

‘Beacons of light’: Peer Mentors’ Experiences in An Online STEM Peer Mentoring Program

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Peer mentors' experiences in an online STEM peer mentoring program: "beacons of light"**Abstract**

Purpose: Racially and ethnically minoritized women continue to be underrepresented in science, technology, engineering, and mathematics programs and careers. Peer mentoring is one strategy that can support their participation. This study explores the experiences of Black women peer mentors in an online peer mentoring program at two historically Black institutions.

Design/methodology/approach: A qualitative case study approach was utilized to explore the impact of an online peer mentoring program on peer mentors' STEM self-efficacy, sense of community, STEM identity, and intent to persist in STEM.

Findings: Analysis identified five themes relating to peer mentors' experiences in the program: (a) an "I can do this" approach: confidence and self-efficacy, (b) utility of like others, (c) "beacons of light": intersecting and malleable identities, (d) skills development, and (e) motivation and reciprocity. Further, challenges of the online relationship were shared.

Originality/value: The study contributes to the body of knowledge by demonstrating the utility of an online peer mentoring model among women mentors enrolled in STEM programs at two historically Black institutions. The findings support those who are historically marginalized in participating in and remaining in STEM.

Keywords: STEM, peer mentoring, racially and ethnically minoritized women, HBCU

Introduction

A diverse science, technology, engineering, and mathematics (STEM) workforce is imperative if the projected needs of the nation's economy are to be met. Currently, the "demand for a larger STEM workforce continues to outpace supply" (Gasman *et al.*, 2017, p. 181) despite efforts to increase participation in STEM degrees and careers. Inequitable representation among genders, races, and ethnicities continues to serve as a barrier to fully capitalizing on the nation's available pool of talent. Specifically, women, including those who simultaneously identify as racially and ethnically minoritized (REM) women, continue to be underrepresented (National Science Foundation [NSF], 2021). Research suggests that mentoring is one strategy for encouraging and supporting the participation of women, including those who identify as REM, in STEM (see Daniels *et al.*, 2019; Haeger and Fresquez, 2016; Ko and Zhadko, 2022; National Academies of Sciences and Engineering [NASEM], 2019; Prunuske *et al.*, 2016; Rockinson-Szapkiw, Herring Watson *et al.*, 2021; Rockinson-Szapkiw, Wendt *et al.*, 2021; Saffie-Robertson, 2020; Wilton *et al.*, 2021). Mentoring is "a process in which an experienced individual (a mentor) provides emotional and psychosocial support (e.g., listening, empathizing, offering advice, providing affirmation or an objective perspective), and helps to educate, guide, and counsel a less experienced person" (Mondisa and Adams, 2022, p. 339). Peer mentoring, defined as "a reciprocal, dynamic relationship between or among peers where one peer is usually more skilled or experienced than the other" (Rockinson-Szapkiw, Herring Watson *et al.*, 2021, p. 268), has shown promise in broadening participation in STEM. Online mentoring is defined as "mentoring in which all or most of the experience takes place utilizing online technology" (Rockinson-Szapkiw, Wendt *et al.*, 2021, p. 174). Further, historically Black colleges and universities (HBCUs) within the United States (U.S.) traditionally carry out the mission of providing a welcoming and culturally supportive environment to REM students, with a specific focus on Black students. The current study explores the implementation of an online peer mentoring program and the impact of participation among REM women peer mentors enrolled at two HBCUs.

Literature review

There exists a need for interventions and supports that broaden the diversity of individuals interested in and engaging in STEM degree programs and careers (Haeger and

Fresquez, 2016; NASEM, 2019; NSF, 2021; Wilton *et al.*, 2021). Mentoring programs have consistently served as one effective strategy, especially during the early years of the post-secondary experience (Haeger and Fresquez, 2016; NASEM, 2019; Wilton *et al.*, 2021). It is during this time that the highest attrition occurs, with a disproportionate number of first-generation college students and REM students leaving STEM degree programs. The disparity in representation, including higher attrition rates among those historically underrepresented in STEM, “leads to a loss in diversity in STEM fields that must be addressed” (Wilton *et al.*, 2021, p. 1). While there are many reasons that students may elect to leave STEM degree programs, “retention in STEM relies on student social integration, fostered interest, and self-efficacy” (Wilson *et al.*, 2021, p. 2). Mentoring can decrease the persistent underrepresentation of women in STEM (Chan, 2018; Francis and Askew, 2022; NASEM, 2019; Mondisa and Adams, 2022; Pon-Barry *et al.*, 2017; Saffie-Robertson, 2020; Stoeger *et al.*, 2019).

Haeger and Fresquez (2016) found that mentoring increases confidence, research skills, academics, and professional skills. Mentoring also supports “higher levels of positive career outcomes such as career planning, career involvement, income, and promotions” (Saffie-Robertson, 2020, p. 567). Mentoring may assist in mitigating challenges created due to work–family conflict – more commonly experienced by those identifying as women than men. However, the need for mentoring models that attend specifically to “socioemotional support and culturally relevant mentoring” (Haeger and Fresquez, 2016, p. 8) has been highlighted (Chan, 2018; Pon-Barry *et al.*, 2017), especially as it relates to supporting women in STEM.

In one study, researchers interviewed 36 women in managerial positions in STEM fields to determine the factors that allowed mentoring relationships to flourish (Saffie-Robertson, 2020). Three factors were identified: fit, commitment of the mentor, and trust. These factors facilitated personal connection, which was essential for mentoring relationships to be “comfortable and authentic” (Saffie-Robertson, 2020, p. 2). Having similar values, worldviews, and cultural backgrounds assisted in facilitating personal connection. When fit was satisfied, trust could develop naturally. Tying into the need for trust, mentors must have demonstrated commitment for the mentoring relationship to grow.

