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ORIGINAL PAPER

"Biomedical Workforce Diversity: The Context for Mentoring to Develop Talents and Foster Success Within the 'Pipeline'"

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Abstract Like all biomedical research fields, AIDS research needs the broadest diversity of experiences and perspectives among researchers in the field if creative advancements are to be achieved. Mentors and mentoring are the most important vehicles by which the talents of young scientists are developed. However, mentoring as a teaching and learning paradigm is very complex and idiosyncratic, and often inadvertently fails to provide the same quality and quantity of opportunity to aspiring scientists who are 'different' from those doing the mentoring. This article provides a theoretical and practical framework for understanding how differences of race, ethnicity, gender, skin color, social status and other identifiable characteristics can play into scientific development during mentoring 'within the pipeline'. It also serves as a foundation upon which mentoring in AIDS is considered by subsequent papers in this series. Finally, it goes beyond mentoring to propose systematic coaching as an effective complement to research mentoring to promote success, especially for individuals from underrepresented groups.

Keywords Mentoring · Coaching · Communities of practice · Diversity · STEM pipeline

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Introduction—Development Within the 'Pipeline' Rather Than Just Getting in and Flowing Out

The pipeline analogy has been used for decades to portray the disproportionately low numbers of women and underrepresented racial and ethnic minorities (URM) who start out with an interest in science in college but do not persist into scientific careers. The pipeline model arose in the 1970s and draws largely on supply-side economics (for a review see [1]). It has been especially useful for making the case for efforts in early educational stages but also has been invoked to draw attention to concerns at the later stages of scientific workforce development [2, 3]. However, it also makes very visible limited progress that has been made for URM scientists despite extensive financial and human resources devoted to improving access to and successful navigation of the pipeline in the past three decades [4, 5]. The purpose of this paper is not to review this vast topic and why improvement has been so slow, but rather to look at human and scientific development that is occurring within the pipeline to enable an analytical view of diversity efforts and the roles of mentoring. The path from an interest in science to a science career is actually an open system, with continual movements in many directions, and this is the context within which mentoring exerts influences along the way. This paper will take a broad STEM perspective, not one unique to AIDS research, but one that will be translated to AIDS research and researchers in subsequent papers.

As others have noted [6] one of the greatest failings of the pipeline analogy is it creates an image of unchanging objects moving through time and space, in one direction, in a closed system. This could not be farther from the truth when it comes to science, technology, engineering and math (STEM) careers, as individuals are going through vast

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personal, academic and career intention changes over time. We have previously summarized many of the STEM diversity efforts past and current, and the value of looking at them from the perspective of 'developing talent' rather than measure flow through a pipeline [7]. The focus here is on how mentoring must operate within this complex social and academic environment where individuals are working to acquire knowledge, skills, attitudes and behaviors (i.e. learning) and making short-term decisions that have profound long-term consequences. Mentoring is one of many influences that can promote or impede ultimate 'survival' with respect to any particular career outcome.

Working Definition of Mentoring for the Series

Whether viewing scientific development on the whole or from a diversity perspective, all roads lead to mentoring. Unlike medicine, law and most other professions (where systematized education is provided, and core knowledge and competencies are assessed through exams and rubrics), research training is built around informal and minimally structured teaching and learning—a.k.a. mentoring. Yet, the term 'mentor' conjures up widely varying mental models among those doing it as to: what it is; how it should be approached; the 'right' and 'wrong' ways to mentor; the appropriate boundaries between scientific and personal relationships; the degree to which it is altruistic, mentee-centric versus constrained or driven by real-world needs of mentor as well as mentee; and on and on. Often, even in the most advanced approaches to teaching effective mentoring skills, one is asked to develop a 'mentoring philosophy' [8], which, by the title alone, conveys a philosophical foundation rather than one based upon empirical or research-based formulations. This is not necessarily bad but it does set up mentoring as an idiosyncratic system in which each mentor has tremendous latitude and freedom to mentor in whatever way they believe in, or, more commonly, what they have experienced and personally preferred as a mentee. As a systematic construct, this can work (as have apprenticeship models for centuries), as long as the goal is replication of the skills and traits of the mentor and there are sufficient jobs for the apprentices who come out like their mentors. However, it will invariably begin to break down with respect to equality of access and training when those in need of mentoring are socially and experientially very different from mentors, and/or demand is limiting with respect to employability of those being mentored.

