Lessons from Diverse Women in STEM: Acknowledging Institutional Challenges and Empowering Agency Towards STEM persistence

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Lessons from Diverse Women in STEM: Acknowledging Institutional Challenges and Empowering Agency Towards STEM Persistence

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Abstract

Women pursuing graduate studies in STEM fields often face challenges, such as implicit and explicit messages (e.g., microaggressions, stereotyping) that communicate their lack of belonging in STEM, the delegitimization of their skills and expertise, and instances where both their voice and physical presence are ignored. These gendered, and in the case of Women of Color (WoC), racialized experiences, result in additional stress that negatively influences women's efforts to persist and succeed in STEM fields. This study, which is part of a larger NSF-funded project within the *Career*WISE (CW) research program, highlighted the voices of white women and WoC in STEM doctoral programs with the goal of identifying factors that promote their STEM persistence. A total of 33 women in STEM doctoral programs across the United States were interviewed. Participants were asked to provide recommendations for fellow women in STEM who are considering leaving their programs to facilitate their persistence amidst challenges they might face. The findings were summarized into four broad themes: 1) seek interpersonal support, 2) prioritize mental health and wellbeing, 3) affirm and encourage one's belongingness in STEM, and 4) explore different academic options if needed. Findings led to important implications for current and future graduate students, departments, and institutions (i.e., building community, fostering a welcoming environment, reducing barriers to persistence).

Key words: STEM, persistence, academic success, women, women of color

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There is compelling evidence demonstrating the continued underrepresentation of women in science, technology, engineering, and mathematics (STEM) fields. Despite having equal qualifications and abilities, graduate women in STEM face significant barriers that thwart their academic persistence. Such barriers include, but are not limited to, feeling undervalued, isolated, and disrespected (Bernstein, 2011; Cabay, et al., 2018; Ong et al., 2011). For Women of Color (WoC), not only must they contend with gendered experiences (e.g., sexual harassment), they must also navigate racialized experiences (e.g., White superiority) within their STEM environments (De Welde & Laursen, 2011; Malcom & Malcom, 2011; Ong et al., 2011; Wilkins-Yel et al., 2019). These barriers have led many women to exit their STEM doctoral programs before graduating, with the attrition rate for WoC being particularly high. The seven-year attrition rate for WoC in STEM doctoral programs is 34%, including half of those withdrawing from their doctoral studies in the first two years of their program (Sowell et al., 2015). These statistics highlight the need for an in-depth understanding of the ways to support STEM persistence among women in STEM amidst these debilitating and prevalent barriers.

Challenges Faced by Graduate Women in STEM

Graduate women in STEM fields must learn to successfully navigate an oppressive environment, known as the chilly STEM climate, while simultaneously navigating the rigors of doctoral study (Wilkins-Yel et al., 2019). They often face inordinate challenges during the pursuit of their doctoral degrees, including systemic barriers and negative interpersonal interactions within their STEM environments (Espinosa, 2011; Wilkins-Yel et al., 2019). A common experience reported by graduate women in STEM is that of gender and/or racial

microaggressions; subtle forms of everyday sexism and racism (Alexander & Herman, 2016; Anderson, 2017, Barthelemy et al., 2016; Brown, et al., 2016; Ong et al., 2011, Ong et al., 2018; Wilkins-Yel et al., 2019). Women in STEM have also reported repeated instances of sexual harassment and hiring discrimination within their graduate programs (Anderson, 2020), as well as the feeling that they must conform to restrictive gender norms (Barthelemy et al., 2016). Black graduate women reported a disproportionate amount of discrimination, racism, and White superiority within their STEM programs, demonstrated by multiple accounts of belittlement and discrediting by White professors and colleagues (Alexander & Herman, 2016). Troubling interactions with faculty and fellow students were similarly reported by Latinx graduate women in STEM (Anderson, 2020).

Experiences of microaggressions and other forms of stigma and discrimination (based on both gender and race) can result in the experience of feeling both hypervisible and invisible for graduate women in STEM, contributing to a sense of inferiority, isolation, and lack of belongingness (Wilkins-Yel et al., 2019). Stereotype threat, an individual's perception of being at risk for confirming negative stereotypes for a group (Steele et al., 2002), is a particularly salient obstacle for graduate women in STEM. For example, the perception that women in STEM may be less capable or credible can make a woman's decision to discontinue her STEM doctoral program due to systemic barriers even more difficult (Cheryan et al., 2013; Collins, 2000), as she may fear that her inability to persist will solidify the belief that women cannot be successful in masculine-dominated STEM fields (Deemer et al., 2014).

