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Abstract: This qualitative case study was part of a larger, multi-year National Science Foundation funded project that centered upon a networked improvement community (NIC) of nine institutions seeking to improve racial climate in STEM graduate programs. We were particularly interested in the role of STEM graduate students at two NIC institutions in changing their depart-

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mental climates and their experiences engaging in this work as they were socialized to their disciplines/fields. We found that STEM graduate students had a multifaceted role that combined being catalysts of change, laborers, and supplements for faculty. STEM graduate students, particularly racially minoritized women, were compelled to initiate change and to engage in labor to advance diversity, equity, and inclusion, since they could not wait for faculty and administrators to act. While STEM graduate students used their agency to engage in work that they believed was necessary, it negatively affected their well-being and academic success, limited their access to professional opportunities, and unintentionally perpetuated faculty inaction. Our findings highlight the asymmetrical nature of bi-directional socialization since graduate students can initiate efforts to improve climate but have limited power to implement change. Furthermore, our work calls for faculty and administrators to fully take up the labor of improving racial climate and to alleviate the burdens placed upon graduate students.

Keywords: Graduate students, STEM, organizational change, professional socialization

Despite calls to increase the compositional diversity of students in science, technology, engineering, and mathematics (STEM) (National Academies of Sciences, Engineering, and Medicine [NASEM], 2018; Wendler et al., 2010), graduate programs in these fields remain dominated by those who are white and/or men (Okahana & Zhou, 2018). While more racially minoritized and women students are entering STEM graduate programs than they have historically (NASEM, 2018; Okahana & Zhou, 2018), these students often receive less mentoring from faculty, are viewed as less capable, and are excluded from peer groups more regularly than their peers who are white and/or men (Burt et al., 2018; Gildersleeve et al., 2011; Noy & Ray, 2012). Ultimately, these hostile racial and gender climates negatively affect students' access to opportunities, their retention and success, and their desire to pursue academic careers (Burt et al., 2018; Gildersleeve et al., 2011; Noy & Ray, 2012; Turner & Thompson, 1993). Given the focus on increasing diversity rather than advancing equity and inclusion through the creation of identity and power-conscious policies and practices that are designed to support minoritized students' sense of belonging and their personal and professional success, the pipeline to careers in STEM remains broken to the detriment of students who are racially minoritized and/or women. Put more plainly, increasing compositional diversity is essential to advancing diversity but it is insufficient to making environments more equitable and inclusive.

Acknowledging the need to better support the personal, academic, and career success of racially minoritized and women students in STEM graduate programs, institutions created initiatives to improve departmental climates (NASEM, 2018; Posselt, 2020). For example, institutions may host workshops

to increase faculty members' understandings of implicit bias or culturally competent mentoring and advising (Hill et al., 2011). However, training may not translate into improved climate and systemic changes that promote more equitable policies and practices, given their focus on enhancing individual knowledge and skills. Furthermore, diversity, equity, and inclusion (DEI) are not consistently viewed as core knowledge in STEM fields, since the dominant stance that science is objective, and scientists' identities are not relevant to their work (Harding, 1994; Le & Matias, 2019; Posselt, 2020). Given the prevalence of identity evasive approaches to science, some faculty do not prioritize, and others actively resist, opportunities to learn about inclusive and culturally responsive teaching, advising, mentoring, and admissions practices in STEM. Moreover, faculty who center DEI in STEM may not be rewarded for their work in these areas, since it is regularly viewed as extra or tangential to the core work of scientists (NASEM, 2018). Resistance to DEI work in the academy is not limited to STEM fields, and yet the dominance of power and identity-evasive approaches to science exacerbates challenges to improving climate and to advancing equity and inclusion.

Since advancing DEI has not historically been a central component of faculty work, particularly for those in STEM, graduate students regularly drive efforts to improve climates for race and gender (Perez et al., 2019; Porter et al., 2018; Truong et al., 2016). Yet, there is limited research on students' efforts in STEM fields to change their environments to advance inclusion (Porter et al., 2018), since most change efforts center faculty, administrators, and professional associations roles in creating and sustaining organizational change (Gehrke & Kezar, 2017; Hill et al., 2011; Kezar et al., 2015; Posselt, 2020). Understanding the role that graduate students play in changing climate is vital since their work is often invisible and may not be sustained by faculty and administrators. Thus, examining graduate students' efforts to change climate may illuminate another way power operates in graduate education to sustain inequitable learning environments and hostile racial climates. Accordingly, our study explored these questions: *What role do STEM graduate students play in trying to change the climates of their departments as they are socialized to their disciplines and fields? How do STEM graduate students describe their experiences trying to create more inclusive departments?*

Review of the Literature

To situate our research, we first examine the nature of STEM graduate education with particular attention to how the content and structure of programs contribute to identity evasive approaches to training and hostile racial and gender climates. Subsequently, we examine the literature related to advancing diversity, equity, and inclusion in graduate education to highlight approaches to improving climate and factors that can enhance or derail change efforts.

STEM Graduate Education

Across disciplines and fields, graduate education is structured to cultivate students' expertise and to provide them with the knowledge, skills, and habits of mind necessary to advance their area of study or practice (Austin & McDaniels, 2006; Gardner & Mendoza, 2010; Golde, 2006; Weidman et al., 2001). Graduate students are socialized to become "stewards of the discipline" or "someone who will creatively generate new knowledge, critically conserve valuable and useful ideas, and responsibly transform those understandings through writing, teaching, and application" (Golde, 2006, p. 5). Although there are disciplinary distinctions in graduate training at the doctoral level, effective stewardship across fields requires developing capacity for conducting research that is designed to advance knowledge, and, in some instances, to address problems in the world (Gardner, 2007, 2010).

Within STEM disciplines and fields, honing research expertise further requires increasing doctoral students' understanding of the scientific method, their technical skills to conduct lab or field research, their abilities to engage in independent research, and their capacity to work in laboratory teams (Burt, 2017; Gardner, 2007, 2010; Louis et al., 2007). Given the emphasis on mastering scientific methods, socially constructed identities and in turn, knowledge and skills related to DEI are widely seen as distant rather than core to STEM disciplines and fields (Harding, 1994; Le & Matias, 2019; Perez et al., 2020; Posselt, 2020). In effect, STEM graduate students are socialized to identity-evasive approaches to their disciplines and fields that frame science as objective. Evading identity, and in turn systems of oppression, are levers in creating and perpetuating hostile racial climates within STEM (Le & Matias, 2019; McGee, 2020).

Learning the norms, standards, and practices associated with becoming a good researcher and steward of the discipline does not happen in isolation. Scholars have highlighted the powerful role that faculty members play in influencing graduate students understanding of their discipline or field, their access to opportunities and resources that would support their development as scholars, and in shaping their career interests (Austin & McDaniels, 2006; Burt et al., 2018; Gardner, 2007, 2010; Gardner & Mendoza, 2010; Noy & Ray, 2012). In STEM disciplines and fields, graduate students' experiences working with faculty, postdoctoral fellows, and peers in laboratory settings also shape their development as researchers and their abilities to achieve their personal and professional goals (Burt, 2017; Gardner, 2007; Louis et al., 2007).

Unfortunately, supportive relationships with faculty, postdoctoral fellows, and peers are not present for all students, and scholars have consistently illuminated the inequalities and hostile environments that exist in graduate education. For example, students who are racially minoritized and/or women receive less mentoring and access to opportunities than their peers who are

white and/or men (Burt et al., 2018; Gardner, 2008; Joseph, 2012; Noy & Ray, 2012; Turner & Thompson, 1993) at predominantly and historically white institutions (PHWIs). Moreover, racially minoritized graduate students are often excluded from peer groups and are seen as less capable than their classmates (Burt et al., 2018; Gildersleeve et al., 2011) at PWHIs. Racially minoritized graduate students regularly describe themselves as being hypervisible and yet completely invisible in their departments (Burt et al., 2018; Gildersleeve et al., 2011; Truong et al., 2016). Participants in Joseph's (2012) study of African American women in STEM graduate programs characterized the climates at their PWHIs as "a little chilly" (p. 129). While participants said they did not experience overt racism, they described white faculty and peers as "ambivalent" (Joseph, 2012; p. 132) about their presence and somewhat suspicious of their academic abilities. This was in stark contrast to racially minoritized participants in other studies (e.g., Burt et al., 2018; Gardner, 2008; Gildersleeve et al., 2011; Perez et al., 2019) who described being explicitly targeted and excluded based on their racialized and gendered identities. In effect, as many racially minoritized and woman graduate students at PWHIs are socialized to become stewards of their discipline, they also receive explicit and implicit messages that they do not belong in their graduate programs and that they are not capable of succeeding.