Since so much of what follows in this series focuses on mentoring, an operational definition is provided as a common language to build from and, more importantly, develop models to maximize effective mentoring for those who are most unlike the current scientific workforce mentors. Regardless of the philosophy or specific definition of mentoring that one adopts, most agree that mentorship ideally consists of a reciprocal, dynamic relationship between mentor (or mentoring team) and mentee that promotes the satisfaction and/or development of both. For this series, the framework of mentoring will primarily be classic dyadic research mentoring by faculty in the life sciences. However, it also is broadened to include dual or multi-mentored research training, as well as the growing resources for career mentoring by others with whom a trainee is not working directly performing research. This definition of mentoring provides room for discussion and analysis of the full range of mentoring styles, from 'provide space and opportunity and get out of the way', to carefully constructed mentoring plans, or micro-managed mentoring that can stifle development. It also provides room for discussion of the full range of mentor rights and responsibility, from mentoring as a philosophical position that each mentor has the right to define, to mentoring as a highly refined skill that mentors should be required to demonstrate before being allowed to mentor.

Recent Research on Approaches to and Attributes of Effective Mentoring Relationships

There are scores of books and opinions on mentoring, but few comparative or analytical studies. However, in the past two decades, a sea change has begun to move mentoring from something that just somehow happens to a highly refined skill and responsibility. Several stimuli have led to this rapid evolution, but probably the most important were the studies that revealed the frequency with which postdoctoral fellows were being treated as workers rather than trainees, often vastly under-paid with no basic employment benefits [3]. This was a national wake-up call that this could not by justified or allowed to continue. The second pivotal event was the publication of *Entering Mentoring*, by Dr. Jo Handelsman and colleagues at the University of Wisconsin, with support from the Howard Hughes Medical Institute [8]. The core skills and themes that Entering Mentoring focus on include: (1) maintaining effective communication; (2) aligning expectations; (3) assessing understanding; (4) addressing diversity; (5) fostering independence; (6) promoting professional development; (7) articulating a mentoring philosophy and plan. Entering Mentoring has grown into a highly sophisticated and rapidly expanding workshop-based approach to developing skills of mentors and promoting effective mentoring relationships. A strong research base supporting this approach is emerging, including a randomized controlled trial conducted at 16 academic health centers across the U.S.

[9–13]. A recent independent qualitative study with mentors of junior faculty at two academic medical centers identified essentially the same attributes as those in Entering Mentoring and its subsequent expansions [14].

Most of the core attributes of effective mentoring relationships may seem self-evident, but the challenges come when they must be implemented within the highly competitive and challenging research environment. Current realities include high levels of competition for limited funding, conflicting needs of mentors and mentees, the multiple roles mentors must play guiding development as well as evaluation of mentees, and the myriad of challenges with effective communication. These complexities become amplified in mentoring relationships involving mentors and mentees with very different backgrounds and experiences related to social class, gender, race, ethnicity, economic resources, sexual orientation and other important identities. Additionally, as described by Manson in this series, to be successful requires a clear understanding of the institutional culture within which a young scientist is developing a career whether it be academia, industry, a government research facility or any location [15]. Mentors are essential for revealing and interpreting institutional cultures and how to best operate within them, but the degree to which they do this can be highly variable.

The knowledge and skills of a mentor within a research mentoring relationship are critical to its success; but just as important is the ability of the mentee to navigate the relationship effectively. We and colleagues at the University of Wisconsin have introduced teaching the same skills and attributes of effecting mentoring relationships to those being mentored [16, 17]. Using very similar interactive workshop approaches, we now teach 'mentoring up' to all levels of research trainees [18]. This approach provides mentees much more responsibility, skill and ownership for their own training, and addresses the equal roles of mentor and mentees for effective relationships. By guiding and expecting mentees to have agency within their mentored relationships, we promote the key roles they can, and should, play in shaping their own futures.

Mentoring within the Context of Development: From an Interest in Science to Successful Scientist

When focusing on what is going on in the pipeline rather than what comes out, and the roles mentors play in that progression, it becomes critical to consider the changes that individuals undergo over time in order to look carefully at the role that mentors play. Starting from entry into college, the developmental changes required to achieve a STEM professional status are enormous. Setting aside personal dimensions for the moment, scientifically an individual has to grow from a rudimentary knowledge of what is known in their field and related fields, to someone who can challenge what is thought to be known and create new knowledge. The technical skills that must be mastered are equally daunting. In some ways it is a continuous process, but it is also punctuated by very clear milestones where individuals have to make dramatic transitions into next developmental steps between educational and career stages. The mentor-based design of research training requires particular attention to discrete roles of mentors during the build-up to each milestone, as well as at pivotal milestone transitions where risks of falling off the survival curve are especially high. During both times, mentors 'act upon' their mentees to influence development and decisions, but mentees are equally 'acting' to make decisions on their own. Their real and perceived competence in the field often drive their decisions, with competency being determined by their internal assessments as well as reflected messages of competence from others. Thus, mentors (e.g.—faculty, postdocs, lab techs, more senior students) play a big role in shaping not only the skills of young scientists but also their internal sense of competence and fit in the field. Although mentors would likely agree with this conclusion, it can be easily forgotten in day to day interactions, and how those interactions can have lasting effects for someone with less well-developed scientific identities.

