing their protégés to correspond to their own likenesses through a hierarchical model (see below for more information). The addition of women into positions of power has changed how mentoring takes place. Practices have moved from utilizing the hierarchical model toward more reciprocal interaction patterns within the mentoring relationship (Buell, 2004; Touchton, 2003).

- *Apprenticeship model* – In the apprentice model the mentor seeks to help the mentee become a valued member of the profession. Lacking from this model are the personal and social components seen in other models (Buell, 2004).

- *Hierarchical Model* – Mentoring takes place by mentors choosing and preparing their protégés to correspond to their own likenesses. In the hierarchal mentoring model, there is a presumption that there are unequal parties. Mentors share information and mentees often benefit from the opportunity of being exposed to privileged information or status (Touchton, 2003).

- *Citizen Model* – There is shared sense of responsibility and neither the mentor nor protégé is seen as having more power or advantage over the other (Touchton, 2003)

- *Cloning Model* – The cloning model is characterized by a mentor seeking to direct and control their protégé. The mentor seeks to produce a copy or clone of themselves within the protégé. Critical to the cloning model are elements of control and power (Buell, 2004).

- *Co-Mentoring Model* – Focuses on a cooperative relationship that improves learning and development of the protégé and focuses on the special emotional needs of the protégé. Based on

feminist constructs that promote an equal sharing of power between the mentor and protégé, the model incorporates emotions and values all of the work involved in maintaining the relationship. Each person has an opportunity to be the learner or the teacher because each person's input is seen as valuable (McGuire & Reger, 2003).

- *Friendship Model* – The friendship model is a collaborative, reciprocal relationship where the mentor and protégé function primarily as peers. The model emphasizes the creation of an interpersonal bond with the individual where the mentor seeks to make him or herself accessible and encouraging (Buell, 2004).

- *Nurturing Model* – Within the nurturing model the mentor seeks to position themselves as a parent figure by providing a safe environment for the protégé to try new things and learn. Opportunities are provided to develop the protégé's own skills and abilities rather than mimicking those of the mentor (Buell, 2004).

- *Relational Model* – A mentoring relationship with shared discussion and ideas that emphasizes mutual engagement, authenticity, and empowerment. This model is suggested for females given prior research that suggests women reap greater benefits from more holistic mentoring that addresses psychological needs as well as vocational (Liang, Tracy, Taylor, & Williams, 2002).

- *Peer Mentoring* – In this model a group of peers provide emotional and professional support to one another. Different individuals take on the role of mentor providing guidance to individuals in the group depending on where the expertise lies in relation to a given situation (Hadjioannou, Shelton, Danling, & Dhanarattigannon, 2007). Peer mentoring relationships can provide self-acceptance and confirmation as peers share their perceptions and experiences (Kram, 1985). Peer mentoring is often implemented in educational institutions and its goals are often formally determined. The drawbacks to peer mentoring are that it draws from a limited pool of information, there is often little diversity, and unidentified hierarchal relationships may still exist (Angelique, Kyle, & Taylor, 2002).

Benefits of Mentoring

Mentoring has been shown to benefit the protégé (Fagenson, 1989; Wright & Wright, 1987) as well as the mentor (Allen, 2003). Organizational benefits also occur as a result of mentoring relationships (Aryee, Chay, & Chew, 1996; Chao, Walz, & Gardner, 1992).

Mentoring can facilitate the protégés' career advancement as they learn technical aspects of a profession from their mentors and are exposed to networking opportunities within an organization. Mentoring has also been associated with an increased sense of confidence, self-esteem, and job satisfaction for the protégé (Fagenson, 1989; Wright & Wright, 1987). In educational settings, mentoring has been found to both increase satisfaction and to improve retention rates among students (Bair, Haworth, & Sandfort, 2004).

There are also several benefits in becoming a mentor. The first benefit is professional or career development. A protégé can bring new ideas, experiences, and energy to a relationship, thereby challenging the mentor to consider new opportunities within his or her career. Mentors may also gain visibility and respect as they are associated with the successes of their protégé (Wright & Wright, 1987). Mentoring gives mentors a sense of accomplishment and continuity in their professional lives. Passing on knowledge to a protégé assures that their accomplishments and legacy will continue to be used by the

organization. In addition, seeing others benefit from their experience gives mentors a sense of personal validation (Allen, 2003).

