STEM faculty members and their perceptions of mentoring: "I do not want to be a role model"

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Abstract

Purpose – The purpose of this case study is to explore the perceptions of science, technology, engineering and mathematics (STEM) faculty members toward mentoring undergraduates.

Design/methodology/approach – Within the context of a student scholarship and faculty development project, funded by the National Science Foundation (NSF), STEM faculty members were interviewed at a small teaching-focused university in South Texas, United States. This research study utilized a qualitative case study approach based on semi-structured interviews with nine Mathematics and Computer Science faculty members. Transcripts were coded thematically, beginning with open coding and continuing with repeated rounds of comparison leading to the identification of four themes.

Findings – Four themes were identified in the data: describing settings where mentoring occurs, identifying the tasks of mentoring, developing skills for mentoring others and inhabiting the identity of a mentor. These findings suggest that increasing faculty engagement and effectiveness in mentoring STEM students may be a matter of broadening the definition of mentoring and helping faculty members develop the identity of a mentor.

Practical implications – In an effort to promote retention of students, specifically within STEM fields, many initiatives highlight the importance of faculty mentoring for undergraduate students. This research suggests that faculty members' perceptions of the role and structure of a mentoring relationship will shape this relationship and have an impact on student persistence and success.

Originality/value – While most studies of faculty–student mentoring focus on the experiences of students, this study explored faculty members' perceptions of that relationship.

Keywords Mentoring, STEM education, Faculty development, Undergraduate

Paper type Research paper

Within higher education, in general, and science, technology, engineering and mathematics (STEM) education, specifically, the challenge of supporting and retaining students is significant. Chen (2013) found that 49% of bachelor's-level students who began college pursuing a STEM field left the field within six years; of those seeking associate degrees, 69% who began in STEM left within six years. While Chen's findings indicate that these attrition rates are similar to other fields (e.g. humanities, education), attrition of STEM students, specifically, is frequently framed as a crisis (e.g. Belser *et al.*, 2018), leading to a shortage of skilled workers and a decline of competitive advantage on a world stage (Xu, 2016).

Mentoring is often held out as a strategy for facilitating STEM student success and improving retention (Hamilton *et al.*, 2019; Lisberg and Woods, 2018; Thiry and Laursen, 2011). Blake *et al.* (2017) decreed that "intentional, structured, intrusive, comprehensive research mentoring" (p. 6207) should be the "bedrock" of retention efforts for undergraduate

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minority STEM students. However, some reports (Amaya *et al.*, 2018) indicate that even in structured undergraduate research experiences, generally embedded in an assumption that novice researchers will be mentored, students may not be receiving beneficial input and guidance.

This may be a problem of definition. Amaya *et al.* (2018) used a very narrow definition of "mentor," while Banks (2010) broadly referred to mentoring as "a gift of time and resources" (p. 68) that might include many roles such as teacher, coach, role model and so on. The word mentor is used in a variety of ways, encompassing a wide range of activities, outcomes and expectations. While many STEM mentoring efforts occur in group settings (e.g. Kobulnicky and Dale, 2016; Russomanno *et al.*, 2010), we chose a definition that focuses on one-to-one mentoring because it reflects the frame of reference that participants in this study used as they discussed mentoring. Rather than outlining the breadth of definitions, we use Cohen and Galbraith's (1995) definition: Mentoring is "a one-to-one interactive process of guided developmental learning based on the premise that the participants will have reasonably frequent contact and sufficient interactive time together" (p. 5). This type of relationship may help the mentee move beyond "passive noninvolvement" (p. 6) to greater commitment toward their studies and career development, a disposition critical to student success and retention.

Although most research related to student mentoring highlights the perspectives of mentees (McCoy *et al.*, 2015), this study takes as its focus the perceptions of faculty members toward mentoring. We also explore the process of faculty development, specifically as it relates to faculty members growing as effective mentors. Furthermore, this study explores the issue associated with the definition of mentoring by examining how STEM faculty members perceive mentoring. After all, calling for "not only skills-based training but also socioemotional support and culturally relevant mentoring" (Haeger and Fresquez, 2016, p. 8) as a means of improving STEM mentoring (and, by extension, STEM retention) will only work if the prospective mentors (i.e. STEM faculty members) operate from a shared definition of mentoring.

Setting

CoastalU (a pseudonym) is a four-year, public institution in Texas with an enrollment of 4,501 for Fall 2019. The institution offers approximately 30 undergraduate majors and 23 master's-level programs. CoastalU is a Hispanic Serving Institution (38% Hispanic), and 64% of students are first-generation college students.

