Inclusive Mentoring in Engineering and Science: An Evolving Workshop Model (Experience)

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Introduction

The quality and role of mentorship in various environments are of crucial importance, and professional development opportunities are necessary for mentors of historically URM protégés. Similarities in the background between mentor and protégé can strengthen their relationship (Muller, Blake-Beard, Barsion, & Wotipka, 2012). However, there is a substantial gap in the representation of students and faculty in higher education. While students enrolled at two-year and four-year colleges are from increasingly diverse racial and ethnic backgrounds (Ginder et al., 2014), the faculty body may not be as diverse. According to the National Center for Education Statistics (NCES, 2019), in 2017, only 5% of faculty members were Hispanic, compared with 20% of undergraduates who were of Hispanic background. Similarly, only 6% of faculty members were African-American, compared with 14% of undergraduates who were black. The portion of URM faculty in STEM is also low, accounting for only 9% of STEM faculty at U.S. colleges and universities (National Center for Science and Engineering Statistics, 2017). As pointed out elsewhere (Qazi and Escobar, 2019), forging a mentorship relationship with individuals based on similarity would either leave many students without mentors or overtax women and URM faculty. There is a need for institutions to educate faculty, staff, and students about cultural competency and awareness of stereotypes and biases, both conscious and unconscious (Walden et al., 2018). From our collective perspective as STEM education researchers and promoters of student success, any individual with mentoring responsibilities or an inclination to support URM students should have access to critically reviewed information and quality training in evidence-based mentoring best practices. To that end, we have developed a vision for our project: *All mentors will be skilled, confident, and motivated to support the success of protégés from all backgrounds, particularly students from groups historically underrepresented in STEM. Mentors will have strategies and tools to facilitate meaningful relationships and mutual understanding of individuals whose life experiences are very different from their own. They will be invested in the success of individual students and overall broadening participation in STEM education and the workforce.*

Why Mentoring Matters in STEM. As stated in the National Academies' recent report on mentoring undergraduate researchers,

> [a]n enterprise-wide commitment to effective mentorship in [science, technology, engineering, mathematics, and medicine (STEMM)] could lead to high-quality, and sustainable mentoring relationships at all career stages, and it could increase student recruitment, retention, engagement, and success in STEMM. This is particularly important for underrepresented students in STEMM, for whom an absence of effective mentorship could disproportionately influence retention and persistence. Supporting effective mentorship and mitigating negative mentoring experiences will likely result in a more diverse and inclusive STEMM workplace. (National Academies, 2019, p. 176)

Mentoring is essential to success in academia and the workplace. The National Academies recognized mentoring as a "catalytic" factor to tap into student potential and improve

environments where these students work (National Academies, 2019, p. ix). Indeed, the dyad of mentorship provides a space where professionals serve as guides and support others in their next stage of education and career development. When done effectively, mentoring relationships can engage and develop the talent of a broader pool of students interested in STEM careers, increasing access, equity, and inclusion (Baker & Griffin, 2010; National Academies, 2017a, 2017b). For example, URM students gain confidence from interactions with their research mentors and broaden their future career and educational possibilities (Thiry and Laursen, 2011).

Importance of Quality Mentoring. The quality of mentoring and support matters greatly to the persistence and success of the student (Thiry & Laursen, 2011); this is particularly true for URM students (Barker, 2009). Consider the undergraduate research experience, which is a well-studied, high-impact practice with strong support from the National Science Foundation (AAC&U, 2008). Undergraduate research positively affects retention in STEM (Eagan et al., 2013), particularly for URM students (NAP, 2019). Mentorship in undergraduate research spaces has also been positively associated with students' identity and confidence as a STEM professional and their sense of belonging (Byars-Winston, Branchaw, Pfund, Leverett, & Newton, 2015). Productive protégés increase the research productivity of their faculty mentors. Other mentor benefits include a sense of personal fulfillment, leadership skill development, and cognitive growth (Laursen et al., 2010). It is reasonable to expect that these outcomes extend to individuals from outside educational institutions (i.e., industry and DoE national laboratory professionals) (National Academies, 2017b).