Advancing Diversity, Equity, and Inclusion in STEM Graduate Education

Given the overwhelming evidence that STEM graduate education has not been consistently designed to support the retention and success of racially minoritized and women students, some departments, institutions, and disciplinary organizations have engaged in initiatives designed to improve racial climate and to advance DEI. Efforts to improve racial climate in STEM have touted the broad benefits to society if more racially minoritized students complete their degrees. For instance, scholars have argued that a racially diverse STEM workforce enriches teams and provides more perspectives to draw upon as individuals develop new technology and scientific innovations that benefit all (McGee, 2020; NASEM, 2018; Wendler et al., 2010). A racially diverse STEM workforce may also have economic benefits as individuals generate new scientific advancements, create new companies, and engage in partnerships with industry and the government (McGee, 2020; NASEM, 2018). Some have also argued that improving racial climate in STEM is an issue of justice and that racially minoritized students should have their intellectual curiosity nurtured (McGee, 2020; Prescod-Weinstein, 2021). Furthermore, the presence of more racially minoritized individuals in STEM may be vital to interrupting how scientific racism has been used throughout history to harm racially minoritized individuals, often to the benefit of (white) society (McGee, 2020).

Despite the potential to frame improving racial climate in STEM as an issue of equity and of justice, it is often approached from the standpoint of diversity and inclusion, which reflect the language of appeasement (Stewart, 2017). Furthermore, approaches to changing climate may happen episodically and may not attend to departmental culture and power dynamics which in turn limits the effectiveness and sustainability of interventions. In effect, many interventions are designed to leave the status quo that centers whiteness intact; they modestly increase diversity and inclusion rather than transform systems to be more equitable (McGee, 2020). For example, departments may focus on recruiting a compositionally diverse group of applicants in combination with revisiting their admissions practices to enroll more students who are racially minoritized and/or women (Griffin & Muñiz, 2015; Jones, 2016; Posselt, 2020). They host workshops and speakers to increase faculty members' understandings of DEI and to improve their capacity to engage in cross-cultural mentoring and advising (Hill et al., 2011). Departments also create programs designed to connect minoritized students with faculty and peers who share their identities (Griffin et al., 2018; Posselt, 2020). These strategies may be met with resistance despite their limited attention to power since DEI work is seen as tangential rather than core to the knowledge and skills needed to advance STEM disciplines and fields (Harding, 1994; Le & Matias, 2019; Perez et al., 2020).

Despite the myriad of challenges to advancing DEI in STEM departments, creating change is possible. Posselt (2020) found that changing climate involves "activity on multiple scales and through a combination of top-down, bottom-up, and inside out forces. These efforts involved intentionally, time, coordination, and honest self-analysis" (p. 14). Rather than relying on one approach to creating change, advancing DEI often required a combination of advocacy from faculty and graduate students, shifts away from daily practices that perpetuated negative environments for minoritized students, creating or changing policies to promote equity, and demonstrating commitment through providing adequate resources and vocal support from departmental and institutional leaders. Jones (2016) argued that creating change in STEM departments also required those involved to understand their political environment, to build relationships within and outside of the institution, and to regularly conduct assessments to demonstrate the effectiveness of DEI initiatives. Thus, changing climate requires full participation from members of the departmental community, a willingness to change individual and group-level policies and practices, relationship building, and sustained commitment from departmental and institutional leadership. Departments may be more inclined to take on the difficult work of improving climate if there are similar efforts across the discipline or field like there have been in biology education (Society for the Advancement of Biology Education Research [SABER], 2021) and engineering (National Academy of Engineering [NAE], 2021).

That being said, many STEM departments do not engage in DEI work in the collaborative manner described by Posselt (2020) and Jones (2016), given the decentralized nature of faculty work and varied commitments to social justice. It is not uncommon for DEI work in STEM to rest on the shoulders of a faculty champion or a committee that is charged with improving departmental climate (Jones, 2016; Posselt, 2020). In turn, the labor of improving climate in STEM departments may fall to minoritized graduate students who are willing to serve on committees or engage in other advocacy work to improve their experiences at the expense of their degree progress and well-being (Perez et al., 2019; Porter et al., 2018; Rodriguez et al., 2021). While scholars have highlighted the vital role that faculty members play in changing climate in STEM departments (Hill et al., 2011; Jones, 2016; Posselt, 2020), there is a need to better understand graduate students' roles in this process since their engagement may be undefined and their work may be invisible. Accordingly, this study examined the roles STEM graduate students played while trying to change the climate of their departments, and their experiences engaging in this work as they were socialized to becoming stewards of their respective disciplines and fields.

Theoretical Framework

Socialization describes how individuals learn the norms, values, culture, and traditions of a group or community they are entering (Thorton & Nardi, 1975; Tierney, 1997; Van Maanen & Schein, 1979; Weidman et al., 2001). In the context of doctoral education, socialization prepares individuals to be stewards of their discipline and to pursue careers in the academy (Austin & McDaniels, 2006; Weidman et al., 2001). Although the graduate education literature centers honing field-level expertise via socialization (e.g., Burt, 2017; Gardner, 2007, 2010), Perez et al. (2020) argued that graduate students are concurrently socialized to understand the relevance of DEI or lack thereof to their work, based on explicit and tacit messages sent by faculty and administrators. Accordingly, we assert that socialization is well-suited to understanding the (un)intentional messages sent to graduate students as they work to improve racial climate.

Given the aims of graduate education, frameworks used to study graduate students' socialization attend to the content, process, and outcomes of this process as students matriculate (Perez et al., 2020). For example, Weidman et al. (2001) built upon foundational work by Thorton and Nardi (1975) that described the developmental stages individuals move through as they acquire new roles, form their professional identities, and commit to their professional communities. In doing so, Weidman et al. (2001) noted that "socialization in graduate programs is a nonlinear process during which identity and role commitment are developed through experiences with formal and informal

aspects of university culture as well as personal and professional reference groups outside the academe" (p. 36). Thus, as graduate students dynamically move through anticipatory, formal, informal, and personal stages of socialization and interact with their various educational environments, they learn about their disciplines/fields and the academy, how they function, and how they view themselves within them.

While Weidman et al.'s (2001) widely used framework has helped scholars understand the complexity of graduate students' socialization, it has been critiqued for not adequately attending to students' identities and how power, privilege, and oppression shape graduate education and students' experiences within it (Garcia et al., 2020; Gardner, 2008; Perez et al., 2019; Winkle-Wagner et al., 2020). Gardner (2008) noted that the "process of socialization generally acts upon individuals uniformly, not allowing for many individual differences … [yet] socialization in academe is neither color-blind nor gender-blind" (p. 128). With this in mind, Brayboy et al. (2014), Garcia et al. (2020), and Winkle-Wagner et al. (2020) argued that understanding Indigenous, Latinx, and Black individuals' socialization in the academy, respectively, requires acknowledging their racialization, their strengths, and the effects of white supremacy. Notably, Winkle-Wagner et al. (2020) argued that Black graduate students' socialization was two-way rather than uni-directional, meaning students can use their agency to influence their departments and their disciplines (Austin & McDaniels, 2006; Perez et al., 2019).

Acknowledging how systems of oppression shape and constrain graduate students' socialization and their agency, our research used a bi-directional view of socialization to explore STEM graduate students' efforts to improve climate as they learned the norms, standards, and values of their departments and fields. Rather than solely focusing on the structure of graduate students' socialization (Van Maanen & Schein, 1979), we attended to how students worked to change the racial climate in their departments (Tierney, 1997). In doing so, we highlight the roles that graduate students played in reorienting socialization processes to attend to DEI and what they learned in the process of engaging in this work (Perez et al., 2019, 2020). While we believe in graduate students' agency, we conceptualize bi-directional socialization as being asymmetrical given the power structures that are inherent in graduate education. Graduate students can leverage their agency (Perez et al., 2019; Winkle-Wagner et al., 2020) to generate ideas and to initiate changes but they often lack the power and authority to make decisions about policies and practices. In other words, graduate students' agency remains constrained in power contexts that are designed to maintain the status quo under the guise of preserving the discipline or field.

