



WIP: What does it mean to mentor? Conceptions of mentoring in K12 outreach programs

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Abstract

This work in progress paper investigates definitions of mentoring in K12 Science, Technology, Engineering, and Mathematics (STEM) outreach programs. Developing a better understanding of mentoring will add to the existing body of knowledge and may provide clarity on the purpose and scope of these programs. Semi-structured interviews were conducted with 19 current and past university student mentors and 8 outreach program coordinators representing six K12 STEM outreach programs at a public research university. Following initial questions, participants were asked, “How do you define mentoring?” Preliminary findings indicate that common themes on mentoring exist across students and faculty. Results from this pilot study will inform future studies and benefit K12 STEM outreach programs.

Introduction

With the ever-growing need for educated scientists and engineers in the workforce, there exists an opportunity for the recruitment and retention of underrepresented minorities (URM) in science, technology, engineering, and mathematics (STEM). High school demographics are not reflected in bachelor’s engineering programs, with African American, Latinx, and female students underrepresented [1]–[3]. Increasing diversity in STEM is a desirable asset; diverse groups show more engagement in active thinking and stronger academic skills [4]. Additionally, diversity in engineering “makes teams more creative, solutions more feasible, products more usable, and citizens more knowledgeable” [5, pp. 73–74]. The National Academies [4] list understanding the role of mentoring as a priority area of inquiry for improving diversity in STEM; however, this requires a rich and nuanced understanding of what mentoring means, since no single definition of mentoring exists.

The history of the term “mentor” stretches back to Homer’s *The Odyssey*, where the character Mentor was responsible for Odysseus’ son’s education and growth [6]. As the National Academies [7] observed, “in time, the term mentor came to refer to someone who is a guide and educator, and a mentoring relationship was seen as a relationship between a teacher and student” [pp. 33-34]. Over the past two decades, the concept of mentoring has shifted and is now seen as a reciprocal relationship between the mentor and the mentee in a specific field or pursuit. Definitions of mentoring differ across the literature; however, common themes exist (Table I).

Research on mentoring in STEM has found diverse benefits to the mentee and the mentor. In their study of an informal mentoring program for undergraduate women in STEM, Hernandez et al. [8] found that mentoring relationships with faculty strengthened students’ scientific identity. Lim et al. [9] studied formal peer mentoring in engineering and found that peer mentees gained support and insider knowledge of their department, and mentors gained communication and interpersonal skills. Dennehy and Dasgupta’s [10] research concluded that female peer mentors seemed to increase belonging, confidence, and motivation of female first-year mentees.

Mentoring can provide different functions, commonly separated into the categories of psychosocial support (i.e., encouragement, counseling, role modeling) and career / instrumental support (i.e., skill-building, evaluating, acknowledging achievements) [7, 8, 10]. Additionally,

mentoring can be either formal (structured / intentional) or informal (developed organically between the mentee and “a more experience[d] individual with whom the mentee has regular contact” [7, p. 37]).

TABLE I. LITERATURE DEFINITIONS OF MENTORING

| Definition | Source |
|--|-------------|
| “a collaborative process in which mentees and mentors take part in reciprocal and dynamic activities such as planning, acting, reflecting, questioning, and problem-solving” | [7, p. 35] |
| “a form of teaching where faculty members provide advice, guidance, and counsel in the areas of academic, career, and personal (psycho-social) development, which can occur either individually or in small groups” | [11, p. 48] |
| “a dyadic, hierarchical relationship between a more experienced person and an inexperienced person in a specific field” | [9, p. 396] |
| “a developmental relationship between a more experienced person...and a less experienced person...where the mentor’s aim is to support the protégé’s professional development and socialization in the profession” | [8, p. 2] |
| “Mentorship is a professional, working alliance in which individuals work together over time to support the personal and professional growth, development, and success of the relational partners through the provision of career and psychosocial support.” | [7, p. 2] |

Attributes of effective mentoring differ across the literature [11–13]. Meier [13] determined four defining attributes of mentoring related to nurturing, mentoring functions / roles, focus on professional / personal development, and the ongoing relationship. Haggard et al. [12] conducted a literature review that encompassed 124 workplace mentoring articles; they determined three core attributes of mentoring from approximately 40 different definitions: reciprocity, developmental benefits (to the mentee’s work / career), and regular / consistent interaction over time. Through examining mentoring using the model of academic persistence and career attainment, Pfund et al. [14] developed a “list of attributes, measurable objectives, and assessment metrics for effective mentoring” [p. S242] spanning domains of research, interpersonal, psychosocial and career, culturally responsive / diversity, and sponsorship.

