CADRE Brief

July, 2015

Mentoring for the Postdoctoral/Early Career Researcher: Key Elements and Broader Impacts

THE PROBLEM

Leading voices in the area of postdoctoral education explicitly define the postdoc experience to involve the idea of mentorship. The National Postdoctoral Association describes a postdoc as a doctoral degree holder "who is engaged in a temporary period of mentored research and/or advanced scholarly training" (NPA, 2011), and the National Science Foundation (NSF) concurs that the postdoc position is "a temporary and defined period of mentored advanced training to enhance the professional skills and research independence needed to pursue [the postdoc's] chosen career path" (NSF, 2014).

Since 2009, the NSF has required that all grant applicants requesting funding to support postdoc researchers submit a one-page statement describing how postdoctoral trainees will be mentored. The NSF provides general information on how mentoring plans should be written, and university administrative offices have begun to offer suggestions on how a mentoring plan should be structured. In 2014, the Community for Advancing Discovery in Research Education (CADRE), a resource network supporting awardees from the Discovery Research K–12 program at the NSF, commissioned an examination of early career supports. Researchers conducted surveys and interviews with 70 early career STEM education researchers and 129 veteran principal investigators. Recommendations urged much better guidance in both mentoring and the writing of NSF mentoring plans; suggestions included a formal written resource guide to mentoring as well as regular mentoring workshops (Riley & Butler 2014, pp. 20–21).

Recent efforts to improve postdoc mentoring within the STEM and STEM education fields have been driven, at least in part, by an expanding literature on the value and process of mentoring, and the growing awareness of a looming crisis in the STEM postsecondary employment outlook. A 2014 report from the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine noted that approximately 60,000 to

100,000 postdocs are currently at work across all STEM fields—up from a fraction of that number a mere 30 years ago—yet the number of open tenure-track faculty positions in the sciences has been flat or declining year by year (NAS/NAE/IM, 2014). Given that more than 50 percent of STEM postdocs still name a tenure-track research professorship as their ultimate goal, the disconnect between market realities and the expectations of newly minted PhDs could not be more stark (Aboukhalil, 2015). Other experts have warned against assuming that postdocs have no need for mentoring relationships: "It can be tempting to suppose that postdoctoral students require little or no mentoring because they have more experience than undergraduate or graduate students…. In fact, postdoctoral students, who might have scant supervision, ill-defined goals, and poor access to a community of peers, tend to incur greater risks of isolation and stagnation than graduate students. A good mentoring relationship can be crucial to the success of postdoctoral students as they develop original research ideas and move toward greater independence and maturity" (NAS, 1997, pp. 36–37).

Obviously, funding agencies cannot improve grantee postdoctoral mentoring programs simply by mandate: meaningful change will entail commitment from faculty, institutions, and disciplinary associations as well as postdocs themselves. Research on professional development among postdocs and early career academics is far from vast—most studies of mentoring systems have tended to focus on youth, K–12 teacher induction, or private-sector businesses—but recognition of its importance is growing. And although very few studies have been done on the specific field of STEM education, valuable insights about mentoring may be gained from studies focusing on other subject-matter areas.

THE RESEARCH AND PROMISING PRACTICES

Thirty years ago, pioneering mentorship researcher Kathy Kram described the work of a mentor as encompassing both psychosocial functions (such as friendship, acceptance, confirmation, counseling, and role modeling) and career development functions (such as coaching, advocacy, sponsorship, protection, and information sharing) (Kram, 1985). Although Kram focused on mentoring within the corporate workplace, her basic model is still highly influential, and a truly effective mentoring plan should account for both halves, so to speak, of the mentoring whole. Five years later, in a speech to the Western Association of Graduate Schools, sociologist Morris Zelditch outlined the roles of the mentor within higher education in similar—if more detailed—terms: "Mentors are advisors, people with career experience willing to share their knowledge; supporters, people who give emotional and moral encouragement; tutors, people who give specific feedback on one's performance; masters, in the sense of employers to whom one is apprenticed; sponsors, sources of information about and aid in obtaining opportunities; models, of identity, of the kind of person one should be to be an academic" (Gaffney, 1995). More recently, education theorist Carol Mullen defined mentorship as "a framework for theorizing developmental relationships in which people with experience and expertise invest time in those who are less experienced, responding to critical needs and enhancing the capacity for growth, productivity, and achievement" (Mullen, 2009). We have kept in mind this range of definitions—of mentoring as both a set of functions and a dynamic process—in our look at the elements of good mentoring practices.