Methodology

This study was part of a larger, multi-year National Science Foundation (NSF) project centered upon a networked improvement community (NIC) of nine institutions seeking to create more inclusive STEM environments. NICs are scientific learning communities that engage in rapid cycles to test, assess, and adjust strategies for addressing a shared problem (Bryk et al., 2011; LeMahieu, 2015). This approach to advancing change allows individuals to test strategies in varied contexts, which can inform understandings of the shared problem and in turn how to adapt interventions to be more effective across settings (Bryk et al., 2011; LeMahieu, 2015).

In our study, NIC institutions support racially minoritized STEM graduate students and their interest in faculty careers by working to improve racial climate within departments. To do this, institutions implement, evaluate, and adjust interventions to cultivate faculty members, graduate students, and post-doctoral fellows' knowledge and skills related to DEI. Members of the NIC share good practices and collaborate to negotiate challenges in order to enhance their collective capacity to better serve racially minoritized students and to improve racial climate. Given that NIC institutions were actively engaged in work to change racial climate in STEM departments, they were well suited to understanding graduate students' role in this process.

We engaged in qualitative research at two institutions within the NIC and utilized purposeful and maximum variation sampling (Patton, 2002) within a constructivist multiple case study design to allow for greater understanding and contextualization of the research site environments. Specifically, a constructivist multiple case study allowed us to recognize multiple perspectives of STEM graduate students and to situate their lived, constructed realities within the rich, complex departmental context in which they participate (Charmaz, 2006; Stake, 2000). Stake (2000) allowed us to take an interpretive and holistic approach, including building an understanding of the relationships between ourselves, as researchers, and participants in the co-construction (rather than discovery) of knowledge. Drawing upon Charmaz (2006) allowed us to engage with the subjective nature of research, highlight participant voices within our process of co-creating knowledge, and contextualize findings within particular settings or a series of events. In doing so, our approach allowed us to understand STEM graduate students' experiences and their roles in trying to change the climates of their departments.

Positionality

For several years, we have served as social scientists working on the NSF-funded project and met regularly with the NIC participants, including campus representatives from the two data collection sites. At regular intervals throughout the project, we presented and discussed our research findings

with the NIC, and campus representatives utilized what they learned from the research to inform their interventions. Our ongoing engagement with the NIC also helped us understand varied approaches to change within and across institutions, and the barriers and opportunities for improving racial climate at our data collection sites.

Rosie is an Asian American woman in a non-STEM field whose scholarship focuses on graduate education and minoritized populations and whose undergraduate degree was in the biological sciences and psychology. Rudi is a Black man and a graduate student who was born outside of the U.S.; they are studying in a non-STEM field and their scholarship focuses on international students. Sarah is a Latina woman in a non-STEM field whose scholarship focuses on STEM education in engineering and computing and minoritized populations. As a team, we collectively identify as equity-minded scholars coming from various social justice-oriented stances whose commitments to advancing DEI are reflected in our approaches to teaching, research, and service. We are also racially minoritized scholars, and our racialized experiences in higher education sensitized us to the roles that minoritized individuals play in changing departmental climate and the costs associated with this labor since we have often engaged in this work ourselves. However, we have varied experiences with and approaches to DEI work as current and former graduate students, administrators, and faculty members. Although our graduate degrees are not in STEM fields, our positionalities and ongoing engagement with the NIC sensitized us to the experiences of STEM graduate students, the roles they play in trying to change the climates of their departments, and the challenges of engaging in this work. Being familiar with, but outside of STEM disciplines and fields also allowed us to understand some of the unique dynamics of DEI work in STEM graduate education.

Data Collection Sites

We conducted research at two predominantly white universities within the NIC, Mid-Atlantic University and Northeast University (pseudonyms). Each institution served as a bounded case for data collection and analysis. We selected these sites based on their differing institutional types and approaches to improving racial climate in STEM departments.

Mid-Atlantic University, a large, predominantly white, urban institution, offers a wide range of highly ranked graduate STEM degree programs and is racially and ethnically diverse. Approximately 25% of graduate students from the U.S. are racially minoritized (i.e., Black, Hispanic/Latinx, Native American, Asian American, Multiracial) and international graduate students are approximately 30% of all graduate students. Interventions at this campus focused on providing community-building and mentoring experiences for racially minoritized graduate students and postdoctoral fellows. They are also creating faculty advising, mentoring, and diversity programming to support racially minoritized graduate students.

Northeast University, a small, predominantly white, elite private, and rural institution has a strong reputation for STEM excellence, draws graduate students and faculty internationally, and has very active graduate school diversity and inclusion programming. Almost half of graduate students come from outside of the U.S., and 20% of students from the U.S. are racially minoritized. Northeast University focused initiatives on improving the abilities of students, faculty, and staff to recognize and combat implicit and explicit bias. They enhanced career development opportunities for racially minoritized graduate students and post-doctoral fellows.

Data Sources

Our primary data sources for this analysis were focus groups conducted with STEM graduate students, faculty, administrators, and post-doctoral fellows at each research site. Our approach enabled research participants to engage in shared meaning-making with each other and surfaced a range of participant perspectives (Glesne, 2011).

Recruitment

We worked with the graduate colleges of each institution to purposefully recruit focus group participants who represented an array of social identities, disciplines, and roles (Patton, 2002). Our definition of STEM was aligned with the NSF, meaning that graduate students from the geosciences, life sciences, mathematics and computer sciences, natural sciences, physical sciences, and selected social and behavioral sciences (e.g., psychology, economics, political science) were eligible to participate. Faculty participants were from STEM disciplines and fields, and administrators were individuals who regularly advised or worked with STEM graduate students. Across institutions, we facilitated 14 focus groups and three interviews with 34 graduate students and 27 faculty and administrators. We conducted interviews when individuals could not attend scheduled focus groups, but still desired to contribute to the study.

Participants

We conducted eight focus groups with 33 STEM graduate students across institutions and one interview with a participant who was unable to attend a focus group. Participants included seven Black, eight Latinx, six Asian/Asian American, three Multiracial, and 10 white STEM graduate students. All participants were U.S. born, with the exception of two international graduate students. Our graduate student participants included 21 women and 13 men who were enrolled in the agricultural sciences (2), biological sciences (13), computer sciences (3), engineering (11), physical sciences (3), and social sciences (2).

We also conducted six focus groups with 25 faculty members, administrators, and post-doctoral fellows across both institutions and interviews with

a faculty member and an administrator who could not attend focus groups. Faculty, administrator, and post-doctoral participants included 19 women and eight men. Seven participants served as administrators, while six served as faculty members; 10 participants identified as having roles as both faculty and administrators. Four participants were postdoctoral fellows at the time of data collection. Participants who were faculty, administrators, and post-doctoral fellows represented a range of disciplines/fields/roles, including agricultural sciences (3), biological sciences (7), computer sciences (3), engineering (3), physical sciences (3), and social sciences (2), and central administrative support (5). Many of the participants who were faculty, administrators, or post-doctoral fellows (16) had worked at their respective institutions for less than five years. We did not collect demographic information related to faculty, administrator, and post-doctoral fellows racialized and gendered identities to reduce the potential of deductive disclosure. Some faculty, administrator, and post-doctoral fellow participants did name their racialized and gendered identities during focus group conversations, and we noted those accordingly.

Focus Groups

Our focus groups placed participants in conversation with those who had similar roles at the institution. We were cognizant of the power differentials between graduate students and faculty members, administrators, and post-doctoral fellows. As such, graduate students met in focus groups separate from those with faculty, administrators, and post-doctoral fellows at their institution. We were also mindful of creating spaces where participants would be more comfortable sharing their racialized experiences and perspectives on changing racial climate. Accordingly, racially minoritized graduate students met in focus groups separate from white graduate students. When possible, we also created opportunities for racially minoritized faculty, administrators, and post-doctoral fellows to meet separately from their white colleagues.

Our semi-structured focus group protocol explored the experiences of STEM graduate students, factors that contribute to the racial climate in the department, and efforts to improve racial climate in the department. Sample questions for all groups included: In what ways does your department promote a positive (or difficult) climate for underrepresented graduate students? Who is engaged in diversity, equity, and inclusion work in your department? We did not explicitly ask graduate students about their efforts to improve racial climate in their departments, nor did we ask faculty, administrators, or post-doctoral fellows about graduate students' engagement in this process. Nonetheless, our questions about departmental efforts to change racial climate yielded rich information about graduate students' role in this work. Each focus group was approximately 90 minutes long and was professionally transcribed.