Recently, the National Academies [7] presented a “starting point” definition of mentoring to provide guidance with the goal of promoting diversity in science, technology, engineering, mathematics, and medicine (STEMM) (see the last definition in Table I). This work in progress paper presents the results from one part of our pilot study that explores conceptions of mentoring in K12 STEM outreach programs at a public research university. Spurred by the directions of the National Academies, we aim to better understand if and how mentoring occurs in these programs through learning how participants in K12 STEM outreach programs define mentoring. This paper focuses on one research question from our pilot study:

How do university student mentor definitions of “mentoring” compare to those of faculty / staff program coordinators?

Theoretical Framework

To categorize participants’ definitions of mentoring, the research team utilizes Pfund et al.’s [14] attributes of effective mentoring relationships, which are “supported by the literature and suggested by theoretical models of academic persistence” [p. S238]. This framework was chosen because of the ample existing metrics and examples of measurable learning objectives provided, which can be mapped to experiences participants share in their interviews. The five domains

across which the attributes span also lend support for the choice of this framework. From the literature, a wide array of definitions of mentoring exist, such that utilizing a broad framework may capture aspects of the diverse definitions collected in this study.

Context

A single large flagship public research university provided the site for this pilot study. This institution offers many opportunities for undergraduate and graduate students to engage in K12 STEM outreach. The pilot study included six of these programs, which varied in characteristics (Table II). Programs mainly aimed to broaden K12 students' awareness of science and engineering and show them pathways to pursue these fields. Although no program included mentoring as a defined goal, relationships between K12 and college students were thought to include attributes of mentoring emerging through regular interaction and communication.

TABLE II. PILOT STUDY K12 STEM OUTREACH PROGRAMS

| Program ^a | Description | Program Coordinators Interviewed | Student Mentors Interviewed |
|----------------------|--|----------------------------------|-----------------------------|
| GK-12 | Ran for 17 years. Graduate students supplemented classroom learning with engineering-related activities in local K12 schools and led engineering afterschool clubs weekly during the academic year (AY) (Aug-May). | 2 ^b | 10 |
| CeTTi | Branched off of GK-12; ran for 12 years. Undergraduate students led STEM activities in weekly afterschool clubs for K12 students at local schools during the AY. | 2 ^b | 1 |
| J-P | Successor of GK-12 and CeTTi; started in 2019. During the AY, undergraduates lead weekly afterschool clubs focusing on engineering design for elementary school students. | 1 | 1 |
| BB-PaCK | STEM disciplinary-specific program that has run for 10 years. Undergraduate and graduate students facilitate weekly afterschool clubs for elementary and middle school students during the AY. | 2 | 3 |
| JAM-B | Program has run STEM summer camps for K12 students for over 30 years. Camps are 1 to 2 weeks long; utilize undergraduate and graduate students as camp instructors and teaching assistants. | 1 | 3 |
| RAd | STEM disciplinary-specific program. Undergraduates design and lead in-class activities during day-long outreach trips to urban and rural high schools during the AY. | 1 | 1 |

^a Due to its multi-institutional nature, GK-12 is identified by name. All other program names are pseudonyms.

^b One faculty member helped coordinate both GK-12 and CeTTi; they were interviewed on their experience across both programs and are therefore counted twice.