ELEMENT 1 (E1): GOOD MENTORING BENEFITS BOTH MENTOR AND MENTEE.

STEM mentees in higher education report numerous benefits of successful mentoring relationships: enhanced effectiveness, self-confidence, personal support, and opportunities for reflection as well as increased access to advice, candid feedback, and inside information (Knippelmeyer & Torraco, 2007, p. 3). In several studies, mentorship has been associated with greater mentee career advancement and satisfaction (Johnson, 2007, pp. 10–11). For mentors, the act of guiding younger colleagues

can promote job satisfaction, self-reflection, professional relationships, peer recognition, and renewed perspective on the mentor's own work and position. A reputation for top-notch mentoring can help the mentor attract superior students and guarantee the sustainability of the research enterprise, since a recipient of good mentoring is more likely to be a good mentor herself (NAS, 1997). The dynamic of mutual assistance and reinforcement is neatly encapsulated in a dialogue on mentoring between Principal Investigators Chris Rogers and Kristen Wendell in a podcast on the CADRE website. When early career academic and Rogers' mentee Wendell said, "I always learned so much from you by watching you do your work, and you were always so generous about letting us tag along—I don't know if that was intentional or not," Rogers responded with a laugh. "It is, because you guys could throw out good ideas!"

E2: EFFECTIVE MENTORING CAN ADVANCE THE CAREERS OF UNDERREPRESENTED GROUPS IN THE STEM AND STEM EDUCATION PROFESSIONS.

According to 2011 U.S. Census Bureau data, women constitute 47.5% of the entire U.S. workforce but occupy only 25.8% of STEM positions. African Americans and Hispanics respectively make up 10.8% and 14.9% of the total U.S. workforce; in the STEM fields, however, they account for only 6.4% and 6.5% of workers (Landivar, 2013, p. 7). In 2013, underrepresented minorities as a group composed only 6.2% of full-time full professors with science, engineering, and health doctorates at U.S. colleges and universities (NSF, 2015). A recent review of the literature on women's participation in the STEM fields argues that a female student's sense of belonging (defined as a perception of fit or complementarity to her environment combined with awareness that her involvement is valued) plays a vital role in contributing to self-efficacy among young women in STEM, and that mentoring can greatly enhance this sense of belonging (Sullivan, 2014). The National Research Council's 2010 survey of approximately 1,800 faculty across the U.S. found that early career female faculty who reported having mentors were significantly more likely to have secured grant funding than those who did not (NRC, 2010). And an exhaustive literature review published in 2009 by the American Institutes for Research describes the decisive role of good mentoring in equipping students from racial and ethnic minority backgrounds to overcome social isolation, combat stereotype threat, and connect to opportunities that will allow them to progress in the STEM professions: "Student support systems, in particular mentorship, are integral to retaining URMs [underrepresented minorities] in STEM education and careers such as the professoriate" (Poirier, Tanenbaum, Storey, Kirshstein, & Rodriguez, 2009, p. 2).