Data Analysis

We coded focus group transcripts with a systematic, inductive approach (Bogdan & Biklen, 2003) to capture developing themes. Sensitized by the literature, socialization theory, our overarching research questions, and reflective memos that we wrote during data collection, we created an initial list of inductive codes of factors that informed graduate students' socialization (e.g., advisor interactions, departmental climate) and efforts to change racial climate (e.g., professional development, committees). Then we independently coded one focus group using the initial list of inductive codes. After coding the first focus group, we met to reassess the list of codes, then came to consensus on a revised coding scheme that was used to examine the remaining transcripts. This revised coding scheme included codes for challenges for racially minoritized graduate students (e.g., racialized taxation, mental health) and resistance to change.

From that initial coding, we subsequently explored relevant excerpts and looked for patterns among participants' experiences. We reexamined excerpts that were flagged with the code "change strategies" to identify what roles graduate students played in creating change and how they characterized these experiences. We independently reviewed the "change strategies" excerpts and generated memos documenting graduate students' role in these processes with illustrative examples to support our commentary. As we reviewed excerpts, we attended to directionality and constraints of socialization, students' learning during change processes, and the effects of trying to change climate (e.g., racialized taxation, effects on degree progress). We then organized the data into themes based on the insights across our coding memos. Our findings represent the shared experiences of graduate students between the two cases based on insights from graduate students, faculty, administrators, and post-doctoral fellows.

We used several trustworthiness strategies to enhance our work, including writing thick descriptions, engaging in de-briefing and consensus building, and exploring our positionalities (Knafl & Breitmayer, 1989). Our team engaged in a series of debriefing sessions to discuss emerging insights as we coded the data and built consensus about the themes we generated. Subsequently, we wrote thick descriptions of each theme with multiple examples to illustrate our insights across participants and institutions. We strengthened our analysis through triangulation among multiple researchers with varying positionalities (Knafl & Breitmayer, 1989). Further, we explored our positionalities and discussed how our socially constructed identities, backgrounds, and experiences shaped how we came to the work and interpreted the data.

Findings

As STEM graduate students tried to change the climate of their departments, they had multifaceted roles that combined being (a) catalysts of change, (b) laborers, and (c) supplements for faculty. These facets of being a graduate student change agent were present across the disciplines and were described by graduate students, post-doctoral fellows, faculty, and administrators (see Table 1 for additional examples). While there were similarities in graduate students' role reported across institutions, disciplines, and fields, there were nuanced differences when we attended to racialized and gendered identities. Few racially minoritized men reported engaging in DEI labor, and white graduate students rarely took direct action to improve departmental racial climate. Accordingly, we primarily use quotes from racially minoritized women to highlight the racialized and gendered labor uncovered in our analysis, the urgency of working to improve climate, and the costs associated with it. Since many racially minoritized participants were one of few or the only individual who holds their socially constructed identities in their department, we did not name their race or ethnicity, and we described disciplines and fields in broad categories to reduce the potential for deductive disclosure.

Graduate Student Change Agents Are Catalysts who Initiate DEI Change to Survive

Efforts to change climate in STEM departments were regularly catalyzed or initiated by graduate students who started and added momentum to initiatives (e.g., recruitment, diversity committees) hoping to improve their experiences and those of future students. Students also asked administrators difficult questions about policies and practices that pushed departmental and institutional leaders to take action to address their concerns. These efforts to shift departmental and at times institutional climate and to create organizational structures, reflect the bi-directional nature of socialization since students used their agency to try to change environments whose norms, standards, and practices contributed to negative climates for race and gender. Along the way, students received (un)intended messages about the role of DEI in the departments; they were socialized to understand that DEI work and improving climate was not a priority for many faculty members, and if change was to occur, they needed to initiate it.

Graduate students acting as catalysts of change was particularly pronounced at Northeast University where many graduate students reported their work trying to improve racial climate. For example, Jackie, a racially minoritized woman student in the biological sciences, described coordinated advocacy efforts by graduate students across the university that culminated in a list of demands to the president. Concurrently, she initiated change in her department:

Table 1.
Additional Quotations Illustrating Facets of Graduate Students' Role in Changing Racial Climate

Institution	*Demographic Information*	*Institutional Role*	*Discipline or Field*	*Illustrative Quote*
		ROLE FEATURE: CATALYST OF CHANGE		
Northeast	Racially minoritized man	Graduate student	Biological sciences	I would say that most of it started with the students. Actually, the former graduate student who was in my lab who has now left, he and I did a lot of outreach from the beginning. And then, we got connected with some cool offices at the graduate school level to start to do some more outreach. And then, I think people started noticing, and we sort of hit this critical mass of, "Okay. We have X number of students that are all interested in this and care about this." And so, when all of us were saying things, eventually, some of the faculty started to notice so, we were able to start forming this committee and working on some things.
Northeast	white woman	Administrator		The students will come to me and they'll say, "I'd really like to take a look at some of the statistics for my field and see what's happening here. Why aren't students of color ending up in our program?" … And then what they do is they take that information and take it to their director of graduate studies and then nothing happens. Or something might happen. We have one field who they're just an absolute trendsetter, I think, here. They have made such a transformation

Institution	*Demographic Information*	*Institutional Role*	*Discipline or Field*	*Illustrative Quote*
				just in three years in terms of the way that they look at applicant, the way they treat their students once they're here. Not everyone, but there have been real changes at the faculty level in this one specific department.
		ROLE FEATURE: LABORER		
Mid-Atlantic	white man	Faculty	Physical Sciences	I think a lot of the diversity work does get pushed onto underrepresented minorities and I think it's a real problem. But if I compare my department with other [physical sciences] departments … I think we're better than most, but that doesn't mean that we don't have a really long ways to go. I would say the same thing within the university. I think, largely driven by our graduate students.
Northeast	Racially minoritized man	Graduate student	Engineering	When you are from a marginalized community, again you're educating people. But it's also like I must do average. I must mentor. I must teach. I must do all of this. Also, I have to do research, because I'm going to be help to the same regard as my peers who maybe are not facing similar challenges. And they are also inherently more productive because I don't have to spend x number of hours a week just focusing on surviving through the PhD … For me I'm racially, ethnically, you know Asians aren't considered a minority by any means in STEM. But that doesn't mean I'm not gonna do my best to be involved in STEM outreach, diversity programs in engineering.

Northeast	white woman	Administrator		I sat down from a friend of mine who's a graduate student right now, saying that she's starting to experience the diversity fatigue because she's involved in a lot of diversity efforts on campus. She said, "I'm having a hard time finding time to do the research I'm excited about." So I think this is a pressure I've only heard expressed by graduate students and postdocs of color, this feeling compelled, like there's so much work that I need to do that's academic and there's so much work that I want to do in terms of changing campus climate, and it's exhausting.
ROLE FEATURE: SUPPLEMENT FOR FACULTY				
Mid-Atlantic	white woman	Faculty/ Admin	Engineering	And they hold spring Open Houses, just like there's college Open Houses and then there's this one that the students put on specifically in [engineering subfield]. And I think, at some level it's nice having the grad students and the undergrad feeling like they're giving back.
Northeast	white man	Graduate student	Agricultural Sciences	I would say that a lot of departments have counsels and things like that but interesting how effective they are and who is involved with them. I was part of organizing a massive recruitment event last weekend. Brought in 40 undergrads from a variety of backgrounds, all across the country. But that was all grad student driven. It's the third year of the program and there's funding from the [college and dean], I think, the reason that we have enough support for it.

Institution	*Demographic Information*	*Institutional Role*	*Discipline or Field*	*Illustrative Quote*
Northeast	Racially minoritized man	Student	Engineering	Many of us are involved with the regular ambassador program. … It's almost a duty for us to go to these conferences, right? Be able to share our experiences with undergrads interested in doing grad school. Be like, "Hey, it's gonna be hard. But, you got me. You have me." I guess that's the reason why we're so passionate about it in the first place … a common pattern that every single one of us share is that we are willing to facilitate an environment so that people who come after us, they won't have to go through the same struggles that we went through.

> My department recently created this diversity council. By we, I mean me, and the girls that were a year below me. We went to the Director of Graduate Studies (DGS), and it was around the time when we did the list of demands [to the university]. We said they should have a diversity council. We thought of bringing [DEI training name] to the faculty. But, the faculty, they don't want to do it. It's too much time, it's only two hours, but they're like, it's too much time.