In addition, gender- and race-based discrimination can contribute to higher reports of mental health issues, including depressive symptoms (Keum et al., 2018), traumatic stress (Moody & Lewis, 2019), and overall psychological distress (Lewis & Neville, 2015). These

conditions may in turn contribute to decreased academic persistence among graduate women in STEM (Cross et al., 2017; Espinosa et al., 2011; Ong et al., 2011; Ro et al., 2015). For example, extant evidence suggests that isolation is a key contributor to Black women considering withdrawal from their STEM graduate programs (Charleston et al., 2014; Johnson, 2007).

Several scholars within STEM have called for increased examinations of the intersectional experiences of WoC (e.g., Ong et al., 2011; 2018), which involves acknowledging the dynamics of power, privilege, and oppression, recognizing that people have been socially stratified and marginalized based on race, class, gender, sexual orientation, ability, and other identities throughout societal history (Collins, 2000; Prilleltensky & Prilleltensky; 2003). Further, Intersectionality Theory (Crenshaw, 1991) asserts that people seldom experience events or are perceived in their life as just one identity, but rather through the context of the multiple identities they hold and their intersection (e.g., woman, Black, Black woman, queer, queer woman, queer Black woman). In STEM, WoC tend to be the least recognized and valued due to their intersecting marginalized identities (Johnson, 2009). Together, these findings point to the importance of understanding the unique experiences of WoC in STEM.

Strategies for Promoting Success of Graduate Women in STEM

The evidence is clear that systemic issues, such as lack of supportive environments and gendered/racial microaggressions, and their cumulative impact affect persistence decisions for graduate women in STEM (Grossman & Porche, 2014; Ong et al. 2018). At the same time, women are employing strategies to thrive amidst these challenges. These strategies act as protective factors to mitigate the negative impact of challenging STEM experiences. To date, studies have focused on understanding the components of women's resilience and ability to persist in male dominated professions such as STEM, despite the disproportionate challenges

they face to that of their male counterparts. For example, Preston (2004) found that women's persistence in STEM graduate programs was strengthened by having access to a strong mentor. Similarly, Dawson et al. (2015) highlighted the salience of resilience among women in STEM, as well as psychosocial support from mentors and advisors to combat the range of barriers that women face, bolstering their success and persistence. Further, in a study by Cabay et al. (2018), women in STEM doctoral programs found that actively seeking out other female students and mentors was helpful during difficult times.

The understanding that psychosocial support can bolster persistence highlights the importance of building community and a sense of belongingness for women in STEM, which can often be found through counterspaces. Counterspaces have been defined as academic and social safe spaces that allow underrepresented students (such as women, students of Color, and WoC) to connect with others who hold a shared identity (Ong, et al., 2018). Ong and colleagues (2018) showed that counterspaces provide a safe haven for women in STEM from the larger male dominated classrooms and lab settings. These spaces have been known to increase access to mentorship, improve peer to peer relationships, combat feelings of isolation, and build supportive communities (Solórzano et al., 2000). They can also help women in STEM cope with common oppressive experiences that occur in academic settings (Ong et al., 2018).

Additionally, there has been a national push across the United States to address the mental health crises of graduate students in STEM (National Academy of Sciences, 2018). This initiative is especially relevant to graduate women in STEM, who often endorse greater levels of stress and anxiety and lower overall mental health to that of their male counterparts (Deziel et al., 2013; Saravanan & Wilks, 2014). A study by Arnold et al. (2019) showed that the utilization of counseling may be a positive strategy for buttressing the success of graduate women in STEM.

Counseling validated students' lived experiences, increased self-awareness, provided skill building, and facilitated decision making. These findings highlight the need for an in-depth understanding of the ways to support persistence among women in STEM amidst the highly prevalent and distressing barriers that they face.

Current Study

This project is part of a larger NSF-funded study within the *Career*WISE (CW) research program, which aims to understand and strengthen the persistence of women in STEM doctoral programs. The current study presents the voices of diverse graduate women in STEM – including both women who completed and who discontinued their STEM doctoral degree programs – to 'listen' and gain insights into their suggested strategies for STEM persistence.