Yet poor mentoring practices are still prevalent. In the Carnegie Initiative on the Doctorate (Golde et al., 2006), researchers explored best practices for developing graduate students as stewards of their respective disciplines. Upon examination of current practices, researchers recognized that undesirable Darwinian strategies pervaded their departmental mentoring practices. Examples of these theories include:

- the *osmosis theory* (students learn by reading good research and being near faculty who are doing high-quality research);
- the *sink or swim theory* (students are thrown into their initial research experiences and thrash their way to completing the assignment with little guidance);
- the *talented-students-will-self-discover theory* ("good" students figure out what they need to know and go get it or abandon the process);
- the *high-pressure crucible theory* (a doctoral student proceeds through a set of high-stakes tests and hurdles).

These poor practices translate to a low seven-year completion rate (less than 75%) for the general STEM student population and a dismal rate (less than 50%) for URM STEM students (CGS, 2008a). The Ph.D. Completion Project (Sowell, 2009) indicated that program environment and mentoring are two key factors "influencing student outcomes that can ultimately affect the likelihood that a particular student will complete a Ph.D. program." Such findings point toward the need for widely promoting cultural changes in doctoral programs and effective mentoring. While the former is currently being addressed by the NSF Alliances for Graduate Education and the Professoriate program, the latter requires immediate attention.

Inclusive Mentoring Best Practices. The literature points to several tenets underlying inclusive mentoring best practices. Key tenets are as follows:

- It is important to develop a respectful and organic relationship between the mentor and protégé (Crumpton-Young, Elde, & Ambrose, 2014; Golde, Bueschel, Jones, & Walker, 2006; Johnson, 2002).
- Learning environments must be purposefully aligned with how people learn. For example, according to the Carnegie Initiative on the Doctorate, a well-structured program should be purposeful (i.e., programmatic requirements and elements should be aligned with specific goals). It should also be created by a process of iterative individual and collective reflection, transparent (i.e., collectively understood by the faculty and graduate students), and accessible (i.e., elements can be evaluated in terms of their contribution in achieving the purposes of the program) (Golde et al., 2006).
- A *cascading mentorship* model works well, in which members of research groups receive mentorship from more senior members and provide it to more junior members (Feldon et al., 2019).
- Institutional programs must assist students in acquiring the appropriate social and cultural capital needed for success within the dominant culture of the academy (Walden, Trytten, & Shehab, 2018).
- The academic and professional benefits of cooperative and internship placements must be promoted to all students without prejudice (Walden et al., 2018).
- The institution must develop advising and mentoring programs that recognize differences in racial/ethnic groups, social classes, and gender identifications (Walden et al., 2018).
- Mentors and programs should focus on helping students understand the *assets* they bring to higher education and the workplace due to their life experiences, as opposed to focusing on *deficits* that students may need to overcome (Martin et al., 2018).

Why workshops? The National Academies of Sciences, Engineering, and Medicine (2019) recommend that all types of institutions ensure that all who mentor students have access to appropriate professional development opportunities to help them grow and succeed in their mentorship roles. While the importance of mentorship is recognized, multiple reviews and reports have identified the significant need to disseminate and train STEM mentors on best practices. In 2019, for instance, the National Academies were "unable to find evidence that [undergraduate research experience] designers are taking full advantage of the information available in the education literature on strategies for designing, implementing, and evaluating learning experiences" (NAP, 2019).

Research has demonstrated the importance of mentorship and highlighted what quality mentorship looks like, particularly for URM students. Furthermore, effective mentoring can be learned (Handelsman, Pfund, Lauffer, & Pribbenow, 2005). However, sources for the professional development of faculty members and others who serve as mentors are limited (National Academies, 2017b, 2019). These professional development experiences should ensure an organized plan for what students will do and how faculty will guide them (Barker, 2009). Additionally, professional development should extend beyond the individual to the culture of the academic and industry organizations students will join. These spaces should cultivate intellectual and pedagogical discourse and break the door open of the "hidden curriculum" that often stunts professional growth (Bender, 2006, p. 305).