Jackie not only worked with her peers to create a new structure in her STEM department that would engage in DEI work, but she identified actionable ways for faculty to learn more about creating more inclusive learning environments. However, she immediately encountered resistance since faculty perceived a two-hour DEI training as taking up "too much time." The faculty in Jackie's department rebuffed efforts by graduate students to infuse DEI into their socialization process and to resocialize faculty to incorporate DEI into their work. In effect, faculty members' resistance reaffirmed identity evasive and objective approaches to science and the idea that knowledge and skills related to DEI were not core to being a good biologist.

Carrie, a white woman faculty member in the biological sciences at Northeastern University, described similar tensions when graduate students engaged in advocacy:

> The students heard that at other departments … were getting rid of the GRE and so the students wrote a letter to the DGS and said, "We'd like you to consider getting rid of the GRE." And before they had done that, the DGS had sort of brought it up with the faculty. And for the most part, the faculty were like, "Yeah we don't need the GRE, whatever. We can get rid of it." Then the students rose up and said, "We demand," right? And half of the faculty was like, "Oh gosh. If you guys are gonna demand it, who do you think you are?" … It took the air out of the room. And I was like, "But, but …" And it was coming from my graduate students, who are totally trained in this activism. So I'm like, "But they're just trying to play an active role. They're not trying to overstep their bounds."

Carrie highlighted that their colleagues' resistance was not to eliminating the GRE. Rather, they were resistant to the idea that graduate students were demanding changes to admissions procedures. While graduate students regularly initiated change due to the inaction of faculty, using agency to challenge power structures was perceived as "overstep[ping] their bounds," stifling change and fueling resistance in some departments. When graduate students encountered resistance, they were often reminded of the power of faculty in decision-making processes and their status as being outside of these processes. Thus, faculty's resistance reflected efforts to maintain asymmetry in socialization; faculty reinforced that they hold power and authority, and that graduate students should be deferent if not silent as they work towards their degrees.

Nonetheless, graduate students were drivers of change since they felt that they had to do this work. In some instances, graduate students were pressured to lead DEI initiatives by departmental administrators. At Mid-Atlantic University, Samantha, a racially minoritized woman in the physical sciences, recounted being cajoled into leading a DEI mentoring program:

> I never really intended to do this, but I was sort of sat down by the chair of the department and was told, "We need somebody to take over this mentoring group [for women]. And the person that's been leading it is graduating." ... So that [mentoring group] was going to essentially die if she left, and there was no one to take it over. So I was basically sat down and told, "We really encourage you to take this on." There was pressure put on me to take this. And so I did.

Rather than shifting oversight of this mentoring program to a faculty member, Samantha's department chair pressured her into coordinating it. Samantha was sent the message that the program was not important enough for a faculty member to run, but it had some value and that she was responsible for sustaining it despite her lack of interest in leading the initiative. While Samantha's department chair framed this leadership opportunity as an optional one, she did not feel as though she had the agency to say no and invested time and energy into sustaining this departmental DEI initiative. Samantha's

experience reinforced that DEI work was not at the core of faculty work and that graduate students' "service" to the department was not always a choice. While she was helping to create change, her DEI labor again reflected the asymmetry of power in bi-directional socialization since she was pressed by departmental leaders to do this work.

While Samantha was pressured to lead change, most graduate students felt as though they could not wait for faculty to act if they were to survive, much less thrive, in their program. Ariana, a racially minoritized woman student in engineering at Northeast University took action to improve the climate in her lab after peers made comments that reflected "stereotypical things that people like to say about people of color" being lazy:

> All these things said in my face, in front of my advisor. And my advisor's one of those people who's very passive. So, it was never something that would actually be addressed. So, I had to do a lot of unpaid work to make my environment be sort of detoxified, so that way, if the next person of color came in. Or, the next student who we're being inclusive, who wasn't a person of color would come in, it would be an environment they can walk in, and not be ostracized for having a balanced life. And, also be credited for the things that they're bringing to the table, and that they are actually doing work.

Ariana was keenly aware that she was engaged in "unpaid work" to "detoxify" her lab because faculty inaction contributed to a negative racial climate. She was actively socialized to engage in uncompensated DEI labor to persist, and her efforts likely created temporary rather than sustained change if the work was not taken up by her advisor. In some instances, racially minoritized graduate student participants saw how their efforts led to substantive changes in the compositional diversity of their programs and their abilities to create supportive communities in STEM. Yet, others knew they would not reap the benefits of their work and hoped that future students would enter more supportive departmental climates.

Graduate Student Change Agents Are (In)Visible DEI Laborers who Suffer from the Work

Since STEM graduate students often felt compelled to initiate efforts to improve racial climate, they subsequently became DEI laborers for their departments. Faculty, post-doctoral fellows, administrators, and graduate students across disciplines and fields were cognizant of the DEI work being done by graduate students, particularly by those who were racially minoritized. Yet, they were less aware of the gendered dimensions of this labor. The burden of improving the climate was often placed on racially minoritized women such as Jackie, Samantha, and Arianna, since few racially minoritized men and white students engaged in DEI work (see Table 1).

In addition to the formal work racially minoritized women did in their departments serving on committees, creating programs, and recruiting new minoritized students, they also regularly did invisible labor that was not acknowledged. Specifically, they educated colleagues when they perpetrated microaggressions, advocated for themselves, and worked to improve toxic lab environments. Felicia, a racially minoritized woman student in engineering at Northeast University, described their experience as follows:

> I think it's exhausting to be an underrepresented minority. Because not only do you face all of the things that are happening to you because you're a minority but then you have to educate people when they say something that's not correct. And then you have to dredge up that experience.

Felicia highlighted the emotional labor that came with educating others who perpetrated racial microaggressions. In many ways, racially minoritized women graduate students in STEM were tacitly socialized to learn that if they did not intervene, they would be subject to additional racialized and gendered harm. Consequently, many took action to try to make their departments more inclusive as a way of surviving their graduate education.

STEM graduate students' efforts to improve their environments had personal and professional costs. Several racially minoritized participants experienced mental and emotional exhaustion, while others stated their advocacy work detracted from their degree progress and cost them opportunities. Given that racially minoritized women were engaged in a substantial amount of DEI labor, they more frequently described the negative effects of being a DEI laborer. Thus, bi-directional socialization was not without consequences, particularly for racially minoritized women. Celina, a racially minoritized woman student in the physical sciences at Mid-Atlantic University, described the effects of DEI labor on their peers' academic progress:

> So, there were two women that sort of built this quasi-bridge program in our department, which took a lot of effort. And they both graduated after seven years, not six years, which is the average. So, there was this, I think, this perception that it took a lot of time away from their research to do that. And that's what made them take longer.

Celina received subtle messages that doing advocacy work and building pathways into the discipline for others detracted from research. Yet solely focusing on academics surfaced new tensions and compounded negative effects of being in a hostile climate, as illustrated by Emily, a racially minoritized woman student in engineering at Northeast University:

> It's either situation A, where you're proactive and you're like, "I want to implement these [changes] for my community and my friends, and the people that are coming in the future." And you're physically dedicating an hour or two …

> But also, if you're not in that active role, … your mental health is suffering, because, "I'm not being productive" and "I'm not being heard." That's also taking away from your productivity at work. Which is just this spiral of, you're not going to be productive and you just feel shittier.

For Emily, working to create change within a bi-directional socialization process was a catch-22. If she engaged in advocacy work, she was taking time away from her research which created feelings of guilt. And yet, if she did not act, her mental health suffered since she was not heard and continued to be in a negative environment. In effect, racially minoritized STEM graduate students were often in a no-win situation. The messages they received to focus on research were at odds with their racialized realities, and their desire to improve their experiences. This tension highlights the asymmetrical nature of bi-directional socialization; graduate students leveraged their agency, but faculty exerted pressure to focus on research and to leave the climate intact.

While some racially minoritized STEM graduate students noted the effects of DEI labor on their mental health and degree progress, Samantha, a racially minoritized woman student in the physical sciences at Mid-Atlantic University, named potential penalties for this work:

> I think that the faculty kind of reward people who just put their head down again and just get through ... So I've often worried that my affiliation with doing a lot of service work and doing a lot of teaching and really caring about my teaching is now being detrimental to me. ... I try to downplay the amount of social justice work and additional load that I take on just doing service, in and out of the department. Because I think that they reward people for not doing things like that.

