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Encouraging Confidence: The Impact of an Online Peer Mentoring Program on Women Peer Mentees in STEM at Two HBCUs

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Abstract: The purpose of this project was to examine the impact of participation in an online peer mentoring program on peer mentees in an effort to broaden participation of racially and ethnically minoritized women in science, technology, engineering, and mathematics (STEM) degree programs. A total of 22 students identifying as women who were enrolled in STEM degree programs at one of two participating historically Black institutions participated in the program. After participating in an online peer mentee training program and engaging in peer mentoring relationships over the course of one academic year, interviews and focus groups were conducted to determine the impact of participation in the program on mentees' STEM self-efficacy, sense of community, STEM identity, and intent to persist in their STEM degree programs. Following a case study approach, findings demonstrated that peer mentees reported overall positive outcomes from participation in the program to include increased STEM self-efficacy, increased sense of belonging, increased STEM identity, and increased intent to persist. Implications and suggestions for future research are discussed.

Keywords: STEM; peer mentoring; women; self-efficacy; identity

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1. Introduction

National reports continue to reiterate that participation in STEM degrees and career fields remains unrepresentative of the diversity found within the U.S. [1,2]. Women who identify as racial or ethnic minorities in particular are consistently underrepresented in STEM degree programs and career fields as compared to their male counterparts. Mentoring has demonstrated promise as a mitigating factor for broadening participation in STEM [3,4] and as serving as a force for change [5]. This is largely because "mentoring interactions have an impact when they communicate messages of invitation or inclusion and equip students to take on the challenges in STEM by increasing their capabilities" [2] (p. 5). Peer mentoring, especially, may be particularly helpful [6]. Peer mentoring is defined as "a reciprocal, dynamic relationship between or among peers where one peer is usually more skilled or experienced than the other" [7] (p. 2). However, most research on mentoring has been situated within the context of the research laboratory and fails to account for a plethora of other mentoring contexts. Likewise, research has historically focused on hierarchical mentoring models, such as those that occur between faculty and student or mentoring relationships among faculty peers. Thus, there is a dearth of research that examines peer mentoring, that occurs outside of the research laboratory, that utilizes a peer mentoring model, and that explores the impacts of mentoring within the context of historically Black

institutions [7–10]. The current study, therefore, sought to add to the body of literature by examining the impact of racially and ethnically minoritized women's engagement in an online peer mentoring program at two historically Black institutions (also referred to as historically Black colleges and universities [HBCUs]).

1.1. Literature Review

A robust body of literature has examined variables associated with students' persistence in STEM degree programs. Within the field of STEM education, especially among HBCUs, efforts to support women in STEM have gained attention due to the persisting underrepresentation of women in these disciplines [1,2]. Despite efforts to understand how to encourage participation in STEM, women and women who simultaneously identify as racial and ethnic minorities continue to engage in STEM degrees and career programs less frequently than their White male counterparts [2,11].

Myriad reasons have been cited for this disparity in representation, ranging from traditional views of gender roles, an unwelcoming climate, and competing responsibilities [12,13]. However, research has indicated that the development of strong relationships with a mentor can assist in the development of a sense of belonging and, in turn, support diverse participation [11,12,14,15]. Peer mentoring programs are emerging as an encouraging and hopeful strategy to foster retention among female students in STEM fields [7,10,16]. Peer mentoring has long been recognized for its role in enhancing academic and social integration, particularly among underrepresented groups in STEM.

When women are exposed to role models with which they can identify and when they receive sufficient support from peers, their engagement in and persistence in STEM degree programs may be increased [7,10–12]. Research has shown, for instance, that the phenomenon of stereotype threat and hindrances due to gender-related attitudes can undermine women's interest in and performance in STEM domains [17]. Study [18] has shown that mentoring programs can enhance academic performance and career aspirations among women who are STEM students. Further, mentoring can support a sense of belonging and increased confidence among women in STEM [7,10]. The retention and success of underrepresented minority women (e.g., African American, Hispanic/Latino, American Indian) is especially significant as it may have a direct impact on diversity for the future STEM workforce [11,13,19].

A significant body of literature also supports the benefits of mentoring in supporting the development of identity, especially scientific identity, among women [6,20,21]. Peer mentoring programs tailored for women in STEM at HBCUs have shown promise in fostering confidence, retention, persistence in STEM fields, a sense of belonging and career aspirations [6,7,10]. Online mentoring programs have the potential to extend benefits to a wider audience, further enhancing the accessibility and effectiveness of these programs. Thus, online mentoring programs can be a valuable strategy for promoting diversity and inclusion in STEM fields [6,7,10].