Organizational benefits also occur from greater satisfaction and commitment experienced by the protégé and mentor. Mentoring facilitates a greater sense of connectedness to the organization and creates a network of support (Wallace, Abel, & Roper-Huilman, 2000), thereby increasing commitment on the part of the protégé. This then reduces turnover and can increase job satisfaction (Aryee, Chay, & Chew, 1996; Chao et al., 1992; Corzine, Buntzman, & Busch, 1994; Fagenson, 1989; Goh, 1991; Ragins & Cotton, 1999; Scandura & Viator, 1994; Viator, 1991).

Gender in Mentoring Relationships

Mentoring research also focuses on the role of gender, particularly on the mentor's gender and the mentoring relationship's gender composition. Sosik and Godshalk (2000) found that female mentors provide greater role modeling but fewer career development skills than male mentors. Debate has surfaced on the issue of gender composition of the mentoring partnership. Scandura and Williams (2001) found that those in cross-gendered mentoring relationships had a lower comfort level, while Feldman, Folks, and Turnley (1999) found that these relationships may provide less task-related, career-related, and social-related support. Several studies (Burke & McKeen, 1996; Ensher & Murphy, 1997) also reported that more psychosocial functions result from same-sex mentoring. Mixed gender mentoring relationships may help females ally themselves within the organization (which is usually male-dominated) and break through the glass ceiling (Ragins, Townsend, & Mattis, 1998; Scandura & Williams, 2001). However, one potential risk of cross-gender mentoring is possible abuse due to power differentials between either party within an organization or institution and the possibility of intimate relationships. Although studies have shown that these incidents are rare, the rumors may be damaging to either individual's career and personal life (Kalbfleisch, 1997; Schwiebert, Deck, Bradshaw, Scott, & Harper 1999). Yet it may be necessary for women to have male mentors since fewer females are in upper-level organizational positions in many fields (Schwiebert et al., 1999).

Some studies suggest that gender may not be as powerful a factor in successful mentoring outcomes as previously thought (Burke & McKeen, 1996; Ensher & Murphy, 1997). Struthers's (1995) study showed organizational rank is a stronger predictor of how much mentoring a protégé will receive and how the mentor will use organizational power than gender alone. Turban, Dougherty, and Lee (2002) found the length of mentoring relationships to be more important than their gender composition

Synthesis of the Findings

While many groups benefit from mentoring, women have been shown to benefit significantly from such relationships (Liang, Tracy, Taylor, & Williams, 2002; McGuire & Reger, 2003; Wallace, Abel, & Roper-Huilman, 2000). Common barriers confronted by females in the STEM fields (Smyth & McArdle, 2004; Tyson, Lee, Borman & Hanson, 2007) can be mitigated through positive mentoring relationships (Chesler, Boyle Single, & Mikic, 2003).

Studies have attributed the low representation of females in STEM fields to insufficient academic preparation prior to enrolling in college rather different educational or career goals (Adelman, 1998; O'Hare, 1995; VanLeuvan, 2004). Females enroll in fewer science and math courses in high school, thereby making them feel ill-prepared for college-level courses and leading them to self-select out of STEM majors (Smyth & McArdle, 2004; Tyson, Lee, Borman, & Hanson, 2007). Studies have attributed low enrollment in such

courses to perceptions that STEM disciplines and associated careers are a male-dominated environment. Stereotype threat, where women feel as though their performance might reflect negatively on the abilities of all women, further compounds issues of representation among women in STEM fields (Bell, Spencer, Iserman, & Logel, 2003; Aronson, Quinn, & Spencer, 1998). Statistics that have tracked female performance and participation in STEM disciplines over time show that the gender gap may vary depending on the age and specific field of study being examined (National Center for Educational Statistics, 2005).