Theoretical Framework

This study is framed by Social Cognitive Career Theory (SCCT; Lent et al., 1994). SCCT is aimed at explaining three interrelated aspects of academic and career development: (1) how academic and career interests develop, (2) how educational and career choices are made, and (3) how academic and career success is obtained. Based largely on Bandura's Social Learning Theory (Bandura, 1977), behavior results not only from the interaction between personal characteristics and environment, but from the interaction between personal development and evolving context. For women pursuing gender in nontraditional careers, such as those in STEM, it is crucial to understand how the combination of cultural, institutional, and individual barriers and support influences their career success, making SCCT particularly relevant to the study of persistence among graduate women in STEM.

Method

Participants

The data reported here were collected from 33 women from 21 different Research 1 universities in the United States. Twenty participants had completed STEM PhD programs and 13 participants had chosen to discontinue STEM PhD programs before completion. Participants ranged in age from 27 to 33 years and identified as Latinx (n = 6), Black/African American (n = 10), White/Caucasian (n = 11), and multi-racial (n = 6). Thirteen different STEM fields were represented across participants, including engineering, biological sciences, physical sciences, and mathematics. Participants who completed their degrees were recruited from academic departments, professional associations, minority STEM organizations, professional listservs, and alumni networks, while participants who discontinued their PhD programs were recruited using snowball sampling and referrals from academic departments and professional networks. Participants first completed a screening survey to determine that they met study eligibility requirements of being a woman who completed or discontinued a STEM doctoral degree since 2015 and who holds one or more of the following race/gender identities: Black, Latinx, White.

Procedure

Data for the current study were drawn from a multi-faceted project that is supported by the NSF and was approved by the Institutional Review Board at both University of Massachusetts Boston and Arizona State University. This larger study was designed to examine participants' perceptions of interpersonal support during challenging times in their STEM doctoral programs. Semi-structured interviews were conducted via the Zoom video conferencing platform and ranged in length from 60 to 90 minutes. Interviews were recorded and subsequently

transcribed. All participants received a $50 gift card upon completion of their participation. Participant names were de-identified for confidentiality purposes.

Data Analysis

The data reported here focus on the responses to the following question on the interview protocol: "*Drawing from your experience, what advice would you like to give to another woman [of Color, when appropriate] who is considering leaving her doctoral program?*" Transcriptions were analyzed by two members of the research team using a constant-comparative, open coding process (Glaser, 1965; Saldaña, 2014). Information from these interview responses led to the development of themes that described participant recommendations for promoting graduate women's STEM persistence. A process of consensus was used in order to increase the research team's understanding of the nuances of the data. Through weekly meetings, members were encouraged to express disagreements in order to refine the findings.

Positionality and Integrity Checks

The investigators for this study are four counseling psychology doctoral students, four professors of counseling psychology, and one professor of engineering. Together, we are committed to a strengths-based approach that focuses on increasing the well-being of others, helping to create positive change within graduate programs, and promoting holistic persistence. Our views have been informed by our current understandings, previous lived experiences, and expectations for the future of this topic. This includes our own gender, racial, and cultural identities (some of us being women, People of Color, and immigrants), our work as mental health clinicians, and our experiences of pursuing doctoral degrees. To help guard against the effects of confirmation bias, we worked to identify our assumptions. Through the processes of

weekly self-reflection, personal memos, and group discussions, we considered how to manage the influence of our privilege, identities, and perspectives in the research process.

Results

A total of four themes were identified to summarize participants' suggestions and recommendations to women and WoC who might be considering discontinuing their STEM doctoral programs, described below. Quotes from (de-identified) participants are utilized to further illustrate participants' recommendations.

Theme 1: Seek Interpersonal Support

The majority of participants (n = 20) underscored the importance of seeking support from individuals both within and outside of the STEM academic environment. This included connecting with other graduate students with shared identities (e.g., race and/or gender), creating support networks if none existed currently, surrounding oneself with people who want you to succeed (e.g., mentors/advisors), and utilizing online resources for support if in-person sources were unavailable (e.g., *Career*WISE, an online academic resilience coach; Bernstein, 2011). Graduate women in STEM suggested that it can be beneficial to have an advisor or another faculty mentor to guide them through the obstacles they might encounter during their academic journey. For example, Maria, a Latinx woman, shared that having a supportive academic advisor was instrumental to her success:

> I think I will advise any woman entering into a program to find an advisor right away, someone that can be [there] for them. That made a big difference for me, and I guess that may be helping them not to leave, because they have someone that is actually there for them, not just because they are part of the label of the department.