Given the dearth in women role models in STEM (Olson and Riordan, 2012), peer mentoring has received increased attention. Online methods for mentoring have shown promise as they transcend the geographic barriers inherent to traditional mentoring approaches and allow

flexibility in the face of competing commitments (Ko and Zhadko, 2022; Stoeger *et al.*, 2019). Research has demonstrated that online peer mentoring can support the development of interest in STEM, STEM self-efficacy, and persistence in STEM among peer mentors (Rockinson-Szapkiw, Herring Watson *et al.*, 2021; Rockinson-Szapkiw, Wendt *et al.*, 2021). Research has shown the need to train mentors in effectively supporting mentees – particularly those who are historically underrepresented in STEM (McGee, 2016; Pfund *et al.*, 2016). However, there remains a need for research to determine the efficacy of online peer mentoring programs, especially those that attend to psychosocial support, cultural responsiveness, and the development of mentoring skills among REM women.

HBCUs

HBCUs have been instrumental in supporting the success of students of color – especially Black students (Kendrick *et al.*, 2013; NSF, 2021). Being surrounded by peers and faculty of the same race can lead to increased student success (Gasman *et al.*, 2017). HBCUs have the potential to foster community and sense of belonging among those who have been historically underrepresented in STEM. This underrepresentation, though, extends beyond that of race and ethnicity and may also include individuals who are deemed non-traditional students and first-generation college students (Prunuske *et al.*, 2016) – both of whom comprise a significant portion of students enrolling in HBCUs (Gasman *et al.*, 2017) and tend to experience the highest rates of attrition (Wilton *et al.*, 2021). To support REM women in STEM – especially Black women – it is imperative that studies focus on what works within the context of HBCUs. Currently, research that examines the experiences unique to students enrolled in HBCUs is still lacking (Gasman *et al.*, 2017).

Conceptual framework

The online peer mentoring program that is the focus of the current study is grounded in several research theories and conceptual frameworks, including Tinto's (1975, 1987, 1993) institutional departure model, Tinto's (1975) integration framework, Bandura's (1977, 1997) theory of self-efficacy, and Lent *et al.*'s (1994) social cognitive career theory (SCCT). Tinto's institutional departure model surmises that individuals possess personal attributes (e.g., gender, race, ethnicity, and culture), familial backgrounds (e.g., socioeconomic status, parental education levels), and past experiences (e.g., academic, socio-emotional) when entering an institution of

higher education. The confluence of these personal attributes will influence students' ability to integrate into both the academic and social realms of their institution. Lack of integration in either realm – academic or social – may lead to low commitment, lower levels of persistence, and a reduced sense of belonging (Tinto, 1975).

Tinto's integration framework (1975) also applies to mentoring (Wilson *et al.*, 2021). Tinto supports the idea that students who are integrated into the campus environment, including their specific program, may experience an increased likelihood to persist. "Feelings of integration often contribute to greater satisfaction with and commitment to the university, both of which influence student retention decisions" (Wilson *et al.*, 2021, p. 2). Mentorship supports integration by providing psychosocial, instrumental, and academic support, which may lead to increased integration. Individuals' perception of competence is enhanced when experiencing psychosocial support, in turn facilitating personal and emotional development (Wilson *et al.*, 2021). Instrumental support is provided through resources that encourage engagement, development of a sense of belonging, and goal achievement. Academic support is provided when individuals gain content-area knowledge, develop career skills (e.g., goal setting), and obtain advice related to their career path.

SCCT (Lent *et al.*, 1994) supports the idea that the value placed in a discipline – in this case, STEM importance (Clark *et al.*, 2016) – contributes to an individual's persistence in STEM and motivation to engage in STEM and leads to a higher likelihood of sustained engagement in STEM. When individuals are provided with opportunities to engage in STEM, they are also presented with opportunities to attempt new tasks, contributing to mastery experience. This contributes to an increase in STEM self-efficacy and sense of belonging (Bandura, 1977, 1997). Sense of belonging, though, is "not equitably experienced among all groups" (Johnson, 2022, p. 60).

STEM self-efficacy (Bandura, 2006; Rockinson-Szapkiw, Herring Watson *et al.*, 2021), defined as an individual's level of confidence in their ability to successfully achieve STEM-related goals, is further mediated by their experiences, level of success in those experiences, support, personal attributes (e.g., ethnicity, race, gender), and behaviors related to career attainment and career choices. STEM self-efficacy both influences and is influenced by an individual's perceptions of whether they belong in a particular field: one's perceptions of belonging and sense of community. Persistence is largely determined by one's personal attributes

(e.g., background, race, gender), prior experiences, STEM self-efficacy, academic integration, social integration, and goal commitment (Rockinson-Szapkiw, Herring Watson *et al.*, 2021).

Mentoring may also support the development of identity and the ability to recognize and support intersecting identities. Clark and colleagues (2016) highlighted the importance of “gender-STEM identity compatibility” (p. 1). Persisting stereotypes tend to assign a low value to women who engage in many STEM fields, affecting engagement and persistence in STEM (Clark *et al.*, 2016). Women tend to experience an unwelcoming environment in STEM that diminishes the complex roles and identities that they historically hold (e.g., primary caregiver, mother, wife). This environment “compromises sense of fit and belonging ... impacting the broader culture of STEM ... by defining notions of who belongs, who is expected to be successful, and who is valued in a given field” (Clark *et al.*, 2016, p. 2). The development and support of STEM identity is key to broadening participation of women in STEM as “it sets up additional processes by which individuals judge their competence and belonging” (Clark *et al.*, 2016, p. 2). Gender–STEM identity compatibility correlates with goal setting, progress toward goals, and decision making inherent to the achievement of goals (London *et al.*, 2011). Gender–STEM identity “predicts increased sense of belonging ... and increased levels of motivation” (Clark *et al.*, 2016, p. 3). The impact of peer mentoring on the development of identity, however, has not been fully explored (see Rockinson-Szapkiw, Herring Watson *et al.*, 2021; Rockinson-Szapkiw, Wendt *et al.*, 2021).