In 2018, the National Science Foundation (NSF) awarded CoastalU a five-year grant to provide scholarships and enhanced support services for undergraduate, low-income, academically talented students majoring in mathematics, computer science or digital gaming, with preference given to students from rural areas. As of Fall 2019, there were approximately 330 students enrolled in these three majors at CoastalU. The grant also provided for faculty development and training related to mentoring. Therefore, the research question driving this study was "How do STEM faculty mentors describe their personal and professional development as mentors?"

Literature review

For at least two decades, research has shown that mentoring could "foster academic competency . . . and academic integration" (Nagda *et al.*, 1998, p. 68). Nora and Crisp (2007) proposed that mentoring created support for undergraduates along four domains: psychological and emotional support, setting goals, supporting academic subject knowledge and providing role models. Mentoring relationships have been shown to foster self-efficacy and ease the transition to college (Crisp *et al.*, 2017), promoting persistence for Latinx students (Anaya and Cole, 2001), other underrepresented minority students (Chelberg and Bosman, 2019; Salto *et al.*, 2014) and students with disabilities (Sowers *et al.*, 2017).

Mentoring and undergraduate research

While some evidence suggests that "a mosaic of internal and external supports" (Blustein *et al.*, 2013, p. 60) is useful and necessary for promoting STEM student persistence and career development, much literature related to mentoring and the persistence of STEM students focuses on undergraduate participation in research. Given that Kuh (2008) identified undergraduate research as a *high-impact practice* for promoting student learning and retention, it follows that involving undergraduates in research would be a focus of research in STEM education. At the same time, many undergraduate research initiatives are grant-funded programs (i.e. externally funded) that carry an expectation of program evaluation and knowledge dissemination. Therefore, as Crisp *et al.* (2017) concluded, "It is not surprising to find STEM and undergraduate research programs to be overrepresented in the mentoring literature" (p. 32). STEM mentoring, therefore, may be broader (and less concentrated on undergraduate research efforts) than related literature suggests.

And yet, this literature does lend valuable insights into the role of faculty mentoring in STEM student retention and development (Jackson *et al.*, 2013). While Thiry and Laursen (2011) found that novice undergraduate researchers perhaps do need additional direction and clarification of tasks, they also noted that these experiences "broadened [the] future career and educational possibilities" (p. 771) of underrepresented minorities and women in STEM fields. Thiry and Laursen suggested that apprenticeship and mentoring helped emerging STEM scholars find their place within the larger scientific community of practice. Mentoring can help mentees to assess their developing skills as researchers and, as Byars-Winston *et al.* (2015) concluded, the mentoring process can also shape students' self-perceptions of themselves as scientists. Jin *et al.* (2019) created structured and scaffolded research mentoring experiences for undergraduates and found an increase in problem-solving and soft skills among participants; in addition, the program itself grew, retention rate doubled and time-to-completion decreased significantly. Undergraduates who were mentored as researchers also demonstrated a "more sophisticated understanding of the nature and construction of scientific knowledge" (Seymour *et al.*, 2004, p. 514) and a more nuanced understanding of a science career, as well as an increased likelihood of pursuing graduate-level education (Jackson *et al.*, 2013; Merolla and Serpe, 2013).

Mentoring and student socialization

Although much of the research related to faculty mentoring and STEM undergraduates focuses on undergraduate research experiences (Chang *et al.*, 2014), the mechanism by which mentoring shapes persistence is multifaceted. Wilson *et al.* (2012) found that because of a comprehensive mentoring strategy, students were more likely to persist as the intervention reversed academic decline, learned helplessness and erosion of self-esteem. In other words, the interactions with students preempted negative thought patterns and ineffective academic approaches in a way that promoted degree completion.

As Lechuga (2014) suggested, the norms of one's field are likely to shape perceptions of how mentoring is best conducted and what faculty members deem to be appropriate educational goals (Marbach-Ad *et al.*, 2019). Therefore, Lechuga (2014) continued, the idea of mentoring "may be a dynamic process grounded in one's socialization into their discipline" (p. 923). Likewise, mentoring itself may become a tool of that socialization (Brodeur *et al.*, 2017; Fuentes *et al.*, 2014). Fuentes *et al.* (2014) also found that students who communicate with faculty members earlier in their college careers are more likely to engage with faculty members as mentors. Griffin *et al.* (2010) demonstrated the positive impact of faculty mentoring on people of color who had themselves gone on to pursue faculty careers.

Developing a "science identity" (Pfund *et al.*, 2016, p. 242) may be a key outcome of mentoring and an important aspect of socialization into a particular discipline as it enhances retention.