If seeking support within their program is not possible, virtual support spaces might be helpful in increasing interconnectedness with other women in STEM who might also not have access to others in their field.

Another aspect of this theme was participants' encouragement to seek support outside of STEM academic departments (e.g., family and friends). Those outside of STEM may be able to listen and offer interpersonal support that might not be readily available in one's STEM PhD program. Joanna, also a Latinx student, shared that her support structures played a crucial role in her persistence. She stated, "I think it's really important to create your community and your support system because without that, I definitely couldn't have made it through." Jessica, a White woman, further stated, "I appreciated when they [family and friends] reassured me that I could handle the situation and that I would make a good choice when selecting my advisor or that I'd properly prepare for the upcoming exam."

Theme 2: Prioritize Mental Health & Wellbeing

More than half of the participants (n = 17) discussed the importance of prioritizing mental health and well-being amidst the myriad of challenges. Specifically, participants suggested exploring and identifying the source of difficulties, assessing how a graduate degree aligns with one's identity, values, and life goals, and obtaining mental health services as needed. Renita, a Latinx graduate student who chose to discontinue her doctoral degree, recommended talking with a mental health professional. She stated:

> I also think mental health, like even if you don't feel like you're depressed, talking about it with professionals, mental health professionals, can help prevent thoughts that sometimes are just artificial, that may not have a basis, like, "Renita, you're not good." Well, where is that coming from? You *are* good. You got accepted into a program. What is it? What is causing that? If I had an earlier intervention on that, I would have been doing that.

Overall, the findings for this theme all focus on prioritizing the individual's mental health and wellness above everything else. The participants suggested that it might be useful to take a break from pursuing a doctoral degree if the individual still feels a significant psychological toll after attempting the mental health strategies (identifying challenges, seeking counseling, practicing

self-care). For example, three participants who chose to discontinue their STEM doctoral pursuits described doing so as an act of protecting their mental health.

Theme 3: Affirm and Encourage One's Belongingness in STEM

Fourteen participants, many of whom were WoC, stressed the importance of affirming women's belongingness in STEM. Further, participants encouraged graduate women in STEM to ground themselves in the knowledge that they are worthy and deserving of their place in the field. For example, Maria stated,

> We have a lot against us, professors, people that think that you don't deserve to be there because you are a minority, people that think that you are less, people that think that because you're a woman you have it easier than the rest, which sometimes is the other way around. You ha[ve] it harder because you have to show yourself three or four times more than a man will do. I think just acknowledging how much you have accomplished and how much you're worth, that's the biggest part of keeping going.

Throughout the academic process, participants asserted that being their own advocate was important and necessary to navigate an oppressive system where they were constantly racialized and/or gendered. Participants also noted that it was important to validate the array of feelings that arose because of the challenging situations, and to attempt to take the first step in identifying what might be helpful to navigate these challenges. A specific example of affirming one's belonging in a STEM doctoral program was positive self-talk, that is engaging in an optimistic internal dialogue that focuses on acknowledging one's strengths and abilities. Positive self-talk boosted overall confidence in navigating the program and helped participants acknowledge their resiliency throughout their path. Thalia, a Black woman, asserted,

> You're smart, you were smart before you got here. You're still smart, you still can do this and even if there are things you don't know, this is a part of your training. You're here to learn. Don't let anybody tell you, you're not smart. Do what you gotta do, I think that's the main thing.

Participants stated that these multiple ways of affirming one's belonging in STEM are likely to facilitate greater acknowledgement of women's academic accomplishments and persistence in their STEM doctoral programs.

Theme 4: Explore Different Academic Options

In addition to affirming women's place in STEM, 14 participants acknowledged the psychological toll that stemmed from persisting in a toxic academic environment and encouraged participants to explore alternative academic options as needed. Such exploration included finding a different advisor, being open to compromise, changing committee members and/or research topics, weighing the pros and cons of persisting in an unhealthy environment, switching to another institution or program to pursue STEM graduate studies, or following another, non-STEM related career path. For example, Libby, a Black graduate student, stated, "It's okay to explore your options and not feel like you have to be obligated to stay in a place that doesn't support your growth." Jane, a White woman, echoed similar statements when she shared,

> There's plenty of other people who've gone through it. Honestly, the only reason why I felt okay about [leaving my program] in the beginning was because I found someone else on Twitter who was very open about how they had left their PhD program after two years, but had gotten a grant, moved to a different school with a more supportive advisor, and they just got their PhD. I think that it's important to know that you're not alone, that other people have done this and that if you do want to finish the PhD, you can still do it somewhere else.