1.2. Theoretical Framework

The structure of the overall online peer mentoring program draws upon several key perspectives from the literature, including multiple theoretical frameworks. These include Tinto's [22] Model of Student Departure, Bandura's [23–25] Social Cognitive Theory and Theory of Self-Efficacy, and Lent et al.'s [26] Social Cognitive Career Theory (SCCT).

Social Cognitive Theory (SCT) [24] places an emphasis on the role of social interactions, observational learning, and self-efficacy in shaping human behavior. For mentoring programs, SCT assumes that peer mentors serve as role models who possess skills and behaviors that mentees look up to and want to achieve. Through ongoing interactions and

feedback, mentees can enhance their self-efficacy beliefs, which encourages their confidence and enhances their academic performance [25].

Self-efficacy, a major part of SCT, refers to individuals' beliefs in their capabilities to organize and execute courses of action required to attain specific goals [23–25]. Mentoring relationships can enhance an individual's beliefs in their capabilities by providing mentees with opportunities for mastery experiences, social persuasion, and vicarious learning [7]. For women in STEM fields, who are often stereotyped, made to feel like they do not belong, and often face gender bias [11,12], building self-efficacy through supportive peer relationships can be particularly empowering [3].

Likewise, Tinto's [22] Model of Student Departure provides insights into the importance of social and academic integration in student retention. According to this model, students are more likely to remain and work through their educational goals when they feel like they belong or fit within their academic community. Peer mentoring programs may support students in feeling like they belong by fostering supportive relationships and creating opportunities for mentees to connect with peers who share similar academic and career interests [27].

Similar to the Model of Student Departure, Lent and colleagues' [26] Social Cognitive Career Theory (SCCT) supports that one's sense of belonging can be enhanced when mentees experience social and academic integration along with an enhanced sense of belonging. The overarching premise of SCCT is that the more a woman in STEM believes in herself the more likely it is that she will flourish in STEM and persist, thus helping to increase the number of women in STEM fields.

2. Methodology

The current study was an extension of a previous pilot study that was implemented to explore the impact of participation in an online peer mentoring program [7,10,28]. In the previous pilot, a series of six online training modules were developed and implemented to train peer mentors in effective mentoring skills. The current study replicated the previous pilot study by including an additional HBCU to assist in expanding external validity by implementing the program at multiple institutions, a stated need within the research literature [13]. Although the previous pilot study included training modules for peer mentors only, the current study implementation included the addition of peer mentee training. This addition was in response to the pilot study findings which demonstrated previous peer mentee participants' desire to engage in training to develop their own skills as both peer mentees and, eventually, future peer mentors (see [7,10]). Thus, a total of 8 self-paced, online peer mentee training modules were developed and implemented for the current study.

2.1. Structure of the Peer Mentee Training Modules

Each of the 8 self-paced, online peer mentee training modules were aligned with the theoretical frameworks guiding the current study. The intent of the peer mentoring program overall was to encourage interest in STEM, intent to persist in STEM, and the development of self-efficacy in STEM. Each training module included an overview and topical discussion, a case study, and a personal application and reflection section. An overview of the topic focus of each respective training module is presented in Table 1.

Table 1. Topic of Peer Mentee Training Modules.

Peer Mentee Module	Topic
1	An Introduction to the Peer Mentoring Relationship
2	The Reflective Mentee
3	Essentials for Building and Maintaining Trust
4	Essentials for Beginning a Peer Mentoring Relationship
5	Essentials for Facilitating Development of the Peer Mentoring Relationship
6	Essentials for Organizing an Ethical Peer Mentoring Relationship
7	Essentials for a Culturally Responsive Peer Mentoring Relationship
8	Essentials for Engaging in an e-Peer Mentoring Relationship

2.2. Structure of the Peer Mentoring Program

The overall peer mentoring program consisted of self-paced, online peer mentor and peer mentee training modules (each containing 8 modules), as outlined in the preceding section. After completion of the peer mentor or peer mentee training modules during the summer and fall 2020 semesters, based on assignment as either a peer mentor or peer mentee, participants were then grouped into STEM communities consisting of one peer mentor and two to four peer mentees. Within these STEM communities, peers worked together to engage in mentoring activities during the spring 2021 semester. The nature and structure of the mentoring activities in which the STEM communities engaged differed based on each respective communities' identification of peer mentoring needs and development of goals. Thus, engagement in mentoring activities was largely flexible. However, each group was required to meet at least two times per month using the mode most appropriate to their particular needs and goals (e.g., web conference, phone, etc.) and to use the tools and strategies presented in the online peer mentoring trainings, as well as an accompanying workbook [29,30], to guide their mentoring relationships.