Methods

A narrative methodology was chosen with the aim of gathering student “stories” of experience in K12 STEM outreach programs. This methodology lies in the interpretivist social constructivism framework, which assumes that “understanding is gained by an active process of construction rather than by a passive assimilation of information or rote memorization” [15, p. 22] and people’s subjective experiences are analyzed through personal stories where facts and values are unseparated [15,16]. Semi-structured interviews were used to gather data. All methods were approved by the university’s Institutional Review Board (IRB) for human subjects research. Given that narrative interviews are commonly unstructured, the authors recognize that the semi-

structured interview format digressed from the target methodology and as such is a limitation of this study. The methods chosen therefore led to students providing individual stories of various disconnected experiences in K12 STEM outreach programs rather than a single, sequential narrative of their experience.

Eight university faculty / staff program coordinators and 19 undergraduate and graduate students were interviewed (some current program participants and others who had participated in the past); see Table II. All participant names are pseudonyms. Program coordinators were first asked to describe their programs, including logistics, goals, and college student recruitment and training; students were asked about their backgrounds and experience in their program. After these initial questions, the participants were asked, “How do you define mentoring?” Interview questions following this definitional question related to additional research questions beyond the scope of this paper.

Interviews were transcribed verbatim and responses to this question are being analyzed for themes. Two researchers are coding the data using the following method. Individually, each coder reads the interview transcripts and applies a priori codes based on Pfund et al.’s [14] attributes of effective mentoring to organize themes. To allow for emergent themes, each coder develops a second coding scheme using the constant comparative method, where emergent codes are “compared against other incidents for similarities and differences” [18], [19], [20, p. 9]. This method guards against bias. The coders also note instances of direct and indirect coding to reduce misinterpretation of interviewee meaning. After coding separately, the two researchers meet to discuss and resolve discrepancies using a negotiated process. Intercoder reliability and agreement will be calculated using the percentage of agreement between coders and the number of coding agreements after negotiation, respectively [18].

Preliminary Findings

Analysis of the interview data is ongoing; however, highlights from preliminary analysis are provided. Of the 27 participants, 26 provided definitions of mentoring. The definitional question asked aimed to promote thought and prepare participants for subsequent questions on mentoring; thus, answers to this question deviated from narrative data and instead offered insight into participants’ specific definition of mentoring developed in the moment. Both program coordinator and student participants exhibited this “in-the-moment” thought process when they struggled to define mentoring. Participants often recalled their own experiences as mentors and mentees while articulating a definition. Some described mentoring in general, others in an academic context, and still others in the specific context of their K12 STEM outreach program. Table III summarizes preliminary results, including codes and number of times they were mentioned by participants, based on Pfund et al.’s framework [14].

A few program coordinators and students included the attribute of “Developing a sense of belonging” in their definitions. Ken, a program coordinator for BB-PaCK, reflected on his experience as a mentee and thought that, “...mentorship in general, especially in the context of education, is really about...enculturation. So, I think it’s...about bringing somebody into a space that you occupy that they want to be in, in a way that helps them become part of the culture of that space.”

TABLE III. ATTRIBUTUES OF MENTORING RELATIONSHIPS IN PARTICIPANT DEFINITIONS [14]

| Code / attribute for effective mentoring relationships | Example measurable learning objective <i>Effective mentors can...</i> | Number of Program Coordinators | Number of Students |
|--|--|--------------------------------|--------------------|
| Developing a sense of belonging | Create a welcoming or inclusive environment, especially at transition points | 2 | 2 |
| Fostering independence | Continuously assess mentees' development and design increasingly challenging tasks and projects to advance mentees' independence | 2 | 3 |
| Listening attentively | Give their undivided attention and listen to both their mentees' words and emotion behind the words | 4 | 4 |
| Building relationships | Offer honest and open feedback on how the relationship is progressing | 3 | 8 |
| Teaching / guiding to learn disciplinary knowledge | Identify the knowledge mentees need to be successful in the discipline and guide them in learning that knowledge | 3 | 9 |

Holly, a PhD student in GK-12, included “Developing a sense of belonging” when she reflected on her experience “creating a welcoming environment” as a mentor, “[It’s] just kind of being like an unbiased safe space to provide support whether it’s about internships or classroom stuff...”