It would be a mistake, however, to assume that only mentors from underrepresented groups can properly mentor underrepresented mentees. In writing of early career academics in search of mentors, Kerry Ann Rockquemore, sociologist as well as president and CEO of the National Center for Faculty Development & Diversity, has warned against placing unrealistic expectations on senior minority faculty, arguing that to do so is as serious a misstep as claiming that race and gender play no role on campus: "The first error is the denial of differential experiences….The second error is taking differential experience to the extreme and believing that underrepresented faculty can ONLY be mentored by other underrepresented faculty. In other words, only people like them can effectively help them navigate their experience on campus. The regrettable outcome is that mentoring underrepresented junior faculty gets added on as additional unrewarded, labor-intensive, and invisible diversity work for the small numbers of already over-burdened senior solo faculty" (Rockquemore, 2011).

E3: PERSONALIZED AND FORMALIZED MENTORING PLANS, WITH MENTEE PERFORMANCE SUBJECT TO REGULAR REVIEW, ENCOURAGE MENTEE PERSISTENCE AND COMMITMENT.

Much of the research on mentoring presupposes that mentoring relationships develop informally and spontaneously, with mentees seeking out the advice of mentors with whom they sense a personal affinity and no paperwork required. However, a 2005 Sigma Xi survey of 7,600 U.S. postdocs found that the respondents most satisfied with their positions were those reporting the highest levels of structured oversight—that is, those required to write formal, individualized plans or goal statements and undergo regular progress reviews with an advisor or other mentor (Davis, 2005). In his book *On Being a Mentor: A Guide for Higher Education Faculty*, W. Brad Johnson makes a comprehensive case for intentional, systematic mentoring in the academy, recommending goal-setting sessions, written agendas, regularly scheduled mentor–mentee meetings, periodic evaluations, and formal evaluative scales of faculty mentorship skill that can be used in decisions about promotion and tenure (Johnson, 2007). A report authored in 2000 ties together several recommendations for greater accountability in postdoctoral mentoring relationships, including the linkage of mentoring ability to grant approval and periodic mentee performance evaluations: "Such evaluations, strongly desired by most postdocs, help avoid confusion about a postdoc's standing, build a more frank and open advising relationship, and provide a meaningful way for the adviser to compensate a postdoc for research performed" (NAS/NAE/IM, p. 103).

E4: MULTIPLE MENTORS AND MENTORING NETWORKS CAN BE AS PRODUCTIVE AS TRADITIONAL ONE-TO-ONE PAIRINGS.

While the traditional idea of mentoring involves an individual senior colleague paired with an individual younger one, a revised concept has gained prominence in recent years—that of a collaborative or cooperative process that allows each mentee to access guidance from multiple sources. Especially useful in workplace and higher education settings, such mentoring communities or networks relieve pressure on each individual mentor to serve as primary authority while encouraging interdependence among all participants (Mullen, 2009, Handelsman, Pfund, Laufer, & Pribbenow, 2005). A 2011 survey of 204 postdocs in Australia found that although 80% rated their relationships with their supervisors as good to excellent, 60% would have preferred a second mentor; several respondents stated explicitly that a mentor from a different department or institution would be more likely to offer advice free of bias or conflicts of interest (Scaffidi & Berman 2011). *The Formation of Scholars*, a 2007 report on doctoral education from the Carnegie Foundation for the Advancement of Teaching, called for a transition "from a system in which students are apprenticed *to* a faculty mentor to one in which they are apprenticed *with* several mentors" (Walker, Golde, Jones, Bueschel, & Hutchings, 2007, p. 6). In an era of budget cuts, a mentoring network approach can also optimize the human and financial resources of strapped departments.

E5: GREATER EMPHASIS IS NEEDED ON THE DEVELOPMENT OF TRANSFERABLE CAREER AND COMMUNICATION SKILLS AS WELL AS TECHNICAL, RESEARCH, AND CONTENT SKILLS AND KNOWLEDGE.