To the extent allowable, mentors and mentees were matched within their STEM communities based on their degree concentrations. Simultaneously, all participants across the program were encouraged to engage with one another via the Slack platform in an effort to facilitate networking and community on a broader scale. Additionally, all participants were encouraged to attend a series of three STEM webinars featuring a talk provided by a successful female STEM professional in order to facilitate networking and community.

The overall peer mentoring program was designed with the ability to be completed fully online while giving the participants the option of engaging face-to-face if desired. However, it should be noted that implementation of the current study occurred during the COVID-19 pandemic when both participating institutions had shifted to emergency remote instruction, thus prohibiting participants from engaging in any face-to-face activity, which would have been an option for STEM communities outside of the pandemic. Peer mentees participating in the program were compensated with a nominal stipend and provided with a laptop to facilitate completion of the online peer mentee training.

2.3. Participants

After receiving Institutional Review Board approval, applications for participation in the program were accepted and reviewed. All peer mentees were required to be enrolled in a STEM degree program at one of the two participating HBCUs, identify as a minoritized individual, and have a grade point average of 2.8 or higher. A total of 34 participants were accepted into the program during summer 2020. Eight participants were assigned the role of peer mentors. Participants who were assigned the role of mentor were required to be enrolled in a STEM degree program at one of the participating HBCUs, identify as a minoritized individual, have a grade point average of 3.0 or higher, and be of junior, senior, or graduate level status. Mentors' experiences are reported separately (see [6]). Twenty-six participants were assigned the role of peer mentees. Four of these participants self-identified as male and were grouped together within a male STEM community—their experiences are reported separately given the specific focus of the current study on the experiences of minoritized women. (It was important not to exclude male-identifying participants from the overall program, however, given equity considerations and funding requirements). Thus, a total of 22 individuals self-identifying as women participated in the program as peer mentees. Of the 22 participants, 18 identified as Black, 1 as Black and Hispanic/Latina, 1 as Asian/Pacific Islander and Hispanic/Latina, 1 as Middle Eastern, and 1 as Caucasian.

2.4. Data Collection and Analysis

Participants were asked to complete the online peer mentee training modules during summer 2020 and fall 2020. During spring 2021, peer mentees were assigned to STEM communities, consisting of two to four peer mentees and one peer mentor. Peer mentors and peer mentees engaged in peer mentoring relationships during spring 2021. Simultaneously, peer mentors and peer mentees were encouraged to collaborate via the Slack platform and attend the STEM webinars held during fall 2020 and spring 2021.

Using a case study design with the female mentees serving as the case [31,32], the peer mentees (n = 22) were invited to participate in individual interviews as well as focus groups during the final week of their program engagement until saturation was reached. Individual interviews and four focus groups were recorded and transcribed. Using Delve, a qualitative analysis software tool, data were then analyzed using a combination of inductive and deductive coding. Codes were then organized into themes (see Table 2). Throughout this process, both researchers coded and organized individually first, then ensured agreement mutually before proceeding. Two separate passes were completed. A positionality statement for the researchers is provided in Appendix A.

The guiding externally valid research questions, in alignment with the theoretical frameworks grounding the overall online peer mentoring program (see Table 2) were as follows:

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

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

RQ3: How, if at all, was participation in the online peer mentee program useful in furthering students' development of a STEM identity?

RQ4: How, if at all, was participation in the online peer mentee program useful in furthering students' intent to persist in a STEM degree program and, ultimately, their intent to pursue a STEM career pathway?

Table 2. Alignment of Research Questions with Theoretical Frameworks, Codes, Themes, and Example Passages.