Consistent across participants' narratives was an acknowledgement of the myriad of difficulties that accompany the pursuit of a STEM doctoral degree for women from various racial/ethnic backgrounds. However, this acknowledgement was often paired with sentiments that affirmed women's belongingness in STEM and empowering suggestions to enact one's agency.

Discussion

This study foregrounded the voices of diverse graduate women in STEM – including both women who completed and those who discontinued their STEM doctoral degree programs – to gain insights into their suggested strategies for STEM persistence. Building on the SCCT framework (Lent et al., 1994), we aimed to increase understanding of the contextual barriers that women in STEM face and the actionable strategies that can be employed to address these barriers. During the qualitative coding process, four themes of recommendations emerged: seek interpersonal support, prioritize mental health and wellbeing, affirm and encourage one's belonging in STEM, and explore different academic options as needed. These themes encompass specific practices designed to facilitate persistence and success of women in their STEM doctoral programs.

It is important to emphasize that it is not a woman's responsibility to change the system that has oppressed her voices and experiences (Cabay, et al., 2018; Ong et al., 2011). Effectively addressing these oppressive environments requires transformational change at the departmental and institutional level. Whilst such systemic change is underway, it is crucial to examine the tools and strategies that women may apply in their current environment. Recommendations for women in STEM, by women in STEM, suggest that acknowledging the negative environments, receiving validation, cultivating empowerment, and taking action are avenues through which women can succeed amidst these challenges. Thus, this study yielded several important implications at both the individual (student) and systemic (academic program/institution) level.

Implications

For women currently in STEM graduate programs, it is beneficial to seek out counterspaces, such as affinity groups or support groups, either within or outside of academic

settings. These groups provide an opportunity to foster relationships and mentorships with peers who hold shared identities (Ong et al., 2018). In addition, advocating for oneself by speaking up about personal and academic challenges can be a valuable practice for graduate women in STEM. Taking a proactive approach to one's mental well-being is also important throughout a woman's academic journey in STEM. Students may seek traditional counseling services or seek other culturally relevant wellness approaches and/or resources.

It is crucial for academic departments and institutions to recognize and acknowledge the traditional systemic barriers in STEM that continue to marginalize women, particularly WoC (Lewis et al., 2013). To address these barriers, STEM departments might use their networks, for example, to connect women to groups of students with shared identities. In addition to recommending affinity groups, they can provide online resources designed to address common challenges faced by graduate WoC in STEM (e.g., ASU CareerWISE: Home, VanguardSTEM, Latinas in STEM). These spaces may help to further facilitate a sense of support, solidarity, and belonging for women in STEM. Similarly, advisors, mentors, and other faculty might be able to foster a more inviting environment by allowing women and WoC to talk about not only academic challenges, but personal challenges that might arise during their doctoral programs.

An important next step at the institutional level is to incorporate specialized training for STEM faculty members to facilitate greater understanding of the experiences of women and WoC in STEM and to improve their mentorship skills. In addition, it is important that STEM faculty members affirm graduate women's place in STEM to counteract the barrage of messages that often discount their legitimacy and credibility. Institutions need to also gain full understanding of the ways that the toxic STEM climates affect graduate women's mental health and take action to address these issues. STEM faculty and academic departments might aid

graduate women who are seeking supportive spaces by promoting greater awareness of available groups and resources at a university, community, and national level.

Conclusion

The current study used an intersectional approach to identify factors that contribute to academic persistence and outcomes among graduate women pursuing STEM careers. Results yielded four major themes that summarized women's recommendations to other women who might be considering discontinuing their STEM doctoral programs. Findings reveal that seeking different types and sources of support, addressing mental health and well-being, self-affirmation, and exploring different options are important practices.

Graduate women in STEM should not have to continuously fight against systemic injustice. Future research is encouraged to focus on identifying ways to provide better support and to facilitate improved mental health for women in STEM doctoral programs. It is our hope that institutional changes will allow women and WoC in STEM to feel confident and valued within academic spaces, giving them a sense of reprieve and a greater capacity to persist in their academic and career goals.

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