Although most postdocs may still view an academic job as their ultimate goal, the importance of preparing postdocs for careers outside academia is increasingly apparent, even to the aspirants themselves (HHMI/BWF 2006, p. 104). A recent survey of early career life sciences professionals revealed that almost 40% were unsatisfied or very unsatisfied with the mentoring they had received in the area of career development; many respondents noted that their supervisors and mentors avoided discussion of non-academic careers altogether (Maxfield, 2013). A comprehensive 2012 report from the NIH's Biomedical Workforce Working Group recommended greater focus on career mentoring for postdocs as well as a realignment of incentives toward limiting the postdoc period and treating the postdoc as a trainee researcher rather than an assistant and subordinate (BWWG/NIH, 2012). Responding to a growing awareness of the disparity between applicants and available jobs, mentors are increasing their active support of attendance at networking events (Bernstein, 2014).

While mentors have typically assisted STEM postdoc and early career mentees in enhancing their research and content skills, it is becoming clear that mentors should also foster the development of skills such as oral and written communication, and project and personnel management. Such a shift in emphasis will aid STEM mentees in finding career positions both inside and outside of the academy; in addition, postdoctoral students and other early career STEM education researchers revealed in the CADRE survey that younger professionals relied most strongly on the support of more experienced professionals in the cultivation of crucial yet broadly applicable skills: proposal development, funding source research, networking/collaboration, writing/publishing, and budget management (Riley & Butler 2014, p. 10).

CONCLUSION

The field of mentoring research is only a few decades old, and concerted interest in the subfield of improving mentorship and other support systems for postdoctoral appointees and early career faculty is even more recent. Both the field and subfield need investigations as well as the sharing of programs and strategies with the STEM education research and development community.

Six relevant main points for future developers of mentoring plans emerged from this overview of the research:

- Ensure that mentoring programs are rewarding for both mentor and mentee.
- Realize that mentees from underrepresented groups often stand in particular need of mentoring.
- Build formal systems of regular check-in, review, and evaluation into mentor–mentee interactions.
- Arrange mentor networks; if your department lacks willing personnel, seek available mentors in different departments, institutions, and organizations.
- Plan for mentees to develop career and communication skills that are usable in a range of STEM positions either inside or outside academia.
- Increase research on various aspects of the mentoring of early career STEM education researchers and developers.

As more and more mentoring plans are enacted in response to the NSF's mandate, further insights will no doubt emerge.

REFERENCES

Aboukhalil, R. (2015, February 17). The elephant in the lab. *NatureJobs* [career blog affiliated with Nature.com]. http://blogs.nature.com/naturejobs/2015/02/17/the-elephant-in-the-lab

Bernstein, R. (2014. December 17). Yes, You can attend that career event, says the U.S. government. *Science,* Retrieved from http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2014_12_17/caredit.a1400315

Biomedical Workforce Working Group/NIH (BWWG/NIH). (2012, June 14). *Biomedical Research workforce working group report*. Bethesda, MD: National Institutes of Health.

Davis, G. (2005). Doctors without orders: Highlights of the Sigma Xi postdoc survey. *American Scientist, 93*(3, supplement). Retrieved from http://www.sigmaxi.org/docs/default-source/Programs-Documents/Critical-Issues-in-Science/postdoc-survey/highlights

Gaffney, N/ A. (1995). *A conversation about mentoring: Trends and models*. Washington, DC: Council of Graduate Schools.

Handelsman, J., Pfund, C., Laufer, S. M., & Pribbenow, C. M. (2005). *Entering mentoring: A seminar to train a new generation of scientists*. Madison, WI: The Wisconsin Program for Scientific Teaching.

Howard Hughes Medical Institute & Burroughs Wellcome Fund (HHMI/BWF). (2006). *Making the Right moves: A practical guide to scientific management for postdocs and new faculty*. Chevy Chase, MD: Howard Hughes Medical Institute. Retrieved from http://www.hhmi.org/sites/default/files/Educational%20Materials/Lab%20Management/Making%20the%20Right%20Moves/moves2_ch5.pdf

Johnson, W. B. (2007). *On being a mentor: A guide for higher education faculty*. New York: Taylor and Francis.