Other studies have cited the lack of support and feelings of isolation as the reason for under-representation of women in STEM fields. Women leaving doctoral programs have cited lack of advising and negative relationships with faculty members as primary reasons for leaving their program (Herzog, 2004). Once in the field, women in STEM careers continue to face barriers including low publication rates and lack of work-life policies that allow women to balance multiple roles associated with career and family (Bystydzuenski, 2004; Koehler, 2008; Sullivan, 2007). Women who leave engineering express less confidence in their abilities than individuals who stay, despite their performance being the same or better than their peers (Brainard & Carlin,1998; Jackson, Gardner, & Sullivan, 1993).

Mentoring has been proposed as a way to address feelings of isolation and lack of support among women in STEM fields (Langdon, 2001). Academic and social support provided through mentoring relationships has been associated with decreased attrition rates among undergraduate women pursuing STEM majors (Wasburn & Miller, 2004). Participating in a formal mentoring program where students meet regularly with faculty members has also been shown to improve the retention of undergraduate women majoring in the STEM fields (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 career in the STEM fields following the experience (McLaughlin, 2005). For women in engineering careers, mentoring has been shown to increase self-confidence and enhance communication skills. Mentoring relationships also provide role models and present opportunities to discuss balancing professional and personal responsibilities (Chesler, Boyle Single, & Mikic, 2003). Seeing professional women engineers helps break down the gender barriers that work against women persisting in the field (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 (Brainard & Ailes-Sengers, 1994; Brainard & Carlin, 1998; Frestedt, 1995).

In particular, women in STEM fields have identified co-mentoring relationships as especially valuable and such relationships were shown to increase self-esteem. These types of mentoring relationships that did not separate personal concerns (i.e., issues at home, family) from academic issues helped mitigate feelings of isolation (Liang, Tracy, Taylor, & Williams, 2002; McGuire & Reger, 2003). Rather than serving as simply a source for information and skill building, research has shown that females have a more positive response to a mentoring relationship with shared discussion and ideas (Grant & Ward, 2000; Liang, Tracy, Taylor, & Williams, 2002). In particular, the collaborative approach of the c*itizen model* has been identified as a mentoring model that is preferred by females (Touchton, 2003). Women in STEM fields may benefit from relationships where there is an equal exchange of information and where both the mentor and protégé feel as though they can contribute and gain personally and professionally from the relationship. Particular elements or dynamics of mentoring relationships that would benefit women have not been frequently discussed in research literature.

Despite the benefits cited with regard to mentoring females in the STEM disciples, females report they receive less mentoring than men at all levels of postsecondary education and in post-doctoral experiences (Nolan, Buckner, Marzabadi, & Kuck, 2008). Other studies have suggested that mentoring has limited potential to influence the retention of women in STEM fields (Green & Bauer, 1995; Paglis, Green, & Bauer, 2006). In a longitudinal study spanning five and half years, mentoring was shown to have positive benefits on the research productivity and self-efficacy of doctoral students in STEM fields, but was not related to the commitment to pursue a research career among women (Green & Bauer, 1995; Paglis, Green, & Bauer, 2006). Other studies have proved inconclusive as to whether relationships formed with faculty members would improve retention of underrepresented groups such as females (Jackson, Gardner, & Sullivan, 1993).

Interventions and Successful Programmatic Initiatives in STEM Disciplines Utilizing Mentoring

In general, successful programs combine the strengths of the various forms of mentoring and aim to fulfill the needs of the target group. Interventions that have cited positive outcomes start with fundamentals associated with good mentoring programs. General programming information to consider when organizing a mentoring program can be found at Mentor.org (http://www.mentoring.org/find_resources/elements_of_effective_practice/). Tips cited on the Web site include having a management team that is well informed, having a mentoring program with clear aim and goals, and providing an orientation for both the mentors and protégés that are involved in formal mentoring programs.

Overall, successful mentors provide necessary support while also providing opportunities to challenge the protégé to facilitate growth and development. Wadsworth (2002) outlines the twelve actions of a successful mentor, which include welcoming, communicating, trusting, accepting, affirming, forgiving, reframing, letting go, rejoicing, balancing, focusing, and gracing. Wadsworth (2002) describes one action in each a chapter, providing mentors with an operational example of how to contribute to a successful mentoring program.