Administrators wanting to create or enhance a mentoring culture in their institutions, colleges, or departments would benefit from a tested training model. Academic and professional individuals who recognize the need for and want to learn how to become effective mentors of URM students and students from other underrepresented groups should also have access to readily available training.

Workshop Components

Since 2021, we have been dedicated to implementing inclusive mentoring workshops for stakeholders. A set of workshops were tailored to academic administrators and STEM faculty. A variant of this set was designed for STEM future faculty. A second set of workshops was developed with DoE national laboratory investigators and professional staff in mind. We developed workshop materials using our experience managing projects dedicated to providing experiential learning experiences to URMs and searching the literature for other models and evidence. We iteratively tested the workshops by offering them at two-year and four-year academic institutions, regional and national conferences, and a DoE national laboratory. Resource materials are now available to mentors interested in open literature on two project websites. Beginning this year, we will offer train-the-trainer versions of the workshops so that others will learn how to use and adapt our materials to offer inclusive mentoring workshops in their organizations.

Operational Definition of Mentoring

One of the main recommendations regarding developing effective mentoring practices is defining mentoring operationally (NAP, 2019). For practical purposes, the definition should include detailed terms and an approach for data collection to assess the outcomes of the mentor-protégé relationship.

We have found that a discussion of mentoring roles facilitates the development of an operational definition. In a workshop setting, participants are presented with multiple roles they may have, discuss what they mean to them, and provide examples for these roles:

> *Advising.* Guiding in areas of cross-functional expertise. Examples: selecting courses, reviewing short-term and long-term educational planning, and discussing time management.
>
> *Advocating.* Recommending or supporting the protégé. Examples: writing support letters for graduate school applications, serving as a reference for scholarship applications, and nominating the protégé for special recognition.
>
> *Facilitating.* Assisting to make processes easy to bring about an outcome. Examples: Guiding conversations in the classroom or laboratory, referring the protégé to a campus resource or office.
>
> *Mitigating.* Lessening the adverse effects of circumstances, undue burden, or mistakes. Examples: sharing tactics to deal with micro-aggressions, giving words of encouragement, and providing perspective to insensitive feedback.

Serving as a Model of Identity. Exhibiting positive personal and professional traits or qualities in activities that are characteristic of the profession (Nadelson et al., 2017). Examples: Giving credit where credit is due, balancing confidence and humility, and showing empathy toward others.

Motivating. Promoting curiosity, enthusiasm, and passion for goal attainment. Example: Showing excitement for research, encouraging the completion of a task, cheering on behaviors and accomplishments,

Sponsoring. Serving as a benefactor by providing financial support, educational materials or supplies, and career-advancing opportunities (Ayyala et al., 2019). Examples: Providing a stipend to compensate the protégé for participation in research, promoting the protégé at a networking event, and protecting the protégé from negative influences.

Tutoring. Providing one-on-one or small-group teaching with a specific objective in mind. Examples: Training on the use of instrumentation, discussing habits of effective learning.

Validating. Acknowledging protégés as valuable members of a learning community, capable of creating knowledge and being successful (Rendon, 1994). Examples: Affirming the value of diversity in higher education, acknowledging contributions, and celebrating accomplishments, successes, and honors.

Case Study

Specific cases that emphasize the roles of mentoring exist in the literature *(Flores, Boklage, and Appleford, 2002).* This case study describes the academic pathway of a young Hispanic woman who transferred from a community college to a research-intensive university to pursue a degree in engineering, which in her social circle is a coveted degree. The student's social network includes family, college peers, and a professor who eventually becomes her mentor. The mentor plays multiple roles sporadically and serves as a woman in engineering as a strong role model of identity for the student.

In our workshops, faculty participants provided their insights into the case study student's background and discussed similarities and differences to students whom the participants teach. Community cultural wealth was a topic of conversation stimulated by the stated perception in the Hispanic community that engineering is regarded as a rewarding career. The underrepresentation of women in engineering was another topic of conversation. For some participants, especially those who were unfamiliar with the role of community colleges in educating commuter students, this was a time to reflect on how most URM STEM students in the US start their college education.