Knippelmeyer, S. A., & Torraco, R. J. (2007). *Mentoring as a developmental tool for higher education.* Paper presented at the Academy of Human Resource Development International Research Conference in The Americas, Indianapolis, Indiana. Retrieved from http://research.utah.edu/_documents/mentoring/Knippelmeyer2007.pdf

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

Landivar, L. C. (2013, September). Disparities in STEM employment by sex, race, and Hispanic origin. *American Community Survey Reports*. ACS-24. Washington, DC: U.S. Census Bureau.

Maxfield, F. (2013, January). A wake-up call on mentoring. *ASBMB Today*. Retrieved from http://www.asbmb.org/asbmbtoday/asbmbtoday_article.aspx?id=24077

Mullen, C. A. (2009). Re-imagining the human dimension of mentoring: A framework for research administration and the academy." *The Journal of Research Administration, XL*(1).

National Academy of Sciences (NAS). (1997). *Adviser, teacher, role model, friend: On being a mentor to students in science and engineering*. Washington, DC: National Academies Press.

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (NAS/NAE/IM). (2000). *Enhancing the postdoctoral experience for scientists and engineers: A guide for postdoctoral scholars, advisers, institutions, funding organizations, and disciplinary societies*. Washington, DC: National Academy Press.

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (NAS/NAE/IM). (2014). *The postdoctoral experience revisited*. Washington, DC: The National Academies Press.

National Postdoctoral Association (NPA). (2011, December 19). *Terms of use for social media pages.* Retrieved from http://www.nationalpostdoc.org/social-media-terms

National Research Council. (2010). *Gender differences at critical transitions in the careers of science, engineering, and mathematics faculty*. Washington, DC: The National Academies Press.

National Science Foundation (NSF). (2014). *Proposal and award policies and procedures guide. Part I: Grant proposal guide*. Arlington, VA: National Science Foundation.

National Science Foundation (NSF). (2015). *Women, minorities, and persons with disabilities in science and engineering: 2015.* NSF 15-311. January 2015. Arlington, VA: National Center for Science and Engineering Statistics. Retrieved from http://www.nsf.gov/statistics/2015/nsf15311/digest/theme7.cfm#women

Poirier, J. M., Tanenbaum, C., Storey, C., Kirshstein, R, & Rodriguez, C. (2009, October). *The road to the STEM professoriate for underrepresented minorities*. Washington, DC: American Institutes for Research.

Riley, D., & Butler, A. (2014, August). *Early career researchers and developers in the DR K–12 program: Needs, supports, and recommendations*. Waltham, MA: Community for Advancing Discovery Research in Education.

Rockquemore, K. A. (2011, November 14). Will you be my mentor? *Inside Higher Ed*. Retrieved from https://www.insidehighered.com/advice/2011/11/14/essay-mentoring-and-minority-faculty-members

Scaffidi, A. K., & Berman., J. E. (2011). A positive postdoctoral experience is related to quality supervision and career mentoring, collaborations, networking, and a nurturing research environment. *Higher Education, 62*, 685–698

Sullivan, Z. (2014). *STEM women: Thriving in the 21st century: A proposal for a group workshop series*. San Luis Obispo, California: Career Services Office, California Polytechnic State University. Retrieved from https://drive.google.com/file/d/0Bx42_Lddk_MtTlRDdDZiNFZvZDA/edit?pli=1

Walker, G. E., Golde, C. M, Jones, L., Bueschel, A. C., & Hutchings, P. (2007). The formation of scholars: Rethinking doctoral education for the twenty-first century. Stanford, CA: Carnegie Foundation for the Advancement of Teaching.

Community for Advancing Discovery Research in Education

CADRE briefs are funded by the National Science Foundation, grant #1449550, and prepared by the Community for Advancing Discovery Research in Education (CADRE) at the Education Development Center, Inc. Any opinions, findings, and conclusions or recommendations expressed in these materials are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.