Practitioners may want to consult the following institutions or authors of research studies when designing a mentoring program in STEM disciplines or improving existing programs given the successful results associated with their mentoring programs:

- The Douglas Project for Rutgers Women in Math, Science, and Engineering, and the related Project SUPER (Science for Undergraduates: A Program for Excellence in Research), developed for women students in STEM fields have reported successful results. Students are paired with more advanced students and faculty mentors (Mappen, 2000).
- The National Council for Research on Women found that mentoring programs combined with the opportunity to participate in hands-on science experiences successfully encouraged females to pursue further education in STEM fields (McLaughlin, 2005).
- Undergraduate women majoring in STEM disciplines who participated in a formal mentoring program were more likely to be retained than non-program participants (Kahveci, Southerland, & Gilmer, 2006).

STEM Focused Web Sites Providing Mentoring

Association for Women in Science (AWIS) has teamed up with one well-known nonprofit e-mentoring organization for diversity in engineering and science, MentorNet (http://www.mentornet.net/), established in 1997. MentorNet's one-on-one program matches college and university students, postdoctoral scholars,

and early career faculty with mentors from professional fields and academia, based on the preferences of both the prospective protégés and mentors. The program addresses the retention and success of women in engineering and science through e-mail correspondence with customized online training and coaching for participants, and ongoing evaluation, the organization also offers online (email- and Web-based) discussion forums, a variety of resources, including those for women in science and engineering, and a resume database for students searching for job opportunities. The Web site is particularly useful for anyone interested in starting a mentoring program, regardless of whether the program will be Web-based or not.

The Alliance of Technology and Women (ATW) is a career life cycle organization that offers mentoring programs. Through the ATW Mentor Program, applicants are matched with executive-level mentors through an online service for individually prescribed mentor/mentee relationships: http://www.atwinternational.com/mentoring.aspx.

Another variation of a Web-mentoring program was established at Northeastern University in 1996 (Wadia-Fascetti, & Leventman, 2000). Entitled E-Mentoring, the program pairs females from five different age groups: middle school, high school, first-year college students, upper-level college students, and working professionals. The purpose of using a wide variation of ages is to encourage the growth of long-term multi-generational relationships and friendships with the hope that each age group will benefit from other age groups' resources. Roughly five individuals are in each E-Mentoring group, arranged by their similar interests, hobbies, and backgrounds. At least once a week, e-mails are sent to the entire group on a range of subjects. In addition, groups have the opportunity of meeting three to four times at university-sponsored socials. Before the program begins, participants are given "Getting Started Pointers" to help them use their resources. Individuals will find this resource useful because of the way it maximizes the benefits of many mentoring variations.

While e-mentoring has proven to be a valuable resource, studies related to the effectiveness of such programs on the retention and success of females in STEM disciplines are limited. As noted previously, mentoring relationships that provide women with an opportunity to discuss personal as well as professional issues appear to be the most effective. Relationships that allow for an exchange of ideas and allow for power sharing have also been shown to be the most beneficial to women overall. The degree to which these elements are present in e-mentoring relationships has not been explored.

Mentoring Publications for Successful Programmatic Initiatives

The Association for Women in Science (2005) produced *A Hand Up*, a recently revised edition that includes a series of 37 interviews and essays produced by women in STEM fields. Contributors offer insights, advice, and assistance to females who are new to the STEM fields as well as to women already established. Author contact information is provided as each offers to serve as a mentor. There is also a section guiding women scientists to organizations, electronic resources, and practical recommendations to consider in their searches for successful professional outcomes.

The National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine jointly produced *Advisor, Teacher, Role Model, Friend: On Being a Mentor to Students in Science and Engineering*. This online resource is a guide for individuals who will serve as mentors to students in STEM fields (particularly science and engineering). Features of successful mentoring relationships are

summarized in an attempt to encourage positive experiences for both the mentors and protégés and can be found online at http://books.nap.edu/catalog.php?record_id=5789

Handelsman, Pfund, Lauffer, and Pribbenow (retrieved May 2008) have created a seminar for STEM faculty members who will be mentoring students. The workbook that is used during the seminar, *Entering Mentoring*, can be found online at http://www.hhmi.org/catalog/main?action=product&itemId=272. The workbook guides mentors who will be serving in STEM fields through the process of developing an intellectual framework that can be utilized in mentoring relationships. In particular, recommendations are made on how to address gender and race as they affect mentoring relationships. More details about the seminar are found on the Web site.