After a couple of trials, we realized the importance of providing an institutional context to anchor the importance of mentorship, especially in minority-serving institutions that have a culture of "servingness" (Garcia et al, 2019). This should allow further conversations on the roles institutions play in valuing and rewarding outstanding mentors, as recommended by the National Academies.

Mentoring Phases

Experienced faculty and program managers who have run undergraduate research experiences may recognize that mentor-protégé relationships purposely evolve in identifiable phases. However, when the need arises in the workshop, it is important to highlight these phases to junior faculty and graduate students engaged in research. There may be variations to the list of phases but the following are generally accepted (Megginson et al., 2006).

> *Matching.* In this initial phase, the protégé is assigned to a mentor based mostly on academic discipline and research interests. Mentors and protégés are introduced to each other, often in a social event that welcomes participants and reminds everyone of programmatic goals.
>
> *Rapport Building.* Next, the mentor and protégé are allowed to develop a rapport that leads to mutual respect building, a general agreement on the purpose of the relationship, and expectations on both ends of the relationship.
>
> *Goal Setting.* In this phase, the mentor sets immediate and end-of-project research goals. The protégé should have an opportunity to discuss program expectations (such as professional development activities, poster development, and conference participation) and the type of support they can expect from the protégé.
>
> *Progression.* This phase is characterized by the most intense learning time interval for both the mentor and the protégé. An effective mentor will assist the protégé in focusing on reaching project milestones while responding to the protégé's needs. Specifically, this phase is a space for implementing inclusive mentoring practices such as establishing a safe environment, building confidence through validation, inviting people to raise and address issues from both perspectives and stimulating personal and professional growth and autonomy.
>
> *Bringing Closure and Moving On.* This is essentially the winding-down stage in which the protégé shares accomplishments and the mentor participates in celebrating what they have achieved. At this point, the mentor assists the protégé in reformulating their relationship collegially. In some instances, this may lead to a renewal of commitments where the protégé is encouraged to consider graduate studies upon completing their college degree.

Workshop participants were asked to reflect on these phases and discuss whether a mentoring agreement signed by both the mentor and the protégé would be a productive way to set goals.

Motivations We identified the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM) recipients and interviewed five in the summer and fall of 2022 (Boklage and Landgren, 2023). The format for the interview was fifty minutes of guiding questions with time for recommendations. Findings from these interviews identified the themes of intrinsic and extrinsic factors of mentoring.

> *Extrinsic.* These factors were motivations such as cognitive, esteem, and social needs, which can be influenced externally. Pursuing knowledge and understanding, self-esteem, status, prestige, being part of a culture, job security, and advancement can also be motivators.

Intrinsic. These factors were motivations by values or a need for self-actualization. This is understood as part of reaching one's full personal and professional potential.

All interviewees expressed an intrinsic motivation for their mentoring activities with an intense sense of satisfaction. Interviewees also expressed that their mentoring philosophies drew from personal experiences growing up and attending college. Following these conversations, we incorporated a workshop section to discuss intrinsic and extrinsic motivation factors in small groups and to report to the larger group.

Mentoring Philosophy Statements

Mentoring philosophy statements are living documents that allow mentors to define their intentions and beliefs in mentorship practice, share effective practices in engaging protégés, express intrinsic and extrinsic motivations to serve as mentors, and highlight outcomes as evidence of successful mentor-protégé relationships. Good mentorship philosophy statements tell a story, complement teaching philosophies, contribute to inclusion, and highlight broader impacts (UROP, 2024).

In our workshops, we asked participants to develop an outline for their philosophy statement and think about what motivates them to serve as mentors. At workshops for DoE researchers, we emphasized how mentoring aligned with their research's broader impacts and diversity statements.

Recommendations for Institutions

The National Academies Consensus Report (NAE, 2019) emphasizes seven recommendations for institutions supporting effective mentoring practices. Six recommendations are listed in Figure 1. The seventh recommendation focuses on the need to mitigate mentorship practices. Workshop participants selected a recommendation, discussed it in a round table format, and reported to the larger group. On more than one occasion, conversations converged on discussions about support and reward systems.