Samantha was concerned that her efforts to change climate would lead to loss of opportunities or support in her department, since her socialization to date had signaled that DEI work was not valued. She, much like Emily, was caught in a precarious position. Samantha received messages from faculty that DEI work was not valued, yet when she tried to stay focused on her research she was "encouraged" by her department chair to lead a DEI mentoring program. These mixed messages about the value of DEI work and its rewards placed Samantha in a no-win situation.

Simone, a racially minoritized woman student in engineering at Northeast University, described more explicit penalties than the subtle messages Samantha had received:

> You get reprimanded for that extra [DEI] work as well. I've been reprimanded for it. Not actively, but in a long email. … I went to my advisor directly after the email was sent. I was like "So, were you talking about me here, because I just want to get it clear, that you understand that I need to bring my whole self to work, and for me to be able to have these outside opportunities, 'cause

> I'm getting work done, and I continue to ask you for evaluations on how I'm working, and you continue to tell me I'm doing fine. So, I think I'm a little confused as to why I think this bullet point came up."

Despite meeting expectations as a researcher, Simone was told indirectly by her Primary Investigator (PI) that she should not do DEI work. Tacitly, the PI conveyed to Simone that she should not "bring [her] whole self to work" and should focus on science even if a more holistic approach to work in the lab would support her success. As Simone tried to use her agency to improve her experiences, her PI actively worked to reinforce the notion that DEI work in STEM was "extra work" and that is not as important as her work in the lab. They defined what constituted meaningful labor and Simone's DEI work did not appear to fill their criteria.

Ultimately, Samantha, Simone, and other graduate students were sent messages that their work to advance inclusion could result in negative effects on their careers which signaled the desire to maintain the status quo despite its harmful effects. Quelling graduate students' efforts to engage in DEI work was an effort to shift socialization to being unidirectional and centered solely on identity evasive constructions of science. Nonetheless, many STEM graduate students, particularly racially minoritized women, continued to resist and to engage in labor to improve their departments despite the potential personal and professional costs. For some students, there were no other choices if they were going to complete their degrees.

Graduate Student Change Agents Are Faculty Supplements without Power

As previously noted, graduate students were often driven to create change through DEI labor since few faculty members did this work. When STEM departments tried to advance inclusion, they often focused on increasing compositional diversity (see Table 1 for additional examples). At both institutions, graduate students regularly led efforts to recruit racially minoritized students and in some instances, created formal opportunities to support prospective students through the application process. Kathryn, a racially minoritized woman faculty member in the biological sciences at Northeast University shared one such effort:

> Graduate students in [STEM department] ... basically said something's wrong here ... we're inviting 24 students for recruitment weekend every year and they're all white, what's going on? So they started this diversity preview weekend ... where they bring in 40 students ... from all sorts of diverse backgrounds, and they purposely are very bright. ... So they advertised it nationally. ... our graduate students basically, tell them what this is, what you're going to encounter. This is what you're going to find. This is how you should write your essay. This is how you should interview.

Since the faculty in this department did not recruit a compositionally diverse cohort, graduate students created an alternative mechanism for recruiting students and mentoring them through the admissions process. In effect, these graduate students supplemented if not replaced the work faculty can and should be doing to recruit and mentor racially minoritized graduate students. The graduate students in this department actively socialized prospective students to the norms of the department and worked to reorient the recruitment process to be more inclusive. Notably, faculty in departments where graduate students led recruitment efforts subsequently took less responsibility for both actively recruiting and retaining underrepresented and minoritized students. These faculty undermined the DEI work of graduate students since they recused themselves of responsibility for improving climate and in doing so limited the potential benefits of bi-directional socialization. While compositional diversity may have increased, concurrent work to cultivate more equitable and inclusive policies and practices may not have happened.

In some units, graduate students also created and provided DEI learning opportunities for their department. Some participants noted that graduate students were the primary members of departmental DEI committees which hosted diversity and inclusion focused professional development (e.g., trainings, speakers). Zoë, a white woman faculty member in a STEM social science at Mid-Atlantic University, described the work of one such committee:

> Well, we do have a grad student and diversity committee and they put on a conference every year, where they bring in speakers, because in [our social science] there's a lot of research on diversity. So, they bring in people to do research in that area. And also, I think they do other initiatives and they're pretty active.

Even though "there's a lot of research on diversity" in the aforementioned discipline, faculty did not lead professional development in this area. Rather, they relied on graduate students to supplement their work and to create professional development in the department. Zoë's comment suggests she thought that the faculty were socializing students to the importance of DEI in their discipline since their department's student-led conference occurred on an annual basis; however, the lack of faculty engagement may have conveyed the opposite to students. Faculty members' inaction reinforced the notion that graduate students are DEI laborers in STEM and that they are the primary drivers of change despite espoused commitments to diversity.

Kirk, a white man graduate student in the agricultural sciences in Northeast University, lamented supplementing faculty labor to advance DEI and to improve racial climate:

> Grad students that have done all the legwork and really pushed for all that [DEI recruitment] stuff. And I've heard that that's pretty common across other

> departments or fields is that the students are the ones creating the change and then faculty will pat people on the back and sometimes even take credit for it, after the fact, and brag about how great their students are, how great their programs are about being aware of things.

Kirk highlighted how faculty reframed and at times claimed graduate students' work to signal their commitments to DEI, though they had limited involvement. While these faculty may have thought they were inclusive by allowing graduate students to lead initiatives, their taking credit for students' work reinforced the power dynamics between faculty and graduate students and in doing so may have perpetuated negative climates. Rendering graduate students' labor invisible was also indicative of a unidirectional socialization perspective from faculty in which they held power and authority over departmental change. If shifts occurred, the faculty described by Kirk likely believed it was through their effort rather than thorough those of graduate students.

If they did not claim graduate students' DEI work as their own, faculty and administrators regularly viewed themselves as supportive and empowering. However, they varied in the extent to which they acknowledged that grassroots work by STEM graduate students detracted from their opportunities and experiences. For instance, Donna, a white woman administrator in the physical sciences at Mid-Atlantic University said:

> So in the last about four years [our department] has really been moving forward on a lot of diversity issues. It really got spearheaded by some grad students ...we had a gay student and she really pushed, you know and got things done. I don't think she had any problems. I hope she didn't have any problems at the time. She certainly helped to spearhead some of the efforts … And she's since graduated and since moved on….

While Donna acknowledged that a gay graduate student-initiated efforts to make their department more inclusive, she assumed the student did not encounter "problems" since they graduated. She failed to acknowledge the reasons why graduate students in the department would drive this work rather than the faculty who bear primary responsibility for creating, sustaining, and changing departmental culture. By framing graduate students as passionate leaders who "spearhead" initiatives, faculty and administrators abdicated responsibility for creating and changing hostile climates and relied on students who "got things done" to improve environments. They reinforced asymmetrical bi-directional socialization since they leveraged their power to remain distanced from DEI work while reaping the rewards of graduate students' DEI labor.

Discussion

While there is a growing body of research that examines efforts to improve racial climate in STEM graduate education (Griffin & Muñiz, 2015; Hill et al., 2011; Jones, 2016; Posselt, 2020), few studies have explicitly centered the role that graduate students play in this process. Our study adds to the literature by highlighting how STEM graduate students work to change their departmental climates as they are socialized to the norms, standards, and practices of their respective disciplines and fields. In doing so, our study reaffirms the potential for graduate students' agency and the power of bi-directional socialization processes (Austin & McDaniels, 2006; Perez et al., 2019; Tierney, 1997; Winkle-Wagner et al., 2020) while extending our understanding of these how processes occur in the context of changing racial climate.

Specifically, our work illuminates the tension of bi-directional socialization in graduate education when situated in the context of power, privilege, and oppression. STEM graduate students leveraged their agency to improve their departmental climates. This work came at the expense of their mental health, degree progress, and career opportunities. Departments socialized graduate students to prioritize their research; however, this was impossible for some students, particularly those who were racially minoritized women. To be successful researchers, racially minoritized women invested extra time and energy into creating lab and departmental environments that were less hostile so that they could attend to their scientific work. While this labor benefited departments and was acknowledged by faculty, administrators, and peers, it was not rewarded or compensated, nor was it considered when reviewing students' productivity. Thus, our study highlights how departments benefit from graduate student labor in the context of DEI work, and the cost that this has for students. Our findings also illuminate the asymmetrical nature of bi-directional socialization which has not been explored in much depth theoretically. Graduate students may leverage their agency, and yet it remains constrained in systems where faculty hold power and authority over decision-making and students' pathways through their programs.