Riordan, Manning, Daniel, Murray, Thompson, and Cummins (1999) share their personal experiences in a journal article and provide an annotated bibliography of resources. By creating this resource for women starting their careers in science and engineering and publishing it in the form of a journal article, the authors hoped that multiple individuals can benefit. Similarly, Moss, Debres, Cravey, Hyndman, Hirschboeck, and Masucci (1999) produced an article aimed at helping women make the most of their mentoring experiences. In particular, they provide advice for women protégés and mentors. The article also provides a section with gender-neutral mentoring pointers.

Assessment Tools

An important component of effective mentoring programs is evaluation of the program and program participants. Assessing mentoring programs is best accomplished through careful planning. Indicators of program quality and effectiveness should be articulated in expected outcomes. Information collected through assessment efforts should be shared with program participants (Rhodes, 2002). The measurement tool selected should match the outcomes and aims of the specific program.

Surveys have been the primary means through which mentoring has been evaluated. Assessment tools associated with studies focusing on mentoring produced by the mentoring programs or sponsoring agency and are generated to fit specific needs for analysis (e.g., program analysis or research driven). Surveys measure how the mentor and protégé perceive the benefits gained from the relationship, what influences the relationship had on their future, and what activities or discussions the relationship included. Survey items cover negative and positive aspects of the mentoring relationships. Some sample statements from assessment tools include: “I can be genuinely myself with my mentor” (Liang et al., 2002); “Do you expect to continue communicating regularly with your mentor next year?” (MentorNet, 2003); “Have you and your protégé ever discussed balancing a career and other interests, family, etc?” (MentorNet, 2003).

Following are assessment tools that have been successfully employed to measure mentoring relationships or evaluate mentoring programs through pre- and post-program surveys. The assessment tools could be employed among groups other than the one it was formulated for. Examples of the types of questions found in the instrument and target groups that the tool could be used with are included to aid practitioners in the selection process. The tools are primarily geared towards assessment of formal programs after relationships have been established between mentor and protégé.

- AWE Mentor/Mentee (Assessing Women in Engineering, 2005). This suite of instruments is designed for use in women in engineering undergraduate mentor programs. AWE Mentor/Mentee includes pre- and post-instruments for both mentors and mentees to measure feelings of isolation

or inclusion in engineering, impact of role models on behaviors and feelings, commitment to completing an engineering degree, and influence of activity participation on academic/social behaviors. Using combined format questions, including forced answer-type questions, the instrument also includes formative items designed to determine the level of respondent participation in the activity and her overall satisfaction. Instruments are accessible to individuals subscribed to AWE; subscription is free: http://www.engr.psu.edu/awe/.

