Expectations Versus Reality: Understanding Women STEM Doctoral Students' Perceptions and Experiences on Doctoral Mentoring Relationships

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Introduction

The representation of women within the STEM field has been increasing over the past decade, yet women still only occupied 35% of the STEM jobs in 2021 [1]. Regarding degree attainment, the National Center for Science and Engineering Statistics expressed that women are particularly underrepresented within most STEM programs [1]. Interestingly, there was a steady increase in the number of women earning a bachelor's in engineering—more than a 100% increase between 2011 and 2020. However, despite this increase, women were only representing a fraction of all of those who earned a bachelor's (24%), master's (27%), and doctoral (25%) degree in engineering in 2020 [1]. A master's or doctoral degree is important to attain when considering career opportunities and advancement [1]. However, as Beck et al. claimed, we "continue to see the ways power and oppression afford opportunities to some (in this case, boys and men) while denying them to others (girls and women)" as they (try to) progress through their STEM journey [2, p.170]. Therefore, it's important to support women enrolled in graduate programs and, coincidentally, support their career trajectory by understanding how underlying power dynamics and oppression may contribute to this underrepresentation.

It is important to support women through their journey *after* entering a STEM program [3]. Mentoring has been found to support students' success in the STEM field. In general, mentoring experiences have been found to positively correlate with one's "academic self-concept" (i.e., "students' perceptions of their own abilities" [4, p. 297]) and their "career commitment" (e.g., continuing through their STEM program and beyond) [4]. There have been a variety of approaches and mentoring designs implemented, such as women-only programs that have career and long-term benefits; however, de Vries found "gendered advantage is being reproduced despite gender equity strategies designed to counter this" [5, p. 6]. Similarly, Dennis and Behie's "analysis demonstrates how mentoring (ironically) undergirds and replicates the patriarchal structures it seeks to trouble" [6, p. 1].

The researchers recognize that a mentoring relationship may vary—either as an established mentor granted through the department, an advisor serving as a mentor, or an informal mentor established organically. For the purpose of this study, mentoring is understood as a journey that the mentor and mentee take together and is defined as

> a process whereby one guides, leads, supports, teaches, and challenges other individuals to facilitate their personal, educational, and professional growth and development through mutual respect and trust. An understanding of cultural and gender differences is critical to the success of the mentoring process. Mentoring is viewed not only as a relationship between two individuals, but as a process. … Mentoring is the all-inclusive description of everything that is done to support the protégé's orientation and professional development. It includes creating the relationship, ensuring emotional safety, and providing the cultural norms needed for risk-taking for the sake of learning and achieving the desired result of accelerated professional growth. [7, pp. 8-9]

In spite of the voluminous literature on mentoring, there is a lack of literature on the mentoring experiences of women Ph.D. students in STEM. There is a need to examine how women's mentoring experiences may differ, such as being influenced by gendered characteristics. The

purpose of this research study is to better understand the mentoring experiences of women Ph.D. students in STEM by answering the following research questions:

1. How do women students perceive their mentoring experience within a Ph.D. STEM program?
2. How does gender influence the mentoring experience of women in STEM?

Literature Review

Reconcile STEM's Representation Deficits

Greater cultural awareness with respect to identity constructs such as race and gender contributes to positive interactions and responsiveness within mentoring relationships. Schwartz et al. indicated "long-term trends in homophily within or across scientific fields has never been investigated" [8, p. 2] as it relates to the impact on mentor relationship and gender. Gender homophily of mentorships is when the mentor and mentee are the same gender [8]. There is lack of consensus in the literature regarding if gender influences the outcome of academic mentoring relationships, but it is notable in social science and STEM fields that there is higher attrition of women in the later stages of their academic careers, resulting in a pool of eligible mentors skewed toward men [8]. Knezz declared emphasis should be placed on the structure and administration of the mentoring dyad rather than the gender of the mentor in STEM [9]. Dennis and Behie believe that some women-centered mentoring initiatives "may seem to support women, but on closer inspection, they may produce the opposite outcome" [6, p. 5]. As quoted by Knezz, a Black woman, Ph.D. engineering student said, "I don't really care if there are more women scientists. They are all playing the same game" [9, para. 11]. The dynamics present in the STEM field do not disappear despite good-intentioned actions [6, 9]. This suggests the presence of an ecosystem within STEM where representation is insufficient to provide an inclusive learning environment to elevate minoritized experiences while dually addressing the embedded culture of high productivity. The representation loss presents a continued minimization of "diverse perspectives and availability as role models for future scientists and engineers" [10, p. 2].