Developing faculty members as mentors

Although the mentoring literature focuses on students' experiences, several studies have explored the relationship that faculty members have with mentoring activities (e.g. Mendez *et al.*, 2017). Within this literature, two key issues emerge: time and skills. Referring to its multifaceted nature, Kobulnicky and Dale (2016) highlighted several aspects of faculty work that hinder effective mentoring for undergraduates: overwork, disruptive travel schedules and mentees' lack of experience. The inclusion of an undergraduate researcher may well make *more* work for the mentor or slow down progress on a project when time is at a premium – especially for pretenure faculty members. In addition, Griffin (2012) found that potential faculty mentors may focus on the negative aspects of this investment (e.g. time, added responsibility, mentees' lack of experience) rather than the longer term payoff for the academic discipline. Griffin therefore proposed a shift in framing: Viewing mentoring as a "conceptual umbrella for a set of activities that come together in a variety of ways" (p. 31) might raise the profile of mentoring activities while simultaneously reducing the real and perceived burden of this engagement.

However, as Schneider *et al.* (2015) suggested, incorporating undergraduate students into research mentoring programs, even as early as their first year, would likely require a shift in the culture of the faculty members. Mentoring – even mentoring students as researchers – is likely to be classified as teaching or service, taking away from the research and publication that is often the key metric for faculty evaluation, promotion and tenure. Including mentoring as a critical standard for faculty evaluation may be the only way to raise the perceived value of mentoring activities. Faculty members who participate in mentoring are likely those who already value the "mutual benefits of collaborating with students" (Eagan *et al.*, 2011, p. 173) or those who feel the freedom to invest in mentoring relationships during a less intense time of the year (e.g. summer; Morales *et al.*, 2016).

Mentoring is a skill that develops over time (Hessenauer and Law, 2017). Faculty members must be given the tools to understand undergraduate learning needs (Goonatilake *et al.*, 2009) and learn how to "not coddle, but rather [guide] students through critical thinking about academic and life choices" (Cramer and Prentice-Dunn, 2007, p. 4). Faculty members may also find it challenging – especially when mentoring cross culturally – to understand "their students' multiple and complex intersecting identities" (McCoy *et al.*, 2015, p. 237), even as those students' identities are emerging and solidifying (Torres and McGowan, 2017; see also Santora *et al.*, 2013). Furthermore, faculty members may need coaching to develop realistic expectations of mentees and their skills (Lev *et al.*, 2010), especially if the setting or form of mentoring is unfamiliar (Kostovich and Thurn, 2006). However, while STEM faculty members may want training in order to become more effective mentors (Hund *et al.*, 2018), that sort of development is often not provided or valued (Ruben, 2020).

Mentoring can become more than the sum of its parts. Those who do it well may make it look easy, but it is a complex skill. While many assume the competencies of mentoring can only be learned as an outcome of acting as a mentor, Pfund *et al.* (2013) suggested that this is one of many mentoring myths. Pfund *et al.* (2006) demonstrated enhanced research experiences for undergraduates after mentors participated in training related to communication, diversity and mentoring approaches. Likewise, when Pfund *et al.* (2014) asked mentors to participate in an eight-hour mentor training, those mentors demonstrated positive gains on several measures of mentoring competency. In some cases, developing faculty members as more effective mentors requires small changes in approach. Russomanno

et al. (2010) found that simply encouraging mentors to informally network with prospective mentees before engaging in any structured mentoring activities may increase mentee participation in mentoring. Eagan *et al.* (2011) suggested that prospective mentors and mentees may each assume that the other party of the dyad should initiate the relationship, resulting in missed opportunities for mentoring relationships. Promoting mentoring, therefore, may simply be a matter of highlighting the impact that faculty mentoring could have on students and encouraging faculty members to take the first step.

Methods

The purpose of this study was to explore how STEM faculty members define their role as mentors when working with undergraduates. We wanted to "focus on learning the meaning that the participants hold" (Creswell, 2007, p. 39) about the mentoring they have experienced. Therefore, a qualitative approach allowed for the flexibility of semi-structured interviews with STEM faculty members, specifically related to their experiences as mentors. We anticipated this would require a "complex detailed understanding of the issue" (Creswell, 2007, p. 41) and therefore be fitting for qualitative inquiry. The research question driving this study was "How do STEM faculty mentors describe their personal and professional development as mentors of STEM students?"

Following Institutional Review Board (ethics) approval, we used a case study design to maximize what could be potentially learned (Stake, 1995, p. 4) about the interactions – mentoring and otherwise – between faculty members and students. As described earlier, "CoastalU" (a pseudonym) was awarded a grant from the NSF to provide scholarships and other supports (including mentoring) for incoming students in three STEM-related majors as well as training for faculty mentors. Therefore, this study is limited to that single institution. Beyond the confines of the grant, this narrowed scope of inquiry allowed for more intentional focus on our primary research interest in the hopes of gaining a nuanced understanding (Creswell, 2007) of the expression of mentoring between CoastalU STEM faculty members and students.