- MentorNet Program Evaluation and Research (MentorNet, 2008). This online source, specifically directed at women in engineering, provides an explanation of mentoring assessment, evaluations of its program, interview studies, and mentor/protégé questionnaires. Although MentorNet's program is Internet-based, the assessment tools can be applied to any mentoring program and can be accessed at http://www.mentornet.net/documents/about/results/evaluation/.
- Mentor Functions Scale (Noe, 1989). Based on Kram's work (1985), this scale assesses the extent to which mentors provide career and psychosocial functions. It has 29 questions and uses a five-point response scale for assessment. For example, questions ask respondents to rate mentors on a scale of one to five based on the amount of career support provided by their mentors.
- Measure of Mentoring Functions (Scandura, 1992). This eighteen-item, five-point response scale survey ranging from one (strongly agree) to five (strongly disagree) was designed to assess vocational support, psychosocial support, and role modeling. Originally used to determine the amount of mentoring in different dyad compositions, it can be used to assess the amount of mentoring in virtually any type of mentoring program. Items question career support (e.g., "My mentor takes a personal interest in my career"), psychosocial support (e.g., "I consider my mentor to be a friend"), and role modeling (e.g., "I try to model my behavior after my mentor").
- Mentor Role Instrument (Ragins & McFarlin, 1990). Instead of assessing Kram's (1985) broad categories of career and psychosocial functions, this survey focuses on Kram's nine mentor functions, as well as two additional psychosocial-related functions: parent and social interactions. The 33-item instrument has three items per mentor role and uses a seven-point response scale with responses ranging from one (strongly disagree) to seven (strongly agree). For instance, items pertaining to the mentor as a sponsor asks the respondents the degree to which they agree the mentor has helped them attain desirable positions. Items that pertain to the role of the mentor as a friend ask respondents to agree whether their mentor is someone they can confide in.
- Mentor Relationships: A Questionnaire for Students (Runco & Albert, 1986a). This instrument was designed for use in examining the relationships between gifted students and their teachers or mentors. Students rate their mentors, using a seven-point response scale. The author states that the items break down into "obvious clusters," such as careers, creativity, etc. No factor analysis data are included (Service, 2003).
- Mentor Relationships: A Questionnaire for Teachers and Mentors (Runco & Albert, 1986b). This instrument was designed for use in a study of relationships between gifted students and their teachers or mentors. Items pertain to behaviors of the mentor's students during their association and are rated as to the frequency of occurrence from "rarely" to "extremely often." Some of the behaviors are in terms of personal characteristics of the student, such as friendliness or enthusiasm.
- Relational Health Index-Mentor (Liang et al., 2002b). This survey assesses growth-fostering connections with mentors. The survey consists of eleven questions, and the answers are given based on a five-point response scale. It has been used to measure the psychosocial functions of mentoring relationships involving young women (Liang, Tracy, Taylor, & Williams, 2002a). Based

on the Relational Model theory (Jordan, Kaplan, Miller, Stiver, & Surrey, 1991; Miller & Stiver, 1997), this survey is available for research use and theory development. The instrument includes attitudinal and behavioral items (e.g., "I can genuinely be myself with my mentor") as well as items that specifically pertain to mentoring based on the relational model (e.g., "my mentor's commitment to and involvement in our relationship exceeds that required by his/her social/professional role).

Qualitative research methods have also been utilized to assess the mentoring experiences of different groups.

Studies have asked mentors and protégés to describe their ideal and actual mentoring relationship through metaphor. Responses were analyzed qualitatively to explore protégés' and mentors' expectations and experiences. Results indicate that protégés expected relationships to follow more hierarchical mentoring ideals at the beginning of the program and that these ideals differed from the actual experiences of the protégés once they entered a mentoring relationship. The researchers suggest that exploring metaphorical processes associated with mentoring experiences through reflection can provide a way to align expectations and realities between mentors and protégés. This type of reflection and subsequent analysis can be used in formal mentoring programs to help participants establish expectations and create relationships in ways that are aligned with the goals of particular mentoring program (Storrs, Putsche, & Taylor, 2008)

Future Research and Conclusions

A great deal of research has been done on mentoring relationships, however, more research is needed on the role of gender in STEM mentoring, particularly cross-gender mentoring relationships and whether they encourage positive socialization to the field in the same manner as same-gender mentoring relationships. Future research could also explore the role of gender in different types of mentoring models and in the terms of mentoring relationships (i.e., formal or informal). For instance, studies could examine whether males and females in STEM fields receive the same benefits through formal and informal e-mentoring programs or whether mentoring relationships that utilize the citizen model facilitate the retention of females within STEM disciplines. Furthermore, some previous studies could be duplicated with current students involved in mentoring programs given the changes that have occurred in how individuals communicate using various forms of technology. 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 also 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 needs to be included in the design of mentoring programs in order to reap maximum benefits.

Multiple definitions and models of mentoring exist, providing individuals with various models to choose from when designing a program that is appropriate for their target group. Females in STEM fields have been shown to benefit from mentoring because it provides them with role models and personal interaction with professors and professionals. A number of tools are available for a variety of assessments or may serve as guides to creating assessment tools for a specific program. The assessments of mentoring thus far show it to be a positive factor that can help prevent women from leaving STEM fields.

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

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