Bob, a PhD student in BB-PaCK, mentioned “Fostering independence.” He provided his definition from the point of view of being a mentor: “...you’re not giving explicit instructions, you’re more like letting the person sort of figure things out by themselves. But, as well as...giving guidance so they don’t get totally lost.”

Caleb and Arnie, two PhD GK-12 participants, emphasized “Listening attentively.” They viewed the mentor as a “sounding board” for students to either “vent their frustrations” or “get as much information as they could about specific topics,” respectively. Tanya, an undergraduate student in CeTTi, viewed this attribute slightly differently, “So my ideal mentoring relationship is, you know, have a mentee come and talk about their goals for the future, and any questions...”

Some students and a few program coordinators mentioned “Building relationships.” Some were indirect codes where participants mentioned aspects of building relationships. Celeste, a program coordinator for CeTTi, thought that “mentoring is when we form...a relationship with one or more other people...[and it] is just this lovely, beautiful exchange.” In contrast, Madelyn, a GK-12 master’s student, explicitly ended her definition by stating that a mentor is, “someone that builds relationships with whoever you’re mentoring so that they trust you and believe in you.”

A few program coordinators and most students mentioned how mentors teach / guide their mentees to learn a specific topic, which was coded as “Teaching / guiding to learn disciplinary knowledge.” Tina, a program coordinator for GK-12 and CeTTi, provided an example,

I think that a mentor is an individual who has...the ability and responsibility...to provide guidance to another individual through his or her expertise in a particular subject or task. So, for example, if it’s a mathematics mentor, they have an expertise in mathematics that the mentee needs to become better prepared or to succeed at something.

Ben, an undergraduate student from JAM-B, conceived “two different kinds of mentoring.” One kind included teaching and was mirrored in other students’ definitions: “you’re actually mentoring somebody on a specific topic and you as the mentor are the...not expert, but authority on that topic...it’s your job to guide your mentee to become better at that subject or topic or whatever.”

Ben’s second “kind of mentoring” included the idea of role modeling, an emergent code separate from Pfund et al.’s framework: “And then also there’s just the idea of in general being a...general role model and especially with kids being somebody who they want to...grow up to be or to grow up to emulate...”

Eight participants mentioned role modeling or setting an example; Ken provided specific examples of how his mentors are role models to him, “...both of these people mentor me sort of in different ways. Partially by...demonstrating what it means to be a thoughtful, pragmatic, caring supervisor, leader, scientists, those sorts of things.”

In contrast, Bobbi, a university staff member and “student” in BB-PaCK, saw role modeling in a more general sense. She softly and earnestly concluded her definition, “Just being an example of who you are at whatever phase of life you are, whatever your age, whatever your understanding. It’s just you’re setting an example of your best self for others to be their best selves.”

Another emergent code is the idea of mentoring as a reciprocal process, which was mentioned by two students. Maria, a master’s student from JAM-B, first mentioned how mentoring helps the mentee grow before expanding her definition, “...but also, it’s about you growing as a mentor as well. I think the focus and the purpose is helping your mentee grow, but you can’t help but grow as a mentor when you do this.”

Further analysis is ongoing. Transcripts are begin analyzed for all of Pfund et al.’s 21 attributes as well as for nuances within those themes. Coding for emergent themes is also ongoing.

Conclusions and Implications

Results from the larger pilot study may inform K12 STEM outreach programs by providing clarity on the purpose and scope of specific programs [21]; they may also provide support for university student participation in these programs, such that student retention can be impacted. Data from this paper’s research question can impact K12 STEM outreach program by shedding light on how program coordinators and university students define mentoring. Deidentified program-specific data shared with program coordinators can help provide direction for these programs, such that agreement on the role of the mentor may be reached to support mentoring practices. Although generalization of this research is limited by the contextual nature of K12 STEM outreach programs, results may also impact other mentoring relationships, such as faculty and peer mentoring.

Acknowledgements

The authors thank the participants for their time and participation in this study. They also thank the Center for STEM Learning and the Engineering Excellence fund at the University of Colorado Boulder for funding this research.

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