Mentoring has been shown to be incredibly promising in supporting self-efficacy, confidence, and sense of belonging, and developing a STEM identity (Carlone and Johnson, 2007; Clark *et al.*, 2016; Hill *et al.*, 2010; Rockinson-Szapkiw, Wendt *et al.*, 2021; Wilton *et al.*, 2021) as well as gender–STEM identity compatibility (Clark *et al.* 2016; London *et al.*, 2011), but it requires more in-depth exploration.

Methodology

Using a case study approach (Merriam, 2016) with the mentor cohort serving as the case, seven open-ended interviews and one focus group were conducted (see Table 1 and Table 2).

[INSERT TABLE 1 ABOUT HERE] [INSERT TABLE 2 ABOUT HERE]

Data collection and guiding questions

Data was collected until saturation was reached and transcribed for analysis. Using a combination of inductive and deductive coding, the data was coded, and codes were grouped into themes. The following research questions guided the data collection and analysis:

RQ1: How, if at all, was participation in the online peer mentoring program useful in furthering students' STEM self-efficacy?

RQ2: How, if at all, was participation in the online peer mentoring program useful in furthering students' sense of community in STEM?

RQ3: How, if at all, was participation in the online peer mentoring program useful in furthering students' intent to persist in a STEM degree program and, ultimately, their intent to pursue a STEM career pathway?

RQ4: How, if at all, was participation in the online peer mentoring program useful in furthering students' STEM identity?

Program and training

The present study extended a previous pilot study that explored the development and implementation of an online peer mentoring model (see Rockinson-Szapkiw and Wendt, 2020; Rockinson-Szapkiw, Herring Watson *et al.*, 2021; Rockinson-Szapkiw, Wendt *et al.*, 2021). While previous studies have demonstrated benefits to students' interest in STEM, self-efficacy in STEM, and persistence in STEM, the current implementation of the program extended to one additional HBCU to address generalizability. Continued exploration also allowed for examination of replicability of previous findings in alignment with calls for rigorous analysis of peer mentoring programs (Wilton *et al.*, 2021). Further, the current study included the addition of two modules to the mentor training – an expansion from six to eight total modules. The additional training modules attended to cultural responsiveness and the development of mentoring competencies (see Supplementary_material_appendix). The current study also included the addition of STEM identity as a potential outcome of engaging in peer mentoring, which was not previously addressed.

Each program component aligned with the conceptual framework to encourage interest in STEM, motivation to persist in STEM, and self-efficacy (see Rockinson-Szapkiw, Wendt *et al.*, 2021). The mentor training modules included (1) an introduction to mentoring, (2) mentor reflection, (3) skills for building and maintaining trust, (4) skills for beginning a peer mentoring

relationship, (5) skills for developing a peer mentoring relationship (6) ethics in mentoring, (7) cultural responsiveness in mentoring, and (8) skills for mentoring online. Each of the eight training modules within the online peer mentor training component of the overall online peer mentoring model included three major components: (1) a topical discussion that provided an overview of the module and the related research pertaining to the module content, (2) a case study that provided a demonstration of how the module content could be applied and that was intentionally designed to encourage motivation, emotion, and volition, and (3) a personal application and reflection that provided an opportunity to apply the module content to the individual's personal experiences. The training modules were self-paced, although a suggested schedule was provided.

While completing the online training, the participants were asked to engage in an online community with other peer mentors hosted on the Slack platform to facilitate networking, reflection, and community. Upon completion, mentors were paired with two to four peer mentees to form STEM communities with whom mentors engaged in mentoring activities with their assigned mentees. Mentors were matched with their mentees based on degree concentrations to the closest extent possible to facilitate shared interest, expertise, and experience in a particular discipline.

Participants and recruiting

The overall program primarily focused on broadening participation of women in STEM. After receiving Institutional Review Board approval, a total of 34 participants were recruited from two HBCUs in summer 2020. Eight of these participants were assigned peer mentor roles. Seven participants engaged in the mentor training, mentored within their assigned STEM communities, and participated in interviews and focus groups. The current paper focuses on the experiences of the peer mentors ($n = 7$), all of whom self-identified as Black women. The experiences of the peer mentees ($n = 26$) are reported separately.

The peer mentoring opportunity was advertised via email, institution website banners, fliers, and word of mouth. Participants were required to be enrolled in a STEM degree program at one of the participating HBCUs, identify as REM, have a grade point average of 3.0 or higher, and be of junior, senior, or graduate level status. After the application process, participants were selected and asked to complete the series of online training modules from summer to fall 2020.

In late fall 2020, peer mentors were assigned to their STEM communities and engaged in a mentoring relationship through the spring 2021 semester. Mentors were required to meet with their mentees within the STEM communities at least twice per month, but the format of such meetings was left to the mentors to decide based on mentor and mentee needs. All STEM community meetings were held either via phone or web conferencing as each group consisted of students enrolled at two institutions significantly geographically distanced. Mentors were encouraged to lead meetings in a manner that attended to group needs using the skills and “best practices” learned in the mentor training. Mentors were also encouraged to utilize a published workbook throughout their training and STEM community meetings as a further scaffold and resource (see Rockinson-Szapkiw *et al.*, 2020). Mentors were invited to attend three STEM webinars (fall 2020 to spring 2021), each featuring a talk given by a REM woman with demonstrated success in STEM. After the completion of the program, mentors completed individual interviews and engaged in a focus group. While the program was designed to enable the ability to implement all program components online, it should be noted that the participating institutions were engaged in emergency remote instruction due to the COVID-19 pandemic. This required that the amount of time allotted to complete the online training be extended from 8 weeks to approximately 16 weeks and prohibited mentors from electing to meet with their mentees face-to-face. Mentors were compensated with a nominal stipend for their participation in the program and were provided with a free laptop.