Research Question & Citations for Theoretical Alignment	Example Code(s)	Theme	Example Passage(s)
RQ1: How, if at all, was participation in the online peer mentee program useful in furthering students' STEM self-efficacy? [23–25]	Self-Efficacy	Self-Efficacy	"Just being able to see there's a lot of a lot of HBCU students who are talented, and who are great, and are in the STEM fields" (Focus Group)
RQ2: How, if at all, was participation in the online peer mentee program useful in furthering students' sense of community in STEM? [26]	Inclusiveness	STEM Inclusiveness and Sense of Community	"I belong here, too" (Focus Group) "It makes me feel encouraged that I'm not the only one in this kind of field" (Focus Group)
RQ3: How, if at all, was participation in the online peer mentee program useful in furthering students' development of a STEM identity? [26]	STEM Identity	Identity	"I'm a woman in STEM" (Focus Group) "this just kind of solidified my stance as a STEM student" (Woman 1 Interview)
RQ4: How, if at all, was participation in the online peer mentee program useful in furthering students' intent to persist in a STEM degree program and, ultimately, their intent to pursue a STEM career pathway? [22,26,33,34]	Persistence	Persistence	"Like, just like my issue with, like, wavering motivation during the pandemic. It was very reassuring to see three other Black women still pursuing their own STEM majors and pushing through during a pandemic" (Focus Group)

3. Findings

Mentee participants provided very positive feedback regarding their experiences in the online peer mentoring training program. Mentees all reported a sense of belonging and were very excited to have participated in the program, making meaningful connections with their peers and other program participants. Each of the female mentees were appreciative of the connections made and the opportunities to see other individuals who were interested in their same degree majors, as well as those who were already successful professionals in STEM fields. This was especially evident when mentees spoke about the impact of the STEM webinars (further explained below).

Overall, six themes were identified as a result of coding and thematic analysis: Self-Efficacy; STEM Inclusiveness and Sense of Community; STEM Identity; Persistence; Mentor Characteristics and the Overall Mentoring Relationship; and Looking into the Future: Challenges and Suggestions. In the following sections, the themes are presented and aligned with the relevant guiding research question.

3.1. Self-Efficacy (RQ1)

One of the goals of the online peer mentoring program was to enhance STEM self-efficacy in hopes of encouraging degree and career persistence in STEM. Self-efficacy refers to individual's beliefs in their capacity to implement action to successfully obtain a desired outcome [23]. As a result of participation in the peer mentoring program, all participants noted that their sense of self-efficacy in STEM was enhanced. Participants shared that

participation in the program "gave me a boost of confidence" (Focus Group) and left them "feeling confident" (Focus Group). One mentee noted in a focus group that, after completing the mentee training and engaging with her peer mentor, she felt "confident enough to compete".

Seeing peers and the speakers at the STEM Webinars in particular promoted mentees' development of confidence. "I think just the community aspect of this program allowed me to be able to see that there are women that are pushing themselves to pursue careers and that makes me proud. It makes me happy because that's exactly what I want to do. So, it just pushes me to success and to try it" (Female Mentee W5). Another mentee shared, "Seeing other people's story, I'm getting encouraged about what I'm doing right now and feeling confident. I'll be successful later on" (Female Mentee W6). Another mentee said, "I can do it. . .. This is hard, but I can do it" (Female Mentee W1).

3.2. STEM Inclusiveness and a Sense of Community (RQ2)

Another goal of the peer mentoring program was to support the development of a sense of community and belonging for participants within STEM degree programs and STEM careers. Within the interviews and focus groups, mentees reiterated the need for STEM fields to be inclusive of all people, regardless of sex, gender, race, or ethnicity. It was interesting to learn that many participants, before participating in the peer mentoring program, felt that they were not being included within their degree programs due to their race or ethnicity, despite attending an HBCU. For instance, one mentee shared:

> I, myself, I'm, uh, Middle Eastern so I'm not African American, but I know that I'm also a minority. Yeah. So as [another participant] mentioned that, like, only 5% of doctors are Black here in America and I don't know, even less than one person might be me.
>
> (Female Mentee W9)

Consistently, the mentees expressed how important it is that STEM fields encourage diversity and inclusion during matriculation at colleges and in the workplace. One mentee shared, "I think that it does need some enhancement" (Female Mentee W3). She went on to explain the importance of recognizing and including those that hold a "queer, non-binary or LGBTQ+ identity. . . especially those that are on the fringes and not represented" (Female Mentee W3). The theme of inclusiveness was evident throughout the individual interviews and focus groups. Mentees shared very openly about their feelings of insecurity, concerns of not being included, or being afraid they would not be included during their educational experiences. Mentees agreed that they were grateful to have mentors, through the current program, that "looked like me". One mentee shared, "My recent answer about ensuring that multiple identities, specifically those that are on the fringes be represented. You know, my mentor was Black. I was really grateful to be starting a relationship with someone that looked like me in that regard" (Female Mentee W2).