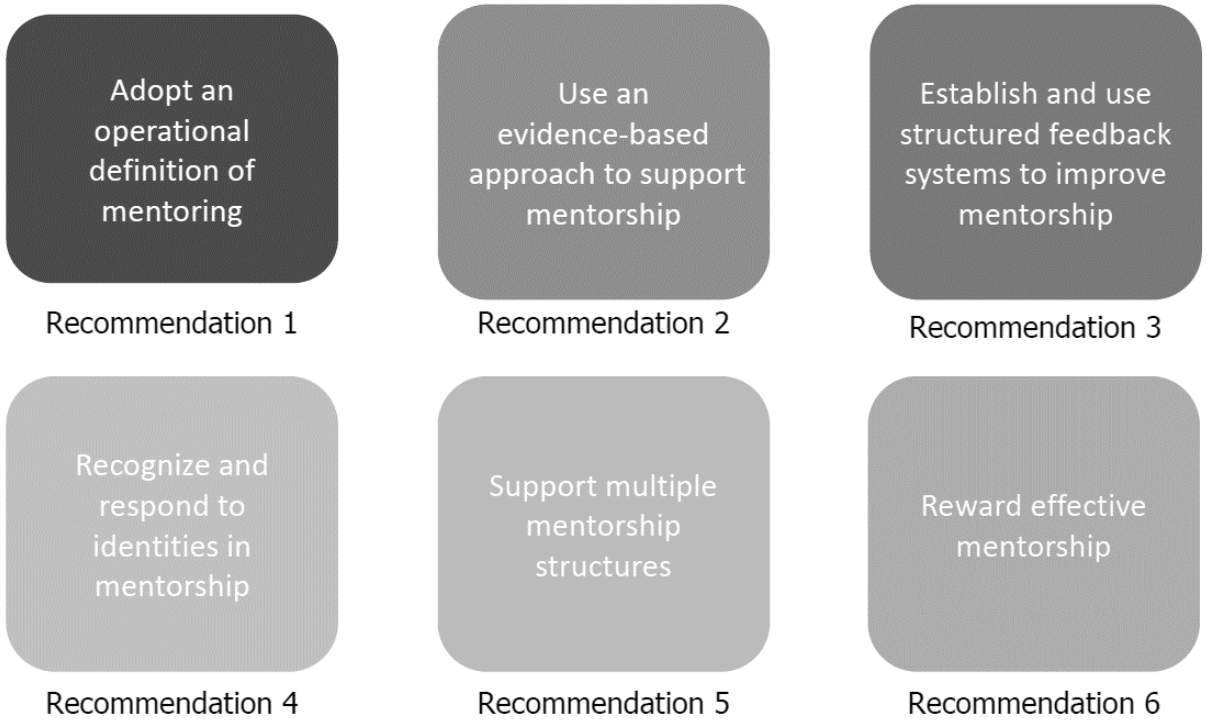

Figure 1. NAP report recommendations for effective mentoring

Challenges and Opportunities

We delivered the inclusive mentoring workshop nine times over the past two years and have identified both challenges in delivery and opportunities for improvement.

Balancing content delivery and exercises. First, the team recognized the importance of balancing the amount of content shared and opportunities to engage in the content through individual reflection and partner-group exercises. Feedback from the first workshops, while positive, asked facilitators to slow down and scaffold the delivery of the content. This resulted in a more refined focus on the content of the workshops, the definition of inclusive mentoring, and the details of the case study, rather than a deep dive into literature and background knowledge. Workshop participants also wanted to include opportunities and time to identify how the information learned could result in actions on their campus. The team then incorporated opportunities for individual reflection as well as opportunities to share as a group what these actions could look like on their campus.