Data analysis procedures

Using the recordings from focus group discussions and interviews of both mentees and mentors, the data was transcribed and entered into Delve, a qualitative analysis software tool. Inductive and deductive coding were conducted in alignment with the guiding research questions. Codes were then organized into themes based on similarities in mentor expressions (see Table 3). To ensure fidelity, multiple passes were made by the two researchers until agreement was met.

[INSERT TABLE 3 ABOUT HERE]

Findings

All peer mentors that participated in the program indicated that their experience in the program was positive. Descriptors of the program provided by participants included “good,”

“great,” and “amazing.” One noted that the program “really motivated” them (Woman 1 Interview). Another expressed a desire to continue in the experience and return as a mentor again. Another shared how beneficial it was to know that someone “is there for you that understands what you’re going through” (Focus Group). By organizing, comparing, and combining the coded data, several themes were identified (see Table 3).

An “I can do this” approach: confidence and self-efficacy (RQ1)

Each of the mentors expressed that participation in the program supported their confidence and self-efficacy in STEM. One mentor expressed that, while her baccalaureate degree and work experience were in STEM and her future goal was to become a lawyer, her confidence that she *could* successfully complete a STEM career and engage in a STEM field was supported through the program. Each of the other mentors expressed that their confidence and self-efficacy in STEM were increased. Several mentors shared that the STEM webinars were pivotal to enhancing their confidence, noting, “Seeing that they [the speakers] were able to do it, that definitely encouraged me to think, yes, I can totally do this as well” (Focus Group) and “Seeing the women professionals making it – I really think that built confidence.” One mentor noted,

I’m the type of person that feeds off other people’s energies. During the talks – that was just them giving background of how they got, where they got ... and I’m a perfectionist myself, so I feel like if one thing goes wrong, I missed the end of the world. So, just hearing that these people got through a different circumstance and everything wasn’t perfect, it helped me understand that the road to being a medical doctor, it’s not going to be perfect and I just have to keep going. (Woman 2 Interview)

Another mentor stated that, as a result of the program, she now knew:

I’m going to be okay after graduation, even though I don’t know exactly to like the detail what I’m gonna do. I know there’s always other options that I can do. ... It’s okay not to know exactly what it is that you want – a goal in terms of STEM, but still knowing that, yeah, STEM is something that I want to do. (Focus Group)

As a result, her confidence and self-efficacy were increased and her intent to persist in her degree program and later career was solidified.

Motivation through reciprocity

Six of the mentors expressed that their motivation was increased as a result of participation in the program, with one noting that her motivation was sustained. This particular mentor shared in reference to her motivation,

I don't know if it really increased. It pretty much stayed the same, honestly, because at the beginning, I knew what I wanted to do. That I was going to do it. No matter what. It did, like, push me to just be, like, okay, you know, for all of your anxieties, like, other people are anxious, too, so like, other people struggle, too, so don't beat yourself up about not feeling, you know, as confident. So, it definitely, like, increased my confidence, but my motivation – my drive to do everything – pretty much stayed the same. (Focus Group)

While there were aspects of the program that encouraged mentors' motivation, such as seeing successful women in STEM as part of the STEM webinars, mentors repeatedly discussed how they sought to motivate their mentees but were in turn motivated by their mentees' successes and accomplishments. Thus, mentors' motivation was facilitated by the reciprocal nature of the mentoring relationship. One mentor shared,

It was really helpful because me and my mentees were able to exchange a lot of information and what to do after graduation. ... I think it was really helpful in figuring out, like, just sharing information on what options can we do as bio majors after graduation? Not like, just, being narrow minded. Like, okay, this is what I want to do, but even talking to someone else who's in the same field, but thinking of a totally different path and seeing – oh, wow. Okay. There are many options that I can do with my bio major. It's like another thing to hear at a career fair, or like your professor telling you "You can do this, you can do that," but doing the same major as you, you can also tell me yeah – you definitely, you can do that, too. (Focus Group)

Another mentor said of her mentees, "We have the same goals, around the same age. We were majoring in the same things. ... I'm a person that moves off vibes and everyone's vibe was the same as mine" (Woman 2 Interview). In the focus group, one mentor reiterated that the accountability with her mentees motivated her: "I think those little things that I've always kind of like been putting in the back burner was actually helpful and actually having someone who can hold me accountable in doing it together." Another mentor shared, "Some of these mentees

have achieved a lot and they minimize some of their achievements, which I tried to not allow them to do. You know, you've accomplished a lot. Everything that you're doing matters. They promote the bigger picture" (Woman 1 Interview). The same mentor also shared that reciprocity was integral in her knowing that she was not alone as a woman in STEM. She continued, "I want to be a powerful woman, too. They motivate me. I can do it, too. If they can do it, I can do it, you know?" In the focus group, another shared, "My mentees – they're amazing. They really are. And they motivate. They're all doing wonderful things ... Who wouldn't feel like you can accomplish more when you are in an environment like that?"