Gender and STEM

Research has found that women doctoral students differ from men in terms of their career goals and challenges [11, 12]. Cidlinská found differences between men's and women's overall career paths and attitudes within the natural and technical sciences—STEM—and the social sciences and humanities—SSH. STEM doctoral students (both men and women) had less "gender sensitivity," meaning "they (STEM mentees) tended to be less sensitive towards gender aspects of formal research career criteria" than their SSH counterparts [11, p. 378]. STEM mentees were less sensitive to strict guidelines surrounding their job criteria because they potentially were accustomed to similar standards throughout their STEM journey, and they believed that their skills led their career path (not their gender) [11]. However, traditional gender roles such as childcare responsibilities were noted as a barrier for women in STEM due to schedule disruptions, and the extended absence from STEM courses or lab work may render comprehension and expertise due to a rapidly changing field [11]. Therefore, women are professionally penalized for caregiver responsibilities that may slow their academic progression. Similarly, Miller and Wai found that women and men had differences in their respective career

goals. Salary was more important for men and contribution to society was more important for women, yet these differences were not found to contribute to persistence [12].

It is important to explore perceived avenues of support for women in STEM because of the gendered-based challenges they confront. This research study considers the dynamic views on women's progression in STEM and the corresponding support (or lack of support) provided to them through mentoring. Additionally, the researchers seek to better understand the mentoring experiences of women Ph.D. students in STEM.

Positionalities

The lead researcher for this study is a White, female doctoral student who is a former math teacher. She acknowledged her own experiences as a woman in STEM throughout the data analysis process to prevent potential biases (but to assist in interpretation) by constant reflection. This research has been supported by a larger group of researchers through data collection and analysis processes. The research team includes (1) an African American female adult education professor, (2) a South Asian American adult education adult educator professor, (3) an African American female educational leadership professor (4) a European post-doctoral research associate (5) a Western Asian American post-doctoral researcher, and (6) an African American post-baccalaureate psychology student.

Methods

Research Design
This research was drawn from a larger multiple embedded case study that sought to understand the nature and quality of STEM doctoral mentorships. However, this work focuses on an extracted case: women STEM doctoral students. Data was drawn from a National Science Foundation Alliances for Graduate Education and the Professoriate (NSF AGEP) grant-funded research study, which included three institutional types: (a) Historically White Insitution (HWI)-Flagship/R1, (b) Historically Black College and University (HBCU)/R2, and (c) HWI-Regional/R2. These institutions were located in the Southeastern part of the United States. Focus groups were held with STEM doctoral students at each institution. In total, there were 15 focus group sessions with 65 STEM doctoral students, of which 39 were women. The focus groups were conducted in 2019 and 2021, and they were 90-120 minutes in duration. The following are examples of focus group questions: (a) what do you believe the goals or outcomes of a doctoral mentorship should be, and (b) What has impacted the quality or effectiveness of your mentoring as a student? Participants received a $25 financial incentive to participate. The focus groups were conducted in person and via Zoom, recorded, professionally transcribed (Rev.com), and confirmed for accuracy. The focus group demographics for this study's preliminary analysis are displayed in Table 1. This preliminary analysis included 19 women who participated in the focus groups, of which 7 were AGEP, 3 were international, and the remaining were White Americans and Asian Americans. The term AGEP is used to identify NSF-targeted population groups (African American, Latine, Native American, Native Alaskan, Native Hawaiian, and Native Pacific Islander). Only comments made by women were extracted for data analysis.

Data Analysis
The Modified Stevick-Colaizzi-Keen Method of Interpretative Phenomenological Analysis (IPA)

was utilized [13, 14]. IPA asks researchers to first acknowledge their position and own experiences surrounding the topic (i.e., reflexivity) before analyzing the data. While consistently recognizing reflexivity, significant statements were identified in each transcript after making annotations. These significant statements were then grouped into meaning units/themes and then analyzed to understand their textural and structural relation.