Researcher positionality

The first author of this article is a coprincipal investigator on the grant as "educational researcher" related to the knowledge-generation activities of the grant. In addition, she manages the logistics regarding recruiting scholarship applicants. She has a background in nonformal education, mentoring and faculty development. Although she maintains working relationships with study participants, she has no supervisory or evaluation responsibility for them. The second author brings a background in international education and counselor education; she joined the study after data collection was completed.

Participants and data collection

At the time of this study, there were six computer science faculty members and four mathematics faculty members. All participants were born outside of the United States, all but one earned their highest degree in the United States, and all are nonnative speakers of English. As part of the grant, the Mathematics and Computer Science (MCS) faculty members attended a two-day training related to mentoring and nonformal learning. In that training, the facilitator highlighted the importance of meaningful relationships between mentor and mentee as well as how learning in nonformal settings, such as mentoring, could augment classroom learning. Interviews took place two or three months after that training.

The first author of this article conducted face-to-face, semi-structured interviews with nine of the 10 faculty members. Participants completed an informed consent document, and the

interviews were conducted using an interview guide. Interview prompts included participants' educational history and career path, their experiences being mentored and their understanding of mentoring. In addition, participants were prompted to describe their perceptions of the skills that mentors need, in general, as well as what they perceived to be the particular needs of CoastalU students that might be addressed through mentoring relationships (see Table 1).

Interviews were conducted face-to-face; all interviews were digitally recorded and transcribed. Interviews ranged from 13 to 53 min, with an average of 31 min of interview time per participant. In the case of the shortest interviews, participants responded to open-ended questions with very short answers and did not elaborate when prompted further. For example, here is a section from the shortest interview.

> Interviewer: How would you describe yourself as a mentor? . . . What kinds of things do you do or what kinds of questions do you ask?
>
> Participant: We discuss the academic research projects.
>
> Interviewer: And how do you think those mentees would describe you? If I were to interview someone that you had mentored, what would they say about you as a mentor?
>
> Participant: If I'm present, they'll say "Dr. __ is great." They like me.
>
> Interviewer: Yeah?
>
> Participant: Yeah.
>
> Interviewer: Okay. Anything else they'd say?
>
> Participant: Well, we work—, we work on certain projects. And in the end, we get the project done.

In instances like this, the interviewer gave the participant several opportunities to expand on the answer, ultimately opting for a shorter interview rather than prompting the participant to elaborate further, which could have been perceived as coercive or badgering.

Data analysis, credibility and trustworthiness

Data analysis began with carefully reading and rereading transcripts to understand "behavior, issues, and contexts with regard to [this] particular case" (Stake, 1995, p. 78), specifically in participants' descriptions of their own experiences being mentored and mentoring others. The first author looked for "repeated patterns of meaning" (Braun and Clarke, 2006, p. 86) related to the research question while working through initial open coding. Clarke and Braun (2013) described this step as more than reducing the data; it is the beginning

Table 1. Participant background

Pseudonym*	Title	Subject area	Years at CoastalU
Anatolia	Assistant Professor	Mathematics	3
Khwarizmi	Assistant Professor	Computer Science	8
Touring	Associate Professor	Computer Science	9
Mary	Lecturer	Computer Science	8
Stevie	Assistant Professor	Mathematics	8
Chee	Professor	Computer Science	15
Sheldon	Assistant Professor	Computer Science	1
Ronaldo	Assistant Professor	Mathematics	9
Wang	Professor	Computer Science	15

Note(s): *Pseudonyms were chosen by participants

of the process of analysis. As suggested by Clarke and Braun, we "[generated] pithy labels for important features of the data" (p. 121) throughout all interview transcripts. Following this first round of coding, codes were arranged and rearranged into themes and subthemes to identify "coherent and meaningful pattern[s]" (Clarke and Braun, 2013, p. 121) in the data. We followed Clarke and Braun's suggested sequence of searching for themes, reviewing them to make sure the identified themes fit with the entirety of the data, and then defining and naming the themes to connect the themes with the data and with the other themes. Through this process, four themes, each with multiple subthemes, were identified in the data, described in the following section.

Creswell (2007) suggested several strategies for building trustworthiness within qualitative studies. He emphasized the importance of prolonged engagement with data; the first author spent extended time carefully proofreading interview transcripts before beginning formal data analysis. In keeping with Stake's (1995) discussion of triangulating various sources of data, the first author attended most of the two-day mentor training provided to CoastalU's MCS faculty members and interacted with the facilitator regarding her perceptions of participants' approaches to mentoring. In addition, while working with the grant, the first author has observed CoastalU's MCS faculty members interact with scholarship recipients, which provided another setting for clarifying how MCS faculty members perceive and position themselves as mentors. For example, during interviews, participants tended to focus on the role of faculty members in imparting knowledge and including students in research projects; when faculty members interacted with scholarship recipients at informal lunch sessions, they talked almost exclusively about their research interests and projects rather than exploring students' needs for and perceptions of mentoring.