Utility of like others (RQ2)

Each of the mentors reiterated the benefit of being surrounded by and exposed to Black women who were engaged in STEM. One mentor shared, "I just love seeing all the women of color and all the mentee groups and all the webinars and just – because you can feel isolated" (Focus Group). This same mentor continued, "There's so many other people are doing it with me – women of color." The mentors overwhelmingly felt the benefits of "getting to know other women in STEM" (Focus Group). Another articulated,

Definitely having every one of my mentees be a woman of color, it was definitely great and definitely getting to know their backgrounds, because a woman of color can mean a whole lot of different things to different people. And, so, just being, you know, understanding that. ... Even though we're all different, we're all still like the same at the same time. (Focus Group)

One shared how her enrollment in an HBCU allowed for her to connect with like others:

It really is encouragement that you can do this, you can be successful, even being at a HBCU. I transferred from a PWI [primary White institution] community college, so I wasn't surrounded by all this culture and African American heritage in the first part. So, something like that was just a push forward to keep going and be successful. (Focus Group)

The mentors all expressed that the speakers for the STEM webinars were instrumental in their sense of belonging, motivation, and self-efficacy in STEM and that being able to see successful others that looked like them was beneficial:

I mean, even though the focus was their journey and their progress and their careers, they all had a good concentration in their mentoring, in their networking. So, it really, you know, it led to this – I think it tied into the mentoring because it just shows that, even though you may be successful, your success is attributed to a whole network of people.

(Focus Group)

One shared how engaging with like others supported her and encouraged her: “Regardless of your economic background ... you have a seat at the table if you work for it” (Focus Group).

Another shared that she now felt less alone:

So, you’re not really alone. Like, you always hear, like, guys brag about, “Oh, I’m going to do this. I’m going to do this,” but like, seeing someone like another woman say, “Yes, I’m going to actually be this person and I know I’m going to be this person” – makes you feel good because you’re like, well, I know I’m going to be this person, too. So, we’re going to be this person together, like, we’re gonna do this together and see ourselves that far. (Focus Group)

“Beacons of light”: intersecting and malleable identities (RQ3)

While none of the participants indicated directly that their STEM identity was directly influenced by their participation in the program, other intersecting identities were. One mentor articulated that her

current identity will probably be a beacon of light. ... There’s just a lot of things that are encompassed with being an African American woman that is a doctor. And, when I say that, I say that because I believe that I hope to serve as an example. That you have a seat at the table, and if you work hard and if you keep continuing to keep going, you will be successful. (Focus Group).

After sharing this ideation of her identity, several other mentors enthusiastically agreed. She continued, “I hope to say that I’m a beacon of light and hopefully what you see that I have done you can do for yourself. ... But right now I identify as a beacon of light” (Focus Group).

Another shared how she held multiple intersecting identities, including as a sister, a twin, a mentor, a mentee, and part of a sisterhood as a result of her engagement in sororities and professional organizations:

I'm just a sister in a lot of places, because I'm part of this sorority, I'm part of a sister organization, and I'm president of one of those, so I'm very much that sister figure to a lot of people and so I feel like that's one of the biggest identities that I have is just being like a sister and then I'm definitely a scientist. (Focus Group)

Another mentor noted that she identified as a volunteer, researcher, and a woman of color. She shared, "It is hard to be a woman of color in STEM because they are often looked down on, but I feel like this program did help me to define my identity due to the people that I worked with in the program and also due to the fact that I do go to a[n] HBCU" (Woman 2 Interview).

One mentor shared how her identities have changed over time:

For the longest time. I just identified as somebody's daughter, like, honestly, like, she just was so abundantly proud of everything I did. It used to be somewhat annoying at the time, but now I'm just like, oh, my God, that was my biggest cheerleader. I loved her. So, identifying as a daughter was like, a big idea to me – I didn't see me, because I am single.

I'm not married. I have no kids and I am 32. (Woman 1 Interview)

She continued, "I think, for me, I'm still defining it," indicating that, her experience – both within and outside of the program – was forcing a shifting and reconciling of her identities. However, all mentors indicated that their identity as a woman of color was supported and reaffirmed because of the program.

Skills development (RQ4)

Mentors expressed their appreciation for the skills that they had developed as a result of engaging in the program. One noted the program "gave me a snapshot of what to expect ... and it really helped me judge how much progress I think I've accumulated" (Woman 1 Interview). She continued in reference to the reflective components of the training, "It was really like a self-diagnosis a little bit, and I think I've improved, like my learning – listening skills, and how I can approach a subject and these different things." Another shared,

I would have to say that this program was beneficial. It just gave me a chance to display a leadership role. And it was something new for me being that I'm kind of a[n] introverted person. It gave me a chance to expand outside my comfort zone" (Woman 2 Interview).

Another shared,

My career path is anesthesiology, so, for me, I know that I will have to do a lot of patient interaction in terms of preparation, letting them know what they'll be going in for surgery, what I will be performing. So, I think it just strengthened the abilities of – I want to make sure that I have the ability to speak to all people, somebody I don't know, be a people person, be open, try to convey to that person. So, having my mentees become comfortable with me after the first or two meetings was just reassurance that, okay, I could do this. (Focus Group)

Mentors also shared that they felt that their skills in “planning, prepping, listening, you know, being a sounding board” (Focus Group) were strengthened, which would be helpful in their future careers. One shared that she was already utilizing the skills she learned in the training in her current tutoring position at her university. Another shared that she found benefit in learning new technological skills through the online nature of the program.