However, while mentees may have experienced a shared racial or ethnic identity with their mentors, some mentees still reported a disparity in match between mentors' and mentees' gender identities. One mentee noted:

> The feeling of being uninvolved, or disregarded is an experience that Black queer people are no strangers to and in my relationship with my mentor, I definitely felt that way at times. It hindered me seeing any changes in that regard and made me more aware of the need for Black queer, you know, people in STEM. And the need to move beyond just being more interrogating of gender binaries in general.
>
> (Female Mentee W3)

Mentees' perceived sense of not belonging in STEM as a whole was evident throughout the interviews and focus groups. The participating women perceived initially that they do not belong in STEM due to their sex or gender identity. One mentee stated:

> I want to do medicine and it is really a very rare career path as a female to choose to go to and it comes with a lot of stress. Sometimes you feel like, am I on the right path doing the right things? Should I be doing this? Is this right for me? Or am I going to be lonely? And you have a lot of doubts, and a lot of things that make you want to stop and make you want to question yourself. Do I want to really become a doctor? Because why do I want to be a doctor or why do I want to go into this long and arduous path? I think just being able to navigate through these struggling times has been good.
>
> (Focus Group)

Another mentee expressed:

> Yeah, I truly understand where you're coming from as far as being an underrepresented minority woman or, you know, an African American woman. Either way, we're all in this minority and even more so because of being a woman. I think you definitely have to know that this is what you want.
>
> (Focus Group)

A separate mentee noted, "the immediate rejection that I received, that's kind of putting off, like, well darn, do you guys even want me here?" (Focus Group). On the other hand, another mentee shared:

> There's a stereotype or a prejudice that most people share that I think mostly is STEM professionals or people who are in STEM are like, White or men, predominantly. Just being able to see there are a lot of HBCU students who are talented and great in the STEM fields is encouraging and makes me want to stay.
>
> (Focus Group 2)

Although the mentees cumulatively shared pronounced feelings of not belonging or feeling lonely, participating in the online peer mentoring program allowed them to connect with the broader STEM community and changed their perspectives about not belonging. Further, participation in the online peer mentoring program encouraged their persistence in STEM degree programs and their future STEM careers.

3.3. Identity (RQ3)

Mentees reported that the online peer mentoring program provided encouragement of their development of STEM identity. For instance, one mentee shared,

> Just knowing that I, I'm being recognized and acknowledged and to some degree appreciated in this program as a woman in the STEM field. Just this is enough for me, and I really appreciate that and I just, because oftentimes, like, there's nobody giving me any credit for being the woman, a minority, in STEM, and to be going through all of this stuff without any support.
>
> (Focus Group)

Another shared, "I'm a nursing major, I didn't really think that STEM would include me, but, overall, the way [mentor's name] created the group, it was so inclusive" (Focus Group). One mentee stated that, prior to enrolling in an HBCU and participating in the online peer mentoring program:

> I felt like a part of me was missing. So, like, when I came to [HBCU]. . .and seeing all of the successful stories of the professors really motivated me. And then the

> seminars that we were invited to with the other mentors, that I'm like, okay, I can see myself.
>
> (Focus Group)

One mentee summed up the experience as the following: "I consider myself as being a part of this STEM field" (Focus Group). Another shared, "I feel like I, I belong here, too" (Focus Group). Another mentee expressed, "I know I am Black and I understand my work as a Black woman". (Focus Group)

3.4. Persistence (RQ4)

There have been an increasing number of interventions and programs that seek to support STEM participation [21]. However, women, including those that identify as racially or ethnically minoritized, continue to be underrepresented [2]. Mentees in the current study, however, expressed that the online peer mentoring program encouraged their desire to persist in their current STEM majors and seek careers in their respective fields. One mentee expressed:

> I think just the community aspect of this program allowed me to be able to see that there are women that are pushing themselves to pursue careers in STEM and that makes me proud. It makes me happy because that's exactly what I want to do.
>
> (Focus Group)

When asked what they believed would be their likelihood to experience success in their STEM degree and pursue a STEM career, one mentee expressed:

> I think my likelihood is more after going through the program. It is a little bit higher, I think, in a sense. Just me being able to see other people doing it, gives me the motivation to be like, okay, well, you know, I can do it too. So, I think it increased my likelihood. Being able to find someone exactly in the profession that I wanted helped me to know that there is hope when I graduate and I won't be lost and will know who I can reach out to.
>
> (Female Mentee W4)

Another mentee concurred; "Yeah, my likelihood increased as well" (Female Mentee W2). Another shared, "I feel like I can do it. I'm confident" (Focus Group). "This is hard, but I can do it", noted one mentee (Female Mentee W1).