Results

This study sought to explore how MCS faculty members at CoastalU conceptualized and enacted mentoring in their faculty roles. Through the data analysis, we identified four themes: describing settings where mentoring occurs, identifying the tasks of mentoring, developing skills for mentoring others and inhabiting the identity of a mentor. Taken together, these themes suggest that participants are likely more engaged in mentoring than they, themselves, are aware.

Theme one: describing settings where mentoring occurs

To better understand how MCS faculty members conceptualized mentoring, participants were asked to describe settings where they had been mentored or participated as a mentor. Two subthemes highlight a straightforward sense of mentoring as a relationship centered on the research process; two subthemes elaborate on teaching and nonformal interaction as places where mentoring happens.

When I was mentored. In each interview, participants described their own experience of being mentored. In all cases, these conversations focused on relationships with their thesis or dissertation advisors while in graduate school. As might be expected, these descriptions included a wide range of experiences, including references to both "good" and "bad" mentors. The quality of mentoring received was generally related to the responsiveness of the mentor in terms of answering questions or providing guidance. In their descriptions, participants outlined a mentor–mentee relationship that focused on research and acquiring the skills and knowledge of the particular discipline rather than broader personal or professional development.

Mentoring = research. When participants described mentoring and mentoring activities, their responses focused, almost exclusively, on training students as researchers, with little

discussion of broader student development or professional development. When asked what CoastalU students might gain from being mentored, Anatolia indicated that they would gain an introduction to research "at the basic level." He continued by saying that mentees might "sort of learn what kind of things they can expect in their future career if they choose to do research." Other participants expressed similar definitions of mentoring; this happened so consistently that the first author wrote "mentoring = research" at several points in her field notes in response to participants' comments about mentoring (c.f., Santora *et al.*, 2013).

Teaching as mentoring. Although direct responses about mentoring focused on research, participants did share vignettes demonstrating the high value they place on imparting both course content and life lessons as they teach. Khwarizmi recounted a conversation with a student who was having a hard time staying awake in class, indicating that the ensuing conversation about sleep habits and time management led to better class participation for the student. Ronaldo talked about how he enjoyed teaching first-year seminars. He said "that also can be considered mentoring" because "it gave me a lot of time to talk to students ... about time management, setting goals, [and] taking notes," unlike the content-driven lower division mathematics classes he generally taught. Likewise, Stevie shared that he deliberately includes stories about how he struggled as an undergraduate student to help students see him as approachable and available to answer questions.

Mentoring happens outside the classroom. As participants talked, they described their interactions with students in ways that suggested broader engagement as mentors than they might have identified in themselves. Khwarizmi described the "small talk" that happens at the beginning or end of a tutoring session as "what opens the mentoring side" of the conversation. Wang indicated that interacting with faculty members in this way can help students understand "how to achieve success [to] go out to use your skill to find a job ... and how to be a good, successful worker for a company, for their field."

Theme two: identifying the tasks of mentoring

As outlined in the literature review, mentoring is a multifaceted endeavor. This second theme captures the scope of mentoring. Subthemes outline three distinct tasks of the mentor.

Scaffolding student knowledge. Participants described mentoring as a place of learning content-related skills. Wang suggested that students who work with faculty members "in any research project, even a minor one" would likely identify shortcomings in their knowledge and become motivated to practice, learn and search for answers. Mentoring may also provide an opportunity to nudge students beyond their own expectations. Anatolia indicated that mentors from his own undergraduate and graduate experience had pushed him to think about "quite complicated stuff" in a way that sparked his desire to pursue additional levels of knowledge. One of the key outcomes, therefore, of mentoring is nudging students past limits they have (consciously or unconsciously) set for themselves. As Sheldon stated,

> Mentoring is showing them that they can do things that they believe they cannot. I think that's—for me—the most important thing. We have students here that say, "Oh because I came from this community, [from this] social background, I cannot do." And when I bring them to the group, I say, "Yes you can do it. Here's what you can do."

The end result, as one of the participants (Touring) indicated, is that students who are mentored "may set higher goals and work harder to achieve more."

Passing on life skills. Participants indicated that interactions between mentor and mentee could help students learn time management (described by Mary as "the number one thing they need") and "soft skills," such as teamwork, working in diverse groups and communicating effectively that would serve them well as they moved into professional

career settings. Stevie suggested that "sometimes [students] need a healthy dose of criticism but sometimes you need to compliment." Mentoring, therefore, could be a setting where students learn to respond well to criticism in a way that – as Stevie suggested – might increase the student's motivation.