Challenges existed but could be overcome (general finding)

While each of the peer mentors indicated that their overall experience in the program was positive, it was not without challenges. Mentors expressed frustration with the challenges presented by the COVID-19 pandemic and the shift for both HBCUs to emergency remote learning. While the program was designed as an online program, the option for mentors to meet face-to-face for the mentoring phase of the program was eliminated due to the pandemic. This hindered mentors' abilities to connect in person with their mentees when desired and hampered communication. One mentor noted when sharing her struggle to get in touch with one of her mentees, “I feel like for some of them, it has to be the pandemic” (Focus Group). Several mentors expressed the desire for the program to be offered through a hybrid approach, with one sharing how face-to-face engagement would likely facilitate the building of trust and comfort:

Even a hybrid approach would work because we met on FaceTime or Zoom and I felt like it was, even though it wasn't in person, it was still meaningful and there was still a good conversation. But, maybe at one time, we could just meet before the process gets started. ... Some people open up faster than others. Some people take the time to try to get to know you. Well, I hope that if you see me in person and I smile a little bit, you'll feel more comfortable rather, even if it's over FaceTime. (Focus Group)

Despite these challenges, the peer mentors each engaged with fortitude and found ways to mitigate the challenges so that their mentees were provided a meaningful opportunity. One mentor shared that despite a preference for face-to-face interaction, she made the best of virtual conferencing tools:

Just trying to really interact, understand, like, emotions, like, a video screen. Like, it is good, because you still get to see their faces and everything, but at the same time, it's just like, you don't know what's going on in their environment. ... We're just trying to, like, figure out what really was going on, making sure that you could best suit them. (Focus Group)

Another shared that working through the challenges helped her to “learn a lot of stuff from it and I got to really see it from everybody else's perspective” (Focus Group). Another shared that the challenges pushed her to be more innovative:

It kind of put me in a place where I had to think of new ways and how to still make it as interactive as it would have been when she was in person. So, I think definitely, like, training my mind to be a little bit innovative now, going back, like, okay – what have I done before? But, thinking a little. (Focus Group)

One mentor shared how the challenges motivated her to be more persistent and intentional, with the mindset that she could still press forward: “I wouldn't want anyone to give up on me, so I'm just gonna keep on reaching out and those who will respond, respond” (Focus Group).

Discussion

Mentor responses highlight that the participants experienced a shared recognition of being trailblazers as Black women in their prospective STEM careers while being enrolled in STEM degree programs at their respective HBCUs. The findings of this study demonstrate that participation in the peer mentor training, STEM webinars, and subsequent mentoring relationships helped mentors to feel less alone and to find others that had shared experiences, cultures, beliefs, and goals, thus enhancing mentors' sense of belonging in STEM as both women and REM individuals. This finding is significant as, despite numerous efforts to create a more welcoming environment for women of all races and ethnicities in STEM, representation still falls short. To fully realize the potential talent available and to embrace a more inclusive work environment, programs that provide the skills, opportunities for connection, and supports are

necessary if the United States is to actually make strides in facilitating a more robust engagement of women in STEM.

The current study aligns with previous research that examined mentoring within the STEM workplace and demonstrated that women in STEM need personal connection for mentoring relationships to be successful (Rockinson-Szapkiw and Wendt, 2020; Saffie-Robertson, 2020). As noted in the findings of this study, the personal connection that mentors were able to make with their mentees proved to motivate and encourage them in their respective STEM fields. It provided a sense of belonging and alleviated the feeling of loneliness, which can often be experienced as a REM woman in STEM. One mentor noted that being REM can be looked down upon within STEM fields, but the program allowed her to have a positive identity in STEM. Importantly, the current study expanded the previous study (Rockinson-Szapkiw, Herring Watson *et al.*, 2021; Rockinson-Szapkiw, Wendt *et al.*, 2021) by adding two additional modules to the peer mentor training and examining the impact of participation on the development of STEM identity.

The previous study cited level of fit as integral to the development of strong mentoring relationships, including the ability to feel comfortable and authentic. In the current study, participants frequently shared the utility of seeing and interacting with others that looked like them, had similar goals as them, and with whom they connected in reciprocally aligned relationships. One mentor noted that having similar “vibes” allowed them to develop a sense of trust and a shared commitment, belonging, and identity within their mentoring relationship. Engaging with like others was supportive and encouraging, further developing a sense of community and belonging.

These findings also align with research on social identity, STEM identity, and gender–STEM identity compatibility (see Clark *et al.*, 2016; London *et al.*, 2011). Gender–STEM identity compatibility purports that “the degree to which an individual believes his or her gender ... overlaps or is compatible with his or her identity as a scientist” (Clark *et al.*, 2016, p. 3) correlates with an individual’s decisions, choice of goals, progress, and likelihood of remaining in STEM (London *et al.*, 2011). The current study demonstrated that participants’ ability to find fit with mentees through shared experiences and goals and through engaging with like others during the STEM webinars allowed them to explore their identities more intentionally. Mentors indicated shared identities as women and as Black – both of which they perceived as belonging

in STEM despite stereotypes indicating otherwise (Clark *et al.*, 2016). The study also demonstrated that identities were malleable and changed over time, with some participants sharing how they had identified in the past compared to how they identified by the end of the program. As Miller (2021) purports, “The question of *Who Am I* is going to have different answers at different times in our lives” (p. 7). This shift and flexibility in identities is influenced by one’s core cultural identity but is also shaped by life experience, environmental factors, and the lens through which they view the world. The fact that one mentor’s identity was shifting could be indicative of her life experiences, including the recent loss of a close family member, but also demonstrated her finding meaning and value in serving as a “cheerleader” for her mentees. Mentors were able to identify with confidence as STEM women, promising to persist in their chosen STEM fields.

The current findings also demonstrate the benefit of matching mentors with mentees in similar degree fields and with similar aspirations. Saffie-Robertson (2020) suggested that mentors and mentees be paired based on fit using a “matchmaking” (p. 577) approach. Otherwise, the mentoring relationship may not “provide fertile grounds in which mentorships can develop and grow” (pp. 576–577). This allowed mentors to interact with mentees in areas in which they held expertise in navigating their respective discipline areas, with whom they shared goals, and in a manner that facilitated reciprocity. Several mentors expressed how they were motivated by their mentees and were proud to be associated with mentees who shared their same interests. The matching of mentors with mentees afforded mentors the opportunity to “pay it forward” and to truly shine, as one mentor stated, “as beacons of light” for others.