Building from the converging evidence of the attributes of effective mentoring relationships, and recognition that development occurs continuously with periodic key milestones, it becomes realistic for mentors to consciously construct a mentoring plan or strategy for each individual mentee. It becomes equally viable to engage mentees to incorporate these into Individual Development Plans [19, 20] and mentoring-up strategies. All of this moves mentoring from its typical position of something that just happens (or not) into a consciously derived scientific and personal development strategy. Combining this with the rapidly expanding attention to providing formal guidance in choosing among career options with a STEM PhD (e.g.—the 17 recently awarded NIH Broadening Experience in Scientific Training (BEST) awards [21]), it is evident the landscape for re-thinking how we prepare future scientists is changing rapidly. Several recent studies have shown how dramatically interest in academic careers declines during training (i.e. survival with respect to this career outcome), especially among URM and women students, so all of this attention cannot come too soon [22–26].

How do Individuals from Underrepresented Groups Experience Mentoring in STEM?

The succeeding paper by Pfund and colleagues provides an in-depth discussion of how several well-established social science theories reveal and explain factors that impact persistence with attention to the many extra challenges that URM scientists face. Developing as a scientist and as a person becomes much more challenging when simultaneously trying to navigate many psychosocial and social impacts of being ‘different’. The word ‘different’ is chosen purposefully to bring attention to the additivity and intersectionality of the multiple domains of race, ethnicity, skin color, class, and other differences. It is a reality that all communities, including the STEM community, have a strong tendency to view people like themselves as the norm and anyone else as ‘different’. The behaviors of identifiable communities like STEM are very well described through the social science theory of communities of practice (C of P), which comes from the work of Wenger and Lave looking at behaviors of groups working to achieve a common goal [27–29]. These communities have tacit or explicit expectations of what is required to be seen as a legitimate member of the group. Each newcomer to the group has to establish their validity, often based on perceived competence with certain practices, as the gateway to group membership.

The reason it is important to understand the tendencies of C of P is that mentoring is one of the strongest practices of the research community and it is easily impacted by contingencies associated with being ‘different’. One example of the utility of viewing research development through a C of P lens is the work of Thiry and Laursen who studied students doing undergraduate research [30]. By examining the apprenticeship aspect of mentoring, they displayed the domains of support that led to the socialization and sense of belonging required to be seen as a legitimate member of the community. They also saw that many URM students were coming from farther back on the scientific developmental spectrum due to lower resourced histories, leading to greater needs for support. Spun a different way, those students would start out less likely being seen as legitimate by the community and more aware themselves of not fitting in. A recent report by Byars-Winston and colleagues examined and established a positive relationship between perceptions of URM students of the mentoring they received and their academic outcomes [31]. Their studies also have begun to reveal the mentor-specific factors related to the positive outcomes.

Many URM students do experience mentoring differently than their non-minority counterparts simply by being different, to say nothing of the social and racial stereotypes that continue to pervade the U.S. In our studies and those of others, many URM young scientists feel like they constantly must prove and re-prove themselves—a classic element of being initially seen as an ‘outsider’ with a high bar to being accepted as an ‘insider’ [32]. URM scientists also must balance many more social and cultural identities that are less compatible with the identity of a scientist than non-URM scientists [33–37]. Ongoing efforts to increase STEM diversity inadvertently lead some to question their legitimacy for being in PhD and advanced stage training. All of this leads to what many URM students refer to as a constant weight or energy burden—a cognitive load that wears them down [38–41].

Many URM young scientists have a strong desire for mentors who are ‘like them’ even if not primary research mentors [42]. In our work and others’, URM and women graduate students often express how difficult it is to sustain an image of a career when they don’t see others like themselves making it. One’s identity as a scientist is continually being remodeled at each career stage so seeing others at the next stage is very important. The best mentors are able to openly acknowledge this challenge and assist their mentees to find others like themselves. However, some mentors can’t see why this is important as it can be hard to recognize the importance of role models when you have always had them around you without realizing it.

Another very critical difference URM students often face during mentoring is the challenge of communication across racial, ethnic, cultural and gender differences. Communicating across these lines is challenging at all times, and especially difficult in the complex world of mentoring and scientific development. Creating new workshop/training tools to help mentors become more comfortable and skilled at ‘culturally responsive mentoring’ is a major goal of the newly funded National Research Mentoring Network—NRMN [43].