Table 1

Year	Focus Group	Gender	AGEP or International	Institution Type
2019	Focus Group 1	4 Female, 2 Male	1 Female is AGEP	HWI-Flagship
2019	Focus Group 2	5 Female, 1 Male	2 Females are AGEP	HWI-Flagship
2021	Focus Group 3	2 Female, 2 Male	1 Female Int'l and 1 is AGEP	HWI-Regional
2021	Focus Group 4	1 Female, 4 Male	1 Female is Int'l	HWI-Regional
2021	Focus Group 5	1 Female, 2 Males	1 Female is AGEP	HWI-Regional
2021	Focus Group 6	5 Females	2 Females are AGEP	HWI-Flagship
2021	Focus Group 7	1 Female, 2 Males	1 Female is Int'l	HBCU

Note. Transcripts were selected chronically and/or for representation purposes.

Findings

Upon completion of the preliminary data analysis for the first round of transcripts of the 19 women's responses (as displayed in Table 1), four preliminary themes emerged: (a) Mentor as a supporter, (b) Emotional hardships, (c) Mentor responsivity, and (d) Long-term expectations. Regarding the first theme, women wanted to be able to go to their mentor and receive support; they overall craved emotional and professional support from their academic mentor. As represented in the following response from a participant, "they (mentors) should understand, not just what your research interests are, but also other things that might have to do with family or other parts of your life." Mentors not only provide "professional" and "career" support, but they also provide "personal" and "psychological support" [15, p. 37]. Mentors were mentioned to be able to recognize areas of improvement and help their mentees improve these skills, including soft and interpersonal skills. The women recognized that their mentor could dually provide support, i.e., emotional, intentional recommendations and advice, regarding their personal and professional STEM career journeys. Additionally, many women expected their mentor to support their culture, as seen in the following quote:

So he's (mentor) been able to encourage us to understand the different people that we have there. Different religions. Different areas that we are from. And even just different backgrounds. Academic and all that. So by us talking to each other during our meetings and even the informal events. We are able to better understand who we are working with and how to deal with them. And even in terms of conflict, you'll be able to know, "I'm a quiet person." And how to be able to know when I have challenges and things like that. And not take offense if someone is probably not approaching him as often as he would want to. Maybe it's just a cultural thing … he tries to understand people and ask questions. And check in more often with you just to make sure that you're all on the same page.

Mentees expected mentors to provide support and understanding regardless of cultural differences. The women spoke highly of their mentor when sharing examples of how their mentor helped them work through challenges, took time to get to know them on a personal level, and was approachable and understanding.

However, the second theme, mentorships can lead to emotional hardships, contradicts this theme. Although the women participants wanted to be able to go to their mentor for help or support, some found that they simply could not–at least not all the time. Some mentors' actions seem to be self-serving or biased, not keeping the mentee in mind. One example of a disheartening mentoring experience was expressed in the following story:

Then in October she (mentor) goes, "I don't think you can publish these papers until you do one more experiment." And I was like, "We talked about this experiment. This experiment will take a year and a half to do for nothing. It's not important." So I was like, "I'm not doing this." And you know she kind of wobbled on it and then I held my committee meeting in December and we finally killed it somehow … We set the date for March fifth. My family does not live here, so we started planning for flights and everything and then two weeks ago she goes, "I can't make the March fifth date, can we move it to another day?" Yeah, we can. And I'll pay the 200 dollar fee to change that flight for my mother, no big deal.

Several women participants mentioned the pressure of publications, including deadlines set by their mentors. The participants noted the STEM field competitiveness of publishing "first" alongside the faculty and feeling the pressure of publications. When a mentor utilizes their positional power against their mentee's best interest, the mentor is no longer fulfilling the supportive role that they were perceived to provide for their mentee.

The third theme, mentor responsivity, represents that communication is an important part of their mentoring experience. The women doctoral students ultimately wanted someone who would simply be *responsive*. For one example, a participant explained, "the person (mentor) left last June. So that has actually caused more hurt than anything else because now it's purely email communication. I've talked about going to where she is to meet with her in person, I've talked about Skype meetings and those emails get ignored completely." This quote represents a key component of what women were looking for in a mentor and like in theme 2, shows how emotional hardships are developed due to feelings of abandonment. Faculty turnover was a factor seen to be contributing to the responsiveness issues or the lack of sustainability within the

mentorship. Faculty were mentioned to leave universities with little to no notice, and this contributed to the challenges of meeting with mentors face-to-face or simply getting a response.