While challenges were shared, the mentors found their participation in the program to be beneficial, indicating the potential for the program to mitigate barriers to REM women’s success in STEM. Challenges could be attended to by including additional opportunities for connection, including face-to-face or hybrid components, and by offering supplemental support for communication. Overall, implementation of the program at the participating HBCUs supported REM women’s sense of belonging, STEM self-efficacy, STEM identity, and intent to persist in STEM.

Implications

The study demonstrates the importance and utility of intentional training for peer mentors, aligning with the research literature (see McGee, 2016; Pfund *et al.*, 2016; Rockinson-Szapkiw and Wendt, 2020). Institutions should consider training peer mentors prior to implementing peer mentoring relationships. This will enable peer mentors the opportunity to not only develop skills related to successful peer mentoring, but also assist peer mentors in recognizing and developing their personal identities, sense of belonging in STEM, and self-efficacy. The current study also demonstrates the importance of match. Institutions should take into consideration students' personal characteristics, discipline areas, and goals prior to matching peer mentors with peer mentees. This will further contribute to identity, sense of belonging, and self-efficacy. Institutions should consider opportunities for face-to-face interactions during peer mentor training and during the mentoring relationship. While online peer mentor training and online peer mentoring relationships can be successful, they can be further enhanced through face-to-face components.

Considerations for future research

Future research should consider the experiences of mentors in other HBCUs and in minority-serving institutions, such as Hispanic-serving institutions. It may also be beneficial to explore the implementation of the program at primarily White institutions where barriers to resources and support for REM students are historically lacking. Longitudinal impacts should be examined. A larger sample size could potentially lead to different results, and the addition of opportunities to engage in face-to-face interaction could enhance understanding of the utility of the program. An examination of the long-term impact of mentorship on students' professional success and career trajectories, as well as identifying effective mentorship strategies and practices in the context of a STEM community at an HBCU, are other considerations for future research. Conducting research to investigate the factors that influence students' willingness to engage in mentorship programs, their preferred mentor characteristics, and the types of support that are most beneficial to their academic and personal development in STEM could add to the current body of literature.

Conclusion

Mentors in the program felt a sense of pride, motivation, encouragement, and belonging in their respective STEM degree programs and future STEM careers. While there were several challenges to overcome when navigating through a pandemic, mentors' experiences deemed the program successful in encouraging them to persist and complete their degrees in STEM and pursue STEM careers. It also solidified their various identities, including STEM identities, and allowed them to see the contributions that REM women are already making in STEM. This connection, in many ways, provided some relief with mentors to learn first-hand that there are people who look like them, have persisted in their STEM fields, and have overcome adversity, which they now understand is a normal progression of completing their degrees and pursuing their careers in STEM.

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Table 1.
Individual interview protocol

<p>General Experience Questions</p> <ul style="list-style-type: none"> • What was your role in the peer mentoring program? (peer mentor or mentee) • Thinking back, describe your experience in the peer mentoring program (think about both the training and the mentoring). • Describe the progress that you have made towards your degree program and/or career (finished the degree, still working towards the degree, changed/dropped out of the degree program). • Thinking back, how, if at all, did the overall experience and the interaction with your mentees and other mentors influence your feelings about the degree and career you were/are pursuing? • Thinking back, what, if anything, would you change about the experience to make it better?
<p>STEM Value/Interest (Eccles & Wigfield, 1995; Lent <i>et al.</i>, 1994)</p> <ul style="list-style-type: none"> • What part of the experience, if any, helped you become more interested in STEM (or see it as a worthwhile pursuit)? Has this changed over time? • Did any part of the program hinder your interest in STEM? If yes, please explain. Has this changed over time?
<p>STEM Self-Efficacy/Confidence/Success Expectancy (Bandura, 1997; Eccles & Wigfield, 1995; Watt <i>et al.</i>, 2012)</p> <ul style="list-style-type: none"> • What do you believe your likelihood is to [continue] to be successful in your STEM degree? Career? • Thinking back, what part of the experience, if any, helped you become more confident in your ability to be successful in your STEM degree program? In a STEM career? • Thinking back, has any part of the program hindered your confidence in your ability to be successful in a STEM degree or career? If yes, please explain.
<p>STEM Career/Degree Commitment/Persistence (Chemers <i>et al.</i>, 2011; Lent <i>et al.</i>, 1994; Tinto, 1987, 1993)</p> <ul style="list-style-type: none"> • Thinking back, what part of the experience, if any, helped you become more solidified in your intent to finish your STEM degree program? [Only ask if not completed their degree.] • What part of the experience, if any, helped you become more solidified in your intent to pursue a STEM career? • Thinking back, did any part of the program hinder your intent to pursue a STEM degree or career? If yes, please explain.

STEM Identity (Carlone & Johnson, 2007; Chemers *et al.*, 2011; Jones & McEwen, 2000)

- Describe your current identities (consider providing an example, “I identify as a woman, a mother, a scientist, and an academic ...)
- Thinking back, what part of the experience, if any, helped you to better see yourself as a “STEM professional”? [Note: add profession]
- Did any part of the program hinder your identity development or intersection? If yes, please explain.

Source: Authors’ own creation.