Developing problem-solvers. It is perhaps not surprising that MCS faculty members would highlight problem-solving skills when discussing mentoring. After all, these fields revolve around identifying problems and solving them. Mentors, therefore, as Chee described, help mentees "learn the whole process" by breaking big projects into smaller, solvable tasks. For Sheldon, who teaches digital gaming and simulation, his role as a mentor for students involves challenging them to think about the problem itself differently:

> [We] work in the creative business . . . you should not be afraid of trying. You know that's the most important thing. We should not be afraid of trying. Yes, you are going to fail a lot of time. But failing is the sense of just learning something that does not work. So try again in a different direction. . . . In the end, they understand that the problem was not the problem. The problem was their idea about the problem. Their understanding. The way they are seeing the problem.

In other words, finding the solution is only part of what mentees need to learn; they also need to become better problem-solvers.

Theme three: developing skills for mentoring others

The third theme emerged from participants' discussions of the skills and dispositions necessary to become effective mentors. This theme highlights what mentors should know, be or do; these topics were also points of discussion during the mentor training provided to participants (described earlier).

What the mentor should know. Throughout the interviews, participants highlighted the centrality of content knowledge as critical to being a mentor. Touring stated it simply: "A mentor certainly needs to understand his subject," and Wang said, "If you want to mentor some people on this subject, you have to be knowledgeable on this subject. That's for sure." At the same time, Sheldon suggested that "things progress so fast" – especially in a technological field – that a student/mentee might know something that the mentor does not know. In that case, the mentor is "not the owner of the truth," and the student might be right in trying something different from what the mentor suggested. He continued by saying, "If you are rigidly providing students with this one single idea, you'll never know what you can come up with trying different things." For these participants, the mentor should definitely have content knowledge, but they also need to demonstrate flexibility and humility to acknowledge incomplete knowledge.

Who the mentor should strive to be. Participants shared vignettes from their own experiences when discussing the dispositions that mentors should have, indicating that one could develop as a mentor by learning from both good and bad examples. In addition, participants indicated that while some aspects of being a mentor may be innate, mentoring skills could be developed. Mentors need to be present, to show up, to engage with students and to be attentive to their needs. Stevie is the faculty advisor for the campus mathematics club. His approach to advising was "go there and I'll just show up and that's pretty much it." Being present – and bringing donuts, he added with a laugh – demonstrates that he is "really supportive" of the students' efforts, and he indicated that he was impressed with the events the club had planned for the good of the university, such as sponsoring a drop-in mathematics tutoring session before finals week each semester. Ronaldo described this aspect of being present as "go there and give it attention and say, 'Well, I care about you.'"

What the mentor should do. Participants' descriptions of the actions and activities in which a mentor should participate were relatively straightforward: communicate effectively, create rapport and exercise patience. Chee described the importance of scaffolding expectations with students: "Don't try to expect that they could do something [as undergraduates] like lots

of master's [students] . . . especially for the undergrad student, you need to be patient and encourage them through the whole process." Stevie discussed the importance of letting students find their own way, especially in the context of advising the mathematics club, stating that if students do not like a particular idea, it does not matter if the advisor thinks it is a good thing. A good mentor and advisor should "let them figure it out and do the work."

Many participants talked about the importance and challenge of creating momentum for the students, especially when the students did not take advantage of the available resources. Participants indicated they did this by displaying their own passion for the material and scaffolding students appropriately. Both Anatolia and Khwarizmi described the necessity – at times – of giving a "little push" to get students moving in the right direction. Sheldon also noted that the "crazy kids," the ones who forge ahead even when "you tell them 'you cannot push this button,'" are important to mentor and nurture because they are often the ones who will be able to focus on possible solutions, not just problems. Chee also highlighted the importance of knowing students' interests so that the mentor "[does not] ask people to do the things they do not like" as a key to improving student motivation.

Theme four: inhabiting the identity of a mentor

As described earlier, being an effective mentor necessitates that the mentor develops skills such as listening and challenging students. This was also a topic during the mentoring workshop described earlier. Subthemes highlight how mentoring shaped both personal and professional identity for these MCS faculty members.

Am I approachable?. Both Anatolia and Wang highlighted the importance of being approachable and available to respond to students. Along these lines, Sheldon described adopting a casual style of dress to break down barriers in the classroom. Khwarizmi noted that most faculty members are "implicitly intimidating." He went on to indicate that his wife (Mary, also a participant in this study), who teaches primarily freshmen in the introduction to technology class, "does a way much better job than I [do]" with engaging entry-level students "because she has that tolerance level." He continued, "I see the interactions with her students. Everybody gives her a hug, [saying] 'I love you Mrs. [Mary].' Nobody's told me 'I love you.'" These responses suggest that these MCS faculty members recognize the inherent distance between faculty members and students. At the same time, participants described efforts to understand and reduce that distance and become more approachable to students.