Our findings are also consistent with research by Porter et al. (2018) about the benefits and burdens of engaging in DEI work in STEM departments. While graduate students may feel compelled to contribute, if not to lead, DEI efforts or to self-advocate, there is a cost to their well-being and academic progress that often goes unacknowledged (Perez et al., 2019; Porter et al., 2018). Despite the costs to graduate students, bi-directional socialization (Austin & McDaniels, 2006; Perez et al., 2019; Tierney, 1997; Winkle-Wagner et al., 2020) is often framed as a positive since it allows for agency. However, this framing may not fully attend to the power dynamics that exist in graduate education and how inequitable systems are designed to capitalize on graduate students' labor as a means of evading structural changes. For instance, many

faculty and administrators who noted graduate students' passion for diversity "supported" these students by allowing them to engage in uncompensated DEI labor while benefitting from their work.

That being said, DEI work was not a priority for faculty who did not see it as central to advancing science (Harding, 1994; Le & Matias, 2019). Graduate students in our study had to be catalysts for change, and they supplemented faculty work because they could not wait for faculty to lead change efforts. Since graduate students' DEI work benefited their departments, it inadvertently created no incentive for STEM faculty to invest their time and energy into improving climate. In some instances, faculty members took credit for graduate students' efforts and in other instances they resisted change efforts since they were not faculty initiated. Faculty members' inaction and resistance reaffirmed identity and power-evasive approaches to science (Harding, 1994; Le & Matias, 2019). Furthermore, faculty members reinforced faculty–student hierarchies since they permitted departmental change so long as it did not encroach upon their authority or give greater power to graduate students.

In effect, the STEM graduate students in our study were (re)socialized into a system where their labor was regularly taken advantage of, and they rarely reaped the rewards of their labor to improve climate. While there may have been small improvements (e.g., increased recruitment of racially minoritized students, creation of mentoring programs), the cultural change needed to create more equitable and inclusive STEM departments (McGee, 2020; Posselt, 2020) did not occur since many faculty and departmental leaders were not meaningfully engaged in work alongside graduate students. Faculty resistance and evasiveness was an effort to reinforce asymmetry in bi-directional socialization if not to shift socialization to being unidirectional to maintain power and the status quo.

Our study also reinforces how socialization in academe is neither race nor gender evasive (Garcia et al., 2020; Gardner, 2008; Winkle-Wagner et al., 2020) since it reflects the literature on the hyper (in)visibility of racially minoritized graduate students (Burt et al., 2018; Gildersleeve et al., 2011) and their unpaid labor (Perez et al., 2019; Porter et al., 2018; Truong et al., 2016). STEM graduate students who are racially minoritized women are often caught in a bind in which their departments socialize them to fix the environments around them or push them to persist within these problematic spaces. This labor and feeling "damned if they did the work, and damned if they didn't," was amplified for racially minoritized women who were targeted, excluded, and undermined based on their racialized and gendered identities. While graduate students who were racially minoritized men, and in some instances, white men and women, engaged in DEI work, the pressure and costs of this work was most pronounced for racially minoritized women who described their labor and its impact on them and others.

Our findings also add to the departmental change literature by demonstrating that minoritized graduate students are emotionally taxed both when they engaged in DEI change efforts and when they choose not to participate in those initiatives. Furthermore, our work highlights how this emotional tax is both racialized and gendered to the detriment of racially minoritized women who are woefully underrepresented (Okahana & Zhou, 2018) and often unsupported in STEM departments (Joseph, 2012; Noy & Ray, 2012; Turner & Thompson, 1993). The labor that racially minoritized women did to improve racial climate was often attributed broadly to racially minoritized students, erasing the gendered dynamic of labor. Though some participants were cognizant of the racial inequities in work to improve racial climate, they did not attend to the concurrent gendered disparities in labor and in doing so minimized the effort and leadership of racially minoritized women in driving change. In this regard, our study also illustrates how sexism and patriarchy operate in efforts to advance racial equity to the detriment of racially minoritized women graduate students in STEM.

Notably, we found similarities in how graduate students were change agents across disciplines and fields though there were subtle differences in how faculty and departmental leaders responded to students' efforts. Although there are field-level DEI initiatives in areas such as the biological sciences (SABER, 2021) and engineering (NAE, 2021), these departments were not immune to leveraging graduate student labor as the primary means of improving climate. Given the work occurring at the field-level, the biological sciences are often thought to be more receptive to DEI work. Our participants described openness to graduate students' initiating recruitment efforts and committees in these departments. However, graduate students in the biological sciences encountered faculty resistance to their advocacy for inclusive policy, avoidance of DEI focused training, and co-opting of their labor. Engineering may also be perceived as a receptive context for DEI work given commitments espoused at the field-level, but participants also described resistance and evasiveness from faculty. While some engineering graduate students were involved in recruitment to increase compositional diversity, much of their labor was situated within labs to improve racial climate in their local environment (e.g., Ariana, Simone). Improving the racial climate of engineering labs was intended to create environments where racially minoritized students could be more successful with their research. Yet, this work was viewed by some faculty as "extra" and a distraction rather than a contribution to scholarship and as such, was actively discouraged despite the field-level commitment to diversity. In fields like the physical sciences that are thought to be more identity-evasive and resistant to DEI work (Prescod-Weinstein, 2021), some graduate students were strongly "encouraged" if not coerced to do DEI labor that was not allocated to faculty. Graduate students' DEI labor in the physical

sciences was attributed to passion for diversity and the hostile racial climates that necessitated their work was left unquestioned. Ultimately, STEM graduate students' experiences as change agents across fields were similar though there were differences in how their work was received.

Implications for Research

Given our findings, there is a need to conceptualize power more explicitly in graduate education and add theoretical complexity to bi-directional socialization models. Future socialization frameworks may incorporate critical or post-structural perspectives to both illustrate how power operates and to envision more liberatory outcomes for graduate education. Accordingly, scholarship on graduate education may use more participatory action or transformative approaches to support translating research findings into action to address inequitable policies and practices, and to improve hostile departmental climates.

We also found that graduate students played a similar role in changing climate in STEM departments across disciplines and fields. Future research should examine the work of graduate students in advancing DEI across the disciplines, since resistance to DEI work is not limited to STEM departments. Thus, there is a need to understand the similarities and differences in the roles graduate students play in changing climate based on the norms, standards, and practices of their respective disciplines and fields. Focused study on graduate students' efforts to improve racial climate within specific STEM disciplines and subfields may also surface nuances at the field level that we were unable to fully capture. Such research may also illuminate if and how faculty members and disciplinary-based professional associations support graduate students' labor and institutionalize change initiatives to create changes more widely. Future research might also take a longitudinal approach to investigate the sustainability of graduate-led DEI efforts and examine how graduate student labor on DEI efforts influences their career trajectories over time.

Implications for Practice

As our findings indicate, graduate students will not and cannot always wait for their departments to create change and, as a result, we urge departments to be proactive. From a practitioner perspective, STEM departments should create a purposeful, cohesive strategy for creating an inclusive departmental climate by assessing their climate, enhancing faculty buy in, and establish collaborations with institutional DEI staff (e.g., diversity offices, initiatives) rather than relying on graduate student labor. On-going assessment of the departmental climate in the form of surveys, listening sessions, and reflective practices with multiple stakeholder groups might enable leaders to understand the specific needs of their department and create tailored plans

for enhancing climate. Departments should also directly address faculty engagement with DEI efforts and create accountability structures. Lack of sustained commitment from individuals with the resources, power, and opportunity to change departmental culture decreases the likelihood of changing departmental climate in the long term, even if it experiences success in the short-term. Departments might enhance faculty commitment to DEI efforts by setting expectations of faculty contributions, explicitly requiring this type of service in promotion and tenure decisions, and providing compensation for DEI-related service.

As departments and graduate student change agents develop strategies to improve racial climate in their departments, they should take an intersectional approach to the work since failing to do so may perpetuate inequitable labor for racially minoritized women. Departments should be attentive to the gendered distribution of labor when asking individuals to contribute change initiatives. Racially minoritized men and white graduate students can engage in critical reflection about how their contributions to change efforts contest and uphold oppression. Furthermore, strategies to improve racial climate can be crafted to concurrently attend to sexism as a means of meeting the needs of racially minoritized women. Finally, the labor of racially minoritized women to improve racial climate needs to be publicly acknowledged within departments and compensated, since it is often expected, co-opted, and minimized if not penalized.