3.5. Mentor Characteristics and the Overall Relationship (Additional Findings)

Although not related to a guiding question, thematic analysis indicated that certain peer mentor characteristics impacted the overall peer mentoring relationship. Communication emerged as one of the most important aspects of the mentor–mentee relationship. When mentors communicated often and clearly with their mentees, the mentees felt that the relationship was enriched. When mentors communicated infrequently or less effectively with mentees, the mentees perceived challenges to the relationship.

For instance, one mentee shared regarding communication from her mentor, "I would have liked to communicate and try to know each other more" (Focus Group). Female Mentee W9 expressed, "One thing that was perhaps ineffective was what we used to communicate and I think that a lot of young people don't really check their group messages, because it's not really like they're there". One mentee was working on an assignment and expressed that her mentor was willing to assist her by communicating through a web conference platform, which really helped her open up more:

> I would say the same thing as well because I know there were a couple of assignments that were difficult for me. I was doing a computer program that

> I didn't finish all the way and she said that I can always reach out and we can always set up a Zoom call or things of that nature. So, like, it really helped me to open up and be willing to have others help me out when I need it.
>
> (Female Mentee W2)

Female Mentee W4 shared:

> One thing that will be most useful that I gained, would be my communicating and my communication skills. She just helped me. Be able to ask more questions because she talked with me and we were able to share and encourage me to let someone know I have trouble with this and I need help. So that is one thing I was able to get from it.

Other mentor characteristics emerged as well, including the ability to encourage and support mentees by praise, discussion, and suggestion of resources. One mentee expressed "being recognized and acknowledged" (Focus Group) as a key factor, while another exclaimed, "my mentor let me talk and share concerns" (Focus Group). Others went on to say, "she [mentor] helped me understand my work" (Focus Group) and "she [mentor] helped me learn how to navigate through STEM and sent me articles" (Focus Group).

Recognition of identity was also important. One mentee shared:

> I enjoyed my mentor, most definitely because she referred to us as young women and young ladies. She told us that being a woman is not a penalty against us, but because we are women that makes us stronger. That really makes us want to go and compete in a majority male career. That's powerful!
>
> (Focus Group)

3.6. Looking into the Future: Challenges and Suggestions (Additional Findings)

The final theme that emerged from analysis was that of challenges and suggestions for the online peer mentoring program moving forward. Many of the mentees requested to continue in the program for a longer period of time, citing how much they enjoyed being a part of the online peer mentoring community and having the opportunity to engage in mentoring activities with their peers and their mentors. They also commented on the feelings of pride they now have being connected with professional women who currently have careers in STEM fields and shared their stories of persisting to complete their STEM degree and remain in a STEM career. They wanted to continue to foster those feelings and to provide support to others in the future, "supporting each other because we're all women and in STEM" (Female Mentee W1).

Challenges that were noted included that of fit and match between mentors and mentees, expressed as "chemistry" by one mentee (Focus Group). Mentees encouraged "ensuring that multiple identities, specifically those that are on the fringes, are represented" (Focus Group), which would include "intentional outreach" (Focus Group) and recruitment in future iterations of the online peer mentoring program. One mentee suggested, "guest lectures and speakers that can speak to, you know, being in, being those identities, and also doing research in those fields" (Focus Group). Age was noted as another challenge experienced by a mentee, "Being a lot older than my mentor may have affected our ability to form a relationship" (Focus Group).

The bulk of challenges expressed, though, included those with communication and frequency of meeting with mentors. Mentees overall suggested more frequent meetings and reiterated the importance of clear, timely communication. One mentee noted, "Actually, I didn't meet with my, um, mentor frequently at all, and I found it hard to meet. Also, I found that my mentor was not that responsive to, you know, me reaching out and asking

for times to meet" (Focus Group). Another shared, "I wish I could have met with my mentor more, but our schedules were kind of conflicted" (Focus Group).