What is my purpose?. Beyond skills, participants talked about mentoring in ways that speak to taking on an identity as "mentor." Participants were reflective about what this meant. One participant described himself as "intimidated by mentoring." To manage this, he intentionally limited the scope of his influence to only his academic discipline rather than larger issues of life or personal development. Khwarizmi, who clearly stated, "I'm not doing this [teaching in at a university] for the money," described his role as an educator and mentor in this way:

> You have to be thankful and you always have to give others. That is my idea, and that's basically why I am in [the] academy and not in the industry. I feel that I have that public servant in me. Because I was blessed with the gifts that I have.

Teaching and mentoring, therefore, is a vocation, inhabiting the identity of public servant. Working with students is a way to work for the betterment of society.

Should I be considered a role model?. Other participants were reticent to take on the identity of mentor or role model. One participant described it as an "intimidating" idea. Mary was careful to highlight that not all "smart people" are good mentors, and another participant indicated they did not have the "personality" to be an effective mentor. Perhaps most notable was Stevie's strong resistance to the suggestion that he was a role model for students. He said,

> Yeah that's weird. Personally, I do not want to be a role model to anyone else. I'm still figuring out how to live myself. I hate that idea. . . . Do you really want to copy the whole thing from all [one] person?—oh that is a dangerous idea. Don't do it. . . . When someone says, "You're my role model. . . ." Oh, don't—, do not do that. Yeah. My life is quite messy.

As indicated earlier, other participants described themselves as "specialized mentors"; while they may acknowledge expertise in one particular area, they were not completely comfortable with serving as a comprehensive mentor for students. Perhaps this resistance is a good thing; participants were unconsciously modeling for students the importance of setting boundaries in healthy relationships rather than insisting on unchallenged allegiance.

Discussion

As McCoy *et al.* (2015) highlighted, most mentoring research focuses on the needs and experiences of students in faculty–student mentoring. This study explored the other side of that dyad, soliciting the perspectives of faculty members related to mentoring, specifically in the context of STEM faculty mentoring STEM students. Participants in this study had received two days of training around concepts of mentoring and nonformal education, and research interviews were conducted two to three months following that training. As described earlier, we identified four themes in the data. Based on these themes, promoting STEM faculty members engagement in mentoring may be a matter of definition and development.

Being a mentor: a matter of definition

When asked directly, "What mentoring have you done?" most participants indicated they had not engaged in any mentoring with students. However, as highlighted in the first two themes, when participants talked about their interactions with students, they described a number of interactions and relational patterns that most would describe as "mentoring." Wang's computer classes for high school students, Ronaldo's "mathemagic" presentations, and Khwarizmi's "small talk" while tutoring students all serve the purpose of developing students. Stevie makes it a point to be present for the mathematics and science club meetings and is available to help them plan events while also letting them figure things out on their own. These CoastalU STEM faculty members are definitely involved in "guided developmental learning" (Cohen and Galbraith, 1995, p. 5) in a variety of settings. And yet, for the most part, participants did not describe themselves as mentors or role models.

Perhaps the key to engaging more faculty members in mentoring relationships is to broaden faculty members' perceptions of mentoring, highlighting the importance of short-term relationships or lower impact interactions. At the same time, as Hund *et al.* (2018) indicated, mentoring requires "many different roles" (p. 9965), so it may be helpful to emphasize to STEM faculty members that mentoring undergraduates need not follow the patterns of an advisor providing an intensive research apprenticeship for doctoral students. Additionally, Higgins and Kram (2001) highlighted the important role of an individual's "developmental network," which encourages a mentee to think of those who are "taking an active interest in and action in" (p. 267) their growth as part of a mentoring resource, rather than focusing on the input of only one individual. Therefore, while Nora and Crisp (2007) identified four dimensions of mentoring relationships (psychological/emotional support, goal setting and career paths, academic subject knowledge support and role modeling), one mentor need not fulfill all of these dimensions. In fact, it may not be ideal (Higgins and Kram, 2001) and could potentially be harmful if the mentee begins to idolize the mentor.

A more granulated and fine-tuned definition of mentoring may also increase faculty members willingness to participate in mentoring initiatives. Faculty workload and time

restrictions are often a key hindrance to engagement in mentoring (Griffin, 2012; Kobulnicky and Dale, 2016; Ruben, 2020), and this may be particularly true for STEM faculty members who are leading large grant-driven research labs. A multifaceted definition of mentoring – beyond the working definition of "mentoring = research" as generally articulated by participants in this study – may also encourage faculty members to more accurately discern the developmental needs of students and more effectively guide the students to the resources they need. Likewise, defining mentoring more broadly and precisely may help faculty members identify mentoring interactions with students and "get credit" for mentoring as a teaching and/or service activity for annual performance evaluations and tenure reviews.