Conclusion

Our study illuminated the complex role STEM graduate students play in changing departmental racial climates. The benefits of graduate students' agency minimized the material consequences to them of leading DEI work. Emotional and unpaid labor, extended time to degree, and loss of professional opportunities were the very real costs students, particularly racially minoritized women, paid to create more inclusive environments. Since STEM graduate students' labor supplemented faculty work, it allowed faculty to evade responsibility for creating inclusive departmental environments. Given STEM graduate students socialization, the question now becomes: Will these future faculty, academic administrators, and industry leaders change this cycle of socialization and continue to advance DEI when they are in positions of power and authority, or will they maintain the status quo with their own graduate students?

References

Austin, A. E., & McDaniels, M. (2006). Preparing the professoriate of the future: Graduate student socialization for faculty roles. In: J. C. Smart (Ed.), *Higher Education: Handbook of Theory and Research* (Vol. XXI, pp. 397-456), Springer.

Bogdan, R., & Biklen, S. K. (2003). *Qualitative Research for Education: An Introduction to Theory and Methods* (4th ed). Allyn and Bacon.

Brayboy, B. M. J., Solyom, J. A., & Castagno, A. E. (2014). Looking into the hearts of Native peoples: Nation building as an institutional orientation for graduate education. *American Journal of Education, 120*(4), 575-596.

Bryk, A. S., Gomez, L. M., & Grunow, A. (2011). Getting ideas into action: Building networked improvement communities in education. In: M. T. Hallinan (Ed.), *Frontiers in Sociology of Education* (pp. 127-162). Springer.

Burt, B. A. (2017). Learning competencies through engineering research group experiences. *Studies in Graduate and Postdoctoral Education, 8*(2), 109-127. https://doi.org/10.1108/SGPE-05-2017-019

Burt, B. A., Williams, K. L., & Smith, W. A. (2018). Into the storm: Ecological and sociological impediments to Black males' persistence in engineering graduate programs. *American Educational Research Journal, 55*(5), 965-1006. https://doi.org/10.3102/0002831218763587

Charmaz, K. (2006). *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis.* SAGE Publications.

Garcia, G. A., Ramirez, J. J., & Patron, O. E. (2020). Rethinking Weidman's models of socialization for Latinxs along the postsecondary educational pipeline. In: J. C. Weidman & L. DeAngelo (Eds.), *Socialization in Higher Education and Early Career: Theory, Research, and Practice* (pp. 55-70). Springer.

Gardner, S. K. (2007). "I heard it through the grapevine": Doctoral student socialization in chemistry and history. *Higher Education, 54*(5), 723-740. https://doi.org/10.1007/s10734-006-9020-x

Gardner, S. K. (2008). Fitting the mold of graduate school: A qualitative study of socialization in doctoral education. *Innovative Higher Education*, *33*(2), 125-138. https://doi.org/10.1007/s10755-008-9068-x

Gardner, S. K. (2010). Faculty perspectives on doctoral student socialization in five disciplines. *International Journal of Doctoral Studies*, *5*(2), 39-53. https://doi.org/10.28945/1310

Gardner, S. K., & Mendoza, P. (Eds.). (2010). *On Becoming a Scholar: Socialization and Development in Doctoral Education.* Stylus Publishing.

Gehrke, S., & Kezar, A. (2017). The roles of STEM faculty communities of practice in institutional and departmental reform in higher education. *American Educational Research Journal, 54*(5), 803-833. https://doi.org/10.3102/0002831217706736

Gildersleeve, R. E., Croom, N. N., & Vasquez, P. L. (2011). "Am I going crazy?!": A critical race analysis of doctoral education. *Equity & Excellence in Education, 44*(1), 93-114. https://doi.org/10.1080/10665684.2011.539472

Glesne, C. (2011). *Becoming Qualitative Researchers: An Introduction* (4th end). Pearson.

Golde, C. M. (2006). Preparing stewards of the discipline. In: C. M. Golde & G. E. Walker (Eds.), *Envisioning the Future of Doctoral Education* (pp. 3-20). Jossey Bass.

Griffin, K. A., & Muñiz, M. (2015). Rethinking the structure of student recruitment and efforts to increase racial and ethnic diversity in doctoral education. *International Journal of Doctoral Studies, 10*, 199-216. https://doi.org/10.28945/2275

Griffin, K., Baker, V., O'Meara, K., Nyunt, G., Robinson, T., & Staples, C. L. (2018). Supporting scientists from underrepresented minority backgrounds. *Studies in Graduate and Postdoctoral Education*, *9*(1), 19-37. https://doi.org/10.1108/SGPE-D-17-00032

Harding, S. G. (1994). Is science multicultural?: Challenges, resources, opportunities, uncertainties. *Configurations, 2*(2), 301-330. https://doi.org/10.1353/con.1994.0019

Hill, P. L., Shaw, R. A., Taylor, J. R., & Hallar, B. L. (2011). Advancing diversity in STEM. *Innovative Higher Education, 36*(1), 19-27. https://doi.org/10.1007/s10755-010-9154-8

Jones, S. (2016). More than an intervention: Strategies for increasing diversity and inclusion in STEM. *Journal for Multicultural Education*, *10*(1), 234-246. http://doi.org/10.1108/JME-12-2015-0046

Joseph, J. (2012). From one culture to another: Years one and two of graduate school for African American women in the STEM fields. *International Journal of Doctoral Studies*, *7*(1), 125-142. https://doi.org/10.28945/1571

Kezar, A., Gehrke, S., & Elrod, S. (2015). Implicit theories of change as a barrier to change on college campuses: An examination of STEM reform. *The Review of Higher Education, 38*(4), 479-506. https://doi.org/10.1353/rhe.2015.0026

Knafl, K., & Breitmayer, B. J. (1989). Triangulation in qualitative research: Issues of conceptual clarity and purpose. In: J. Morse (Ed.), *Qualitative Nursing Research: A Contemporary Dialogue* (pp. 193–203). Aspen.

Le, P. T., & Matias, C. E. (2019). Towards a truer multicultural science education: How whiteness impacts science education. *Cultural Studies of Science Education*, *14*(1), 15-31. https://doi.org/10.1007/s11422-017-9854-9

LeMahieu, P. (2015, August 18). *Why a NIC?* Carnegie Commons Blog. https://www.carnegiefoundation.org/blog/why-a-nic/

Louis, K. S., Holdsworth, J. M., Anderson, M. S., & Campbell, E. G. (2007). Becoming a scientist: The effects of work-group size and organizational climate. *The Journal of Higher Education*, *78*(3), 311-336. https://doi.org/10.1080/00221546.2007.11772318

McGee, E. O. (2020). *Black, Brown, Bruised: How Racialized STEM Education Stifles Innovation*. Harvard Education Press.

National Academies of Sciences, Engineering, and Medicine. (2018). *Graduate STEM Education for the 21st Century*. The National Academies Press.

National Academy of Engineering (2018). *Engineering societies' activities in promoting diversity and inclusion: Proceedings of a workshop—in brief.* Washington, DC: The National Academies Press. https://doi.org/10.17226/25323

Noy, S. and Ray, R. (2012). Graduate students' perceptions of their advisors: Is there systematic disadvantage in mentorship? *The Journal of Higher Education, 83*(6), 876-914. https://doi.org/10.1080/00221546.2012.11777273

Okahana, H., & Zhou, E. (2018). *Graduate Enrollment and Degrees: 2007 to 2017*. Council of Graduate Schools.

Patton, M. Q. (2002). *Qualitative Evaluation and Research Methods* (3rd ed.). SAGE Publications.

Perez, R. J., Harris Jr., L. W., Robbins, C. K., & Montgomery, C. (2019). Graduate students' agency and resistance after oppressive experiences. *Studies in Graduate and Postdoctoral Education, 11*(1), 57-71. https://doi.org/10.1108/SGPE-06-2019-0057

Perez, R. J., Robbins, C. K., Harris Jr., L. W., & Montgomery, C. (2020). Exploring graduate students' socialization to equity, diversity, and inclusion. *Journal of Diversity in Higher Education*, *13*(2), 133-145. https://doi.org/10.1037/dhe0000115

Porter, K. B., Posselt