4. Discussion

This project examined the impact of participation in an online peer mentoring program on peer mentees in an effort to broaden participation of racially and ethnically minoritized women in STEM degree programs. Findings demonstrated that participants experienced an increased level of STEM self-efficacy, increased sense of belonging, increased STEM identity, and increased intent to persist in STEM degrees and STEM career fields. These findings align with and are supported by the underpinning theoretical frameworks, especially SCCT [24]. SCCT emphasizes the role of social interactions, observational learning, and self-efficacy in shaping human behavior and, thus, influencing perceptions and decisions. While participating in the program and engaging in mentoring relationships with the peer mentors, participants had the opportunity to socially engage with like others—those that also identified as women and as racially and ethnically minoritized. By viewing the training module videos, observing peer mentors and other peer mentees, and participating in the STEM webinars, participants were able to engage in observational learning. In making connections with mentors, other mentees, and the STEM webinar speakers, mentees were able to develop an enhanced sense of self-efficacy, self-confidence, sense of community, and identity as women in STEM—women who truly belonged and fit within STEM. Intent to persist was impacted as mentees were able to envision themselves graduating with a STEM degree and being employed in STEM fields, demonstrating a shift in belief as a result of participation in the program. Making connections and having regular interactions with their mentors encouraged the mentees to feel more confident in their own STEM abilities and future careers, while simultaneously contributing to STEM identity through academic integration [22,33,34].

The perception of community and the enhancement of a sense of belonging experienced by participants was made evident by each of the peer mentees within the interviews and focus groups. Mentees' sense of belonging was enhanced when they experienced social and academic integration [22,26,33,34]. Aligning with the research literature, the relationships built among mentors and mentees contributed significantly to mentees' sense of belonging and sense of community [11,12,14,15]. Importantly, mentees and mentors were able to foster friendships while simultaneously navigating through the COVID-19 pandemic—a very isolating time.

Mentees reported being appreciative of the opportunity to be included and of having a program that was diverse in racial and ethnic participation. As one mentee shared, "like, only 5% of doctors are Black here in America and I don't know, even less than one person might be me" (Female Mentee W9). Participation assisted mentees in finding a place where they fit in an otherwise underrepresented field, reiterating the need to and benefit of cultivating safe and welcoming spaces for racially and ethnically minoritized individuals, including women, in STEM [13,35]. The findings align with the literature that suggests the need to provide academic and social support to women, including those that also identify as racially or ethnically minoritized, in STEM fields and careers in order to broaden participation [36]. The current study, thus, attends to a widely recognized need within the literature to examine methods to support the participation of women in STEM [2,12,21,36] by demonstrating the utility of the current online peer mentoring program.

Tying to the theoretical underpinnings of the current study, Tinto's [22] Model of Student Departure provides further insights into the importance of social and academic integration in student retention. According to this model, students are more likely to remain and work through their educational goals when they feel like they belong or fit within their

academic community. In the current study, mentees frequently expressed their desire to remain in STEM, especially after engaging in the program. One mentee commented that it made her proud to know others like her in STEM (Focus Group), while another said her likelihood of staying in STEM is more now than before (Female Mentee W4). As another mentee expressed, "Yeah, my likelihood increased as well" (Female Mentee W2). These findings align with the research literature demonstrating the benefit of peer mentoring in supporting minoritized women's intent to persist in STEM [6,7,28,37].

The online peer mentoring program encouraged and enhanced STEM identity among the mentees as well. In gaining a sense of belonging, community, and the desire to persist, participants realized their passion for their particular STEM field and identified with others like them. They were able to visualize themselves as being competent in STEM, having the skills, knowledge, and grit necessary to persist in STEM, and to make valuable contributions through work in a STEM field. The connections that mentees made with their mentors and other mentees facilitated the drive and motivation necessary to remain competitive in male- and majority-dominated fields [35,38,39] Further, the connections between mentors and other mentees in the program assisted in meeting the need for fit within the mentoring relationship—key to ensuring that the mentoring relationships supported authenticity [12,21] which further extends to participants' recognition and development of personal and professional identity. As participants shared, having others in the program traversing STEM fields that "looked like me" helped them in feeling not only as if they belonged, but also supported their perceptions of holding a STEM identity. They, too, were part of the STEM arena, regardless of the disconnect or outright rejection that many reported having experienced previously: "I consider myself as being a part of this STEM field" (Focus Group), further aligning with experiences recurrent throughout the body of literature [6,13]. While some participants did report a desire for enhanced match between mentor and mentee, especially related to gender identities, overall participants felt the experience to be beneficial. These findings support not only the significance of the current study, but also demonstrate the necessity for future study that examines more fully the influence of gender identity match.