Table 2.
Focus group protocol

<p>General Experience Questions</p> <ul style="list-style-type: none"> • Describe your experience in the peer mentoring program. • How, if at all, did the experience and the interaction with your mentor and other mentees influence your feelings about the degree and career you are pursuing? • What was the most useful part of participating in the project? • What, if anything, would you change about the experience to make it better?
<hr/> <p>STEM Identity (Carlone & Johnson, 2007; Chemers <i>et al.</i>, 2011; Jones & McEwen, 2000; Robnett <i>et al.</i>, 2015)</p> <ul style="list-style-type: none"> • What are your personal identities? Identities, for instance, could include “father,” “mother,” “academic,” etc. • What part of the experience, if any, helped you to better see yourself as having an identity in your specific STEM field? • What part of the experience, if any, helped you to better see yourself as having an identity as a woman in a STEM field or integrate your developing identity as an individual in a STEM field with other important identities you have? • What part of the experience, if any, helped you to better see yourself as having an identity as a person of color in a STEM field or integrate your developing identity as an individual in a STEM field with other important identities you have? • Did any part of the program hinder your identity development or the overlap or intersection of your different identities? If yes, please explain.
<hr/> <p>STEM Self-Efficacy/Confidence/Success Expectancy (Bandura, 1997; Eccles & Wigfield, 1999; Watt <i>et al.</i>, 2012)</p> <ul style="list-style-type: none"> • What do believe your likelihood is to be success in your STEM degree? Career? (Follow up: How would you compare your level of confidence about your ability of be successful compared to others in your degree program?) • What part of the experience, if any, helped you become more confident in your ability to be successful in your STEM degree program? In a STEM career? • Did any part of the program hinder your confidence in your ability to be successful in a STEM degree or career? If yes, please explain.

Source: Authors’ own creation.

Table 3.*Alignment of research questions with example codes, themes, and passages*

Research Question	Code	Theme	Example Passage
RQ1: How, if at all, was participation in the online peer mentee training useful in furthering students' STEM self-efficacy?	Confidence	An "I Can Do This" Approach: Confidence and Self-Efficacy	"Seeing that they were able to do it, that definitely encouraged me to think, yes, I can totally also do this as well." (Focus Group)
RQ2: How, if at all, was participation in the online peer mentee training useful in furthering students' sense of community in STEM?	Like Others	Utility of Like Others	"There's ... so many other people are doing it with me – women of color." (Focus Group)
RQ3: How, if at all, was participation in the online peer mentee training useful in furthering students' STEM identity?	Identity	"Beacons of Light": Intersecting and Malleable Identities	"My current identity will probably be a beacon of light." (Focus Group)

RQ4: How, if at all, was participation in the online peer mentee training useful in furthering students' intent to persist in a STEM degree program and, ultimately, their intent to pursue a STEM career pathway?	Skills Developed	Skills Development	“It definitely helped me figure out how to balance everything and give my all to everything.” (Focus Group)
Development of Further Salient Theme	Reciprocal Relationship	Motivation and Reciprocity	“Me and my mentees – we were able to exchange a lot of information.” (Focus Group)
Discussion of Challenges	Challenges of Virtual Relationship	Challenges Existed but Could Be Overcome	“Everyone had different schedules ... I wanted to get to them.” (Focus Group)

Source: Authors' own creation.

Appendix.*Peer Mentor Training Module Alignment and Goals*

Peer Mentor Training Modules	Goals
Mentor Module 1 An Introduction to the Peer Mentoring Relationship	By the end of this module, you will: (1) Identify the benefits of participating in a peer mentoring relationship (2) Define peer mentorship (3) Identify the phases of a peer mentoring relationship (4) Identify the characteristics, roles, responsibilities, and competencies of peer mentors and mentees (5) Develop a philosophy of mentorship
Mentor Module 2 The Reflective Mentor	By the end of this module, you will: (1) Identify the role of reflection in the peer mentoring relationship (2) Reflect on present and past experiences (3) Develop a reflective journal
Mentor Module 3 Essentials for Building and Maintaining Trust	By the end of this module, you will: (1) Identify relational and interpersonal competencies to build and maintain trust (2) Practice relational and interpersonal competencies to build and maintain trust (3) Reflect upon current relational and interpersonal competencies to build and maintain trust
Mentor Module 4 Essentials for Beginning a Peer Mentoring Relationship	By the end of this module, you will: (1) Identify the purpose of your peer mentoring relationship (i.e., Why) (2) Understand how to assist your mentee in developing an individual development plan (i.e., What) (3) Identify the importance of scheduling regular meetings (i.e., How and When) (4) Identify the importance of aligning relational and communication expectations (i.e., How and When) (5) Develop a peer mentoring relationship agreement
Mentor Module 5 Essentials for Facilitating Development for the Peer Mentoring Relationship	By the end of this module, you will:

	<p>(1) Identify competencies needed to support your mentee's instrumental and psychosocial development</p> <p>(2) Practice skills to facilitate, inform, instruct, connect, challenge, model and motivate</p> <p>(3) Reflect upon current skills, knowledge, and abilities needed for a productive peer mentoring relationship</p>
Mentor Module 6 Essentials for Organizing an Ethical Peer Mentoring Relationship	<p>By the end of this module, you will:</p> <p>(1) Identify the 3 parts to every peer mentoring meeting</p> <p>(2) Identify the importance of documentation in a peer mentoring relationship</p> <p>(3) Discuss ethical behavior for a peer mentoring relationship</p> <p>(4) Identify 3 necessary components to ensure a good ending to the peer mentoring relationship</p>
Mentor Module 7 Essentials for Culturally Responsive Peer Mentoring Relationship	<p>By the end of this module, you will:</p> <p>(1) Define diversity, inclusion, culture, and cultural responsiveness</p> <p>(2) Identify how diversity affects the peer mentoring relationship</p> <p>(3) Identify strategies to foster an inclusive and culturally responsive peer mentoring relationship</p>
Mentor Module 8 Essentials for Engaging in an e-Peer Mentoring Relationship	<p>By the end of this module, you will:</p> <p>(1) Define e-mentoring</p> <p>(2) Identify ways technology can be beneficial and challenging in peer mentoring relationships</p> <p>(3) Identify technologies that can facilitate communication in peer mentoring relationships</p> <p>(4) Create Slack and Zoom Accounts</p> <p>(5) Make a Technology Plan for your peer mentoring relationship</p>

Source: Authors' own creation.