Becoming a mentor: a matter of development

There is a fundamental question raised by the third and fourth themes: Is being a mentor something one *does* or something one *is*? If mentoring is an *action*, then the skills and actions can be learned. Helping someone develop the *identity* of a mentor may require a more nuanced approach.

Participants in this study seemed comfortable with their understanding of what a mentor does. Several highlighted the importance of content knowledge; a mentor can only be effective if they know what the mentee wants to learn. At the same time, Sheldon highlighted the importance of maintaining the posture of a learner and letting mentees try things that might be unpredictable, saying, "You'll never know what you can come up with." Likewise, Ronaldo highlighted the importance of showing up: "Go there and give it attention" and in the process demonstrate care and concern. For these participants, becoming a better mentor began with acknowledging the importance and effectiveness of these seemingly simple activities. This attention to the smaller components of mentoring moves in the direction of Griffin's (2012) suggestion to view mentoring as a "conceptual umbrella for a set of activities" (p. 31). Furthermore, as Cramer and Prentice-Dunn (2007) and Goonatilake *et al.* (2009) suggested, helping faculty members understand how undergraduates learn and develop skills like critical thinking may lead to deeper engagement with mentees at the point of their immediate needs.

In this study, participants talked about mentoring in terms of the activities they engaged in, rather than speaking of it as an identity they embraced. Stevie, for example, strongly resisted being referred to as a role model because of his "quite messy" life. Others actively limited their mentoring to a particular element of expertise, primarily knowledge related to their academic discipline. Promoting informal engagement with mentees (Eagan *et al.*, 2011; Russomanno *et al.*, 2010) may be one way to shift the mentor's mindset from one of "doing" to one of "being."

Limitations and future research

This is a small, qualitative study conducted at one institution in the South United States. As such, these findings are not broadly generalizable. In addition, the composition of the faculty members (e.g. all participants being born outside the United States) may shape participants' mentoring in a way not readily apparent to researchers. For example, while there are many forms of mentoring noted within the literature (e.g. small group mentoring, informal mentoring; c.f., Kobulnicky and Dale, 2016; Russomanno *et al.*, 2010), our participants tended to speak only in terms of one-to-one mentoring, abridging this discussion of mentoring between STEM faculty members and STEM students. Furthermore, several interviews were shorter than typical in qualitative research despite prompting participants to elaborate; these concise responses potentially limit deep understanding of participants' development as mentors.

Participants in this study were all STEM faculty members. Future studies should explore the perceptions of mentoring held by faculty members in other disciplines. This may also

allow for exploration of how training that faculty members receive in the context of their academic disciplines shapes their eventual understanding of mentoring. In addition, the MCS faculty members interviewed here teach primarily undergraduate students; future studies could investigate the perceptions of STEM faculty members working primarily with graduate students.

Conclusion and implications

As suggested in the STEM education literature, there is a critical need to promote STEM student retention and success (Belser *et al.*, 2018; Xu, 2016). This case study of STEM faculty members suggests that simply telling faculty members to "do mentoring," as if it were a task on a to-do list, will likely miss the mark. Improving the efficacy of STEM faculty members as mentors begins with creating a shared definition of what is meant by the term mentor. In many cases, frameworks already outlined in the literature (e.g. Nora and Crisp, 2007) can serve as a helpful starting point. However, a mentoring initiative is likely to be more broadly effective if would-be mentors create a context-specific shared definition of mentoring. In that way, the idiosyncrasies of the institution (e.g. requirements for promotion, available resources) will be reflected in the expectations placed on faculty mentors. Without these shared definitions, training efforts and mentoring initiatives are likely to fall short of their potential. This may need to be a recurring conversation; a mentor's understanding of their role will likely emerge as they work with students in this way.

Many institutions are quick to claim that "our faculty are our greatest resource." If faculty mentoring is a pathway to increased student retention (e.g. Chelberg and Bosman, 2019; Crisp *et al.*, 2017), the findings here suggest the importance of helping faulty members *be* mentors and the value of encouraging them to *become* mentors who can be the resource students need. Helping STEM faculty members develop a more nuanced understanding of mentoring can support those who wish to work with students in this way. Promoting a broader definition of mentoring can encourage those who "do not want to be a role model" that there are many ways to mentor and support STEM students. Success in STEM fields is driven by the development of problem-solving skills; faculty members experience and expertise extend far beyond what can be conveyed in a classroom setting. Therefore, faculty members who do not embrace the possibilities of mentoring as an integral part of their faculty role effectively truncate their students' learning and preparation for their chosen fields. If developing a "science identity" (Pfund *et al.*, 2016, p. 242) is a key outcome of a STEM education, then developing the "mentoring identity" of STEM faculty members is imperative.

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