The final theme, long-term expectations, represents that a mentoring relationship is a committed relationship. In a successful mentoring relationship, the mentor seems to go above and beyond and is there for the student beyond the doctoral program. For instance, a participant shared: "She's (their mentor) very invested in my success as far as not only doing the research that is for her, but finding a career that I'm happy with and that I can have the type of lifestyle that I have, and helping me to reach all of those goals." The invested interest was recognizable to the mentee, looking ahead toward long-term goals can support women students in an impactful way. This included the mentor providing valuable networking opportunities.

Discussion and Recommendations

Examination of focus group transcripts suggests there are a few structural components contributing to the identified themes. Similar to Noel et al.'s findings, this study found that regular meetings and consistent and clear expectations can contribute to the overall feelings of support felt by mentees [16]. Furthermore, a lack of trust in a mentoring relationship can contribute to students not viewing their advisor as a mentor [17]. This was evidenced by the women in this study whose experiences highlighted how lack of support, responsivity, and emotional hardships contribute to lack of trust. As a result of these challenges, there was tension in the mentee-mentor relationship instead of a positive and supportive relationship.

The findings relate to the themes described by Cabay et al., who studied third- and fourth-year doctoral students who were women in a physical science or engineering program [10]. Although Cabay et al.'s research was focused on their overarching experience as a doctoral student and not specific to mentoring, their findings were similar in terms of their contrast: some opportunities supported their growth in identifying as a scientist (cf. theme 1), yet there were many incidents where they felt this support was missing (cf. theme 2) [10]. It is important for mentoring programs to recognize when women are not being supported so that they can be proactive in responding to provide guidance and monitoring. It should not be assumed that mentoring will automatically support women in STEM and solve representation problems.

However, either through formal or informal opportunities, mentoring is shown to provide positive opportunities for students as mentees. By recognizing the importance of this mentor-mentee relationship and the potential impact it may have on the women's trajectory, it is recommended to prioritize this relationship within the departmental context. For example, departmental (or university) leaders can provide training for mentees on how to select a mentor and promote direct communication between both parties (such as the mentor inquiring what the mentee's needs are) [18]. Mentors can also conduct a needs assessment to be aware of goals and appropriately support their mentee; this structure is especially supportive for women in STEM [2].

It is important to note that although data collection occurred before and during the COVID-19 pandemic (i.e., 2019 and 2021), no relevant categories emerged regarding the specific impact of the pandemic. There were individual significant statements that related to the COVID-19 pandemic (such as working remotely during the pandemic hindered or supported communication,

grouped under responsiveness). The lack of emergent overarching groups/themes may be because the protocol was not designed with the COVID-19 pandemic in mind.

When considering the women's experience in this present study, it is recommended that future studies include an additional subgroup analysis to understand the mentoring experiences of minoritized women. Although focused on peer mentoring in an undergraduate setting, Rockinson and Szapkiw found that racial and ethnic minority (REM) women were supported through peer mentoring because of the positivity, networking, accountability, and career navigation tools shared. These concepts (e.g., networking, positive support, navigation) were identified throughout the themes of this study [19], and it may be helpful to further investigate how race may influence their lived experiences as minoritized women in STEM. Also, it is recommended that future research be conducted to compare men's and women's mentoring experiences through a comparison analysis. McKeen and Bujaki shared that "gender and mentoring research has the potential to enhance our understanding of the antecedents and consequences of mentoring for women and men" [20, p. 217].

The findings are not surprising when considering the impact that mentoring can have, specifically for women. The findings of this study will hopefully support the total population of women STEM Ph.D. students and their respective mentoring experiences. Highlighting these lived experiences helps us understand how STEM departments can effectively support women doctoral students through mentoring, including the need to understand faculty responsibility in shaping and informing the next generation of scientists. Faculty need to be cognizant and responsive to women doctoral students by knowing their mentoring experience may impact their overall STEM journey.

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