Participants' responses also echoed the sentiments of Mullen [5] that the mentoring experience is an effective method for both recognizing and encouraging human possibility. The mentoring experience, to be meaningful and effective, should "honor human potential" [5] (p. 68). This is especially salient as the current study also adds to the body of literature on effective practices for supporting underrepresented groups within the context of HBCUs which have historically been overlooked within the bulk of the research literature and, specifically, the mentoring literature [40–42]. While historically underfunded [43,44], HBCUs are the "institutions that educate Black students in the United States and prepare them for the next step in their careers by acknowledging the links between the lived experiences of Black students with their success as STEM students" [45] (p. 50). They are credited for producing a greater proportion of STEM graduates than their primarily White institution (PWI) counterparts when considering the ratio of HBCUs to PWIs [42]. Thus, HBCUs' contributions to supporting the participation of racially and ethnically minoritized women must be explored if the problem of underrepresentation within STEM is to be seriously addressed, recognizing the talent and potential of all individuals. The current study helps attend to efforts to understand experiences of students specifically at HBCUs and practices that might support their enrollment in and retention in STEM degree programs and subsequent careers.

5. Limitations

While the findings of the current study are promising, future study is needed to determine the generalizability of the findings to other institutions of higher education, including other HBCUs. It is possible that different populations of students enrolled may be impacted differently, based on personal identity (including gender identity), experiences, and even geographic conditions. Future study should employ an increased sample size among various HBCUs, as well as minority-serving institutions (MSIs) and primarily White institutions (PWIs). Quantitative measures of STEM self-efficacy and sense of community in particular might also yield additional insight. Likewise, longitudinal study could also increase understanding of the long-term effects of participation in the online peer mentoring program. Although outside of the scope of the current study, future study could also explore the impact of participation in the online peer mentoring program on the development of mentoring competencies, skills, and knowledge. It is likely that the limitations posed by the COVID-19 pandemic and the fact that both participating institutions were engaged in emergency remote instruction during the study implementation impacted communication and participants' ability to connect to an extent, although the online peer mentoring program was intentionally designed as an online program regardless of the pandemic. While mentors were required to meet with mentees at least twice per month, the quality and length of such meetings were not measured. Thus, these aspects could be further explored in future study.

6. Conclusions

College attainment and success among underrepresented groups in STEM is of urgent importance to our nation's economic survival and competitiveness across the world and the flourishing agendas of diversity and inclusion. Diversity and inclusion agendas must bring together students of diverse backgrounds and STEM fields [46]. The current study attends to this urgent need by exploring the impact of an online peer mentoring program on the STEM self-efficacy, sense of belonging, STEM identity, and intent to persist in STEM degrees and career fields among women enrolled in STEM degree programs at two HBCUs.

Overall, participants within the current study reaped positive benefits from their participation in the online peer mentoring program. Mentees experienced a sense of community and belonging, were excited to have participated in the program, and made meaningful connections with their peers and other program participants. Mentees were appreciative of the connections made, which in turn helped support their intent to continue persisting in STEM. These connections also supported mentees' development of STEM identity. While challenges related to communication and frequency of meeting with mentors were noted, mentees cited the desire to participate in the program again as well as to become part of the network of support for other women in STEM degree programs and STEM careers. Thus, the online peer mentoring program imparted benefits to mentees' and can serve as one method of support for women in broadening participation in STEM.

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Appendix A

Positionality Statement for V.O.J.: I identify as an African-American, middle-class female who conducts research on the effects of mentorship in STEM fields at historically Black colleges and universities, that represent underrepresented and marginalized populations. As an underrepresented minority, my personal experiences influence my lens through working with data and making the appropriate interpretations. I am committed to infusing the world with the experiences of this community of individuals in a way that encourages equality, diversity and inclusion.

Positionality Statement for J.L.W.: I identify as a White, middle-class, cisgender woman who conducts research on the experiences of historically marginalized populations, primarily at historically Black colleges and universities and in the STEM fields. My personal experiences may influence the lens through which I interpret data and understand the lived experiences of others. I am committed to interrogating diverse experiences with respect, compassion, and value.

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