Capturing the perspective of community college mentors. At four-year institutions, mentoring is commonly associated with undergraduate research programs that are externally funded. Institutional infrastructure is readily available to implement these programs, as they are an integral part of the institutional mission of advancing knowledge. At two-year institutions, however, institutional missions are much more focused on providing educational opportunities to local students who wish to pursue an education beyond high school. With a few exceptions, community college faculty seek external funding to develop new academic programs, improve curricula and teaching, or implement student-centered professional development programs, often in partnerships with four-year institutions. Community college faculty's two main responsibilities

are teaching and advising students. In this context, mentoring takes shape (Hensel, 2021). For instance, mentoring may occur in the classroom, the laboratory, and the office. In their classrooms, faculty uncover the hidden curriculum, introduce academic language, and promote the notion of students becoming scholars. In the laboratory, faculty become models of identity, tutoring their teams of students to think as scientists and learn techniques that they can use subsequently in a summer research experience. In the office, faculty explore assets, such as the drive and perseverance that students bring to the campus. Faculty are also likely to share their personal experiences, failures, and accomplishments as students in this space.

The workshops we conducted at two-year college conferences have given us insight into how the community perceives mentoring as an opportunity to improve the overall experience for students. Some facets of mentoring like tutoring, advising, validating, and motivating resonated with faculty participants. They also saw participating in these workshops as a professional development activity that served them well.

Graduate students as mentors. Graduate students, especially those working as teaching assistants or research assistants, are an obvious resource for undergraduate students who have contact with them in the classroom, laboratory, and other professional settings (Brown, 2016). Undergraduate students consider their graduate peers easy to engage, understand, and know. Faculty recognize this perception of proximity and often assign graduate students a supervisory role over junior students. This role can become a mentorship with its unique challenges, some of which spring from reduced age gaps, professional inexperience, and power differentials.

In our first workshop offering, we found that graduate students had enrolled as they learned about their assignment as a go-between for their faculty mentors and undergraduate students participating in summer research programs. Essentially, they saw the workshop as just-in-time training that assisted them in developing the confidence to answer questions and provide feedback to their junior peers. Because of this perceived need, we reviewed resources available through the Center for the Improvement of Mentoring Experience (CIMER), to better align our workshop to the needs of participating graduate students. The two main ideas that emerged from this exercise were the case study and the phases of mentoring.

Social wealth of mentors and protégés. It was clear from each workshop that participants recognized the importance of the social capital of both mentors and protégés. Mentoring is not a unidirectional relationship, meaning knowledge flows from mentor to protégé. Rather, an inclusive mentoring relationship is one in which both the mentor and protégé learn from and support one another in an iterative process. In the workshops, recognizing this and offering participants the opportunity to share this iterative learning process made the workshop an inclusive environment. With this recognition, graduate students and tenured professors could participate and offer insight into the workshop, as all forms of knowledge were welcome and recognized.

Familiarity with the US education system. In our conversations with college educators from other countries, we have found that many need to familiarize themselves with US higher education and the co-curricular opportunities for undergraduate students such as their participation in research experiences or internships. Thus, mentoring undergraduates over short periods appears as a novelty. Likewise, junior research faculty who earned undergraduate degrees abroad may need to be fully aware of undergraduate research programs and their benefit.

Conclusions

In this paper, we discussed the evolution of a workshop curriculum model to introduce faculty and future faculty to the concept of evidence-based inclusive mentoring. As we collected participant feedback and gained insight into how to deliver crucial topics, we incorporated elements with each workshop delivery to enrich the conversations and bring new evidence. Participants asked for case studies that are more inclusive and have well-defined institutional contexts. Conversations with DoE managers and researchers focused on matching mentors and protégés and, not surprisingly, the sense of accomplishment that bringing closure to the mentor-protégé relationship brought. In contrast, two-year institution faculty contextualized mentoring as a way to address community college student needs. Four-year institution faculty preferred discussing case studies as a means to unveil the nuances of the mentor-protégé relationship.

By designing and redesigning the workshop model, we better understood how they perceived inclusivity in their mentoring roles. The next phase of this project is to expand the workshop to incorporate training models. A workshop assessment survey and interview protocol are under development to formalize feedback from trainees. This assessment exercise will help us engage in a cycle of training optimization, enrich conversations among participants for better learning, and explore institutional resources and campus culture that promote inclusive mentoring.

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