Is Mentoring Enough for Achieving Diversity in STEM?

Having been immersed in STEM diversity efforts for more than 35 years, I have begun to question if mentoring as a talent development construct can ever work fast enough. Even with efforts to improve the effectiveness of mentoring, it still has major limitations as the sole teaching and learning model. Thus, we and others [43, 44] have begun experimenting with the addition of ‘coaching’, particularly group coaching, to complement research mentoring. A full description of coaching to augment mentoring is beyond the space possible here, but the design we are testing will be briefly described. Just as with ‘mentor’, the word ‘coach’ conjures up a wide array of interpretations and applications. Within biomedical research training, coaches are successful scientist mentors who provide some of the same guidance that effective mentors do, but they do it *outside of a research relationship*. They can fill in gaps within less than ideal mentoring relationships, and provide independent confidential guidance to trainees who can be concerned about revealing important personal issues to research mentors who have great influence over trainees' careers. Coaches can also bring unique expertise to scientific development beyond what many mentors can, such as in teaching grant writing, networking and communications skills, and deciding among career options. Coaches may interact with trainees for short, focused periods of time or for more extended periods like research mentors. Unlike research mentoring, coaches can interact with groups of trainees as well as individuals, bringing in a combination of peer support and teaching of professional skills. Coaching groups can also be constructed drawing trainees from different institutions, enabling those with unique identities and interests to 'find' each other to minimize a sense of isolation in home institutions. Finally, of key importance to diversity efforts, coaches can be selected for demonstrated effectiveness with underrepresented groups and be provided with extra training around recognizing and addressing the unique differences experienced by URM STEM scientists.

As with mentoring as a talent development model, coaching is not without limitations. They can never replace the focused training and expertise within a scientific discipline that mentors must provide. Coaching trainees across institutions, usually with little or minimal compensation, requires personal dedication and available time. Logistical limitations can make it hard to have regular in-person or virtual coaching sessions, however, these are not insurmountable. Effective group facilitation skills are also not something that all scientists typically have developed so they may have to be taught to coaches. Despite some of these limitations, described below is an example of where carefully constructed coaching can be particularly valuable to URM young scientists.

Through an NIH Director's Pathfinder Award to Promote Diversity in the Scientific Workforce, we created an ongoing coaching intervention deployed for both beginning and late stage biomedical PhD students—*The Academy for Future Science Faculty (Academy)*. It is being conducted as a randomized controlled trial. One Coach was matched with ten students from around the U.S. [43, 44]. All of the Coaches and students came together for annual intensive professional development conferences, three for beginning students and two for advanced students. Coaches and coaching groups also kept contact during the time between meetings using a variety of video, audio and email methods. The *Academy* was designed from the social science theories and principles discussed here and in the succeeding papers. These theories were taught to the Coaches and introduced to the students in an effort to make visible what operates invisibly throughout research training. The coaching groups were purposely constructed to have equal representation by gender, race and ethnicity to: (1) enable comparisons between groups; (2) make it clear the coaching being provided was valuable to all young scientists; (3) see if it was possible to engage this mixed group in conversations about race, racism, privilege, and unconscious biases and assumptions in a 'safe' group setting.

The overall response of Coaches and students to the Academy has been extremely positive. We are seeing good evidence of it having a positive effect on the achievability, desirability and persistence of some students toward academic careers [44]. URM students often commented on how the Academy was a 'safe space' where they could talk honestly about the extra challenges and burdens they face as it is almost impossible to bring these up in their programs for fear of being judged and/or discounted. There are also many instances where coaches were providing guidance students were not getting from research mentors. Time and much more analysis will tell if these effects are lasting and translate to positive outcomes. The research findings and observations from this coaching trial and other grant writing coaching approaches are also being brought to the National Research Mentoring Network (NRMN) for application and testing with graduate students, postdoctoral fellows and junior faculty [45].

Conclusion

The goal of this contribution was to set the context and starting point for more detailed papers to follow both in regard to what is known about the mentoring with URM individuals, and diversity in AIDS researchers in particular. If these papers were written 10 year ago they would have read very differently with respect to the prospects for activating highly effective mentoring and coaching for improving diversity in the future. We are in a new era, one which recognizes the importance of developing skills of mentors and mentees to maximize the development of the skills of young scientists. Through evidence-based approaches to mentoring and coaching, those who have already made it through the pipeline can improve the success of those entering and trying to navigate their way through it, including future AIDS researchers.

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Compliance with Ethical Standards

Conflict of Interest The author declares that he has no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of Northwestern University, and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Animal Rights This article does not contain any studies with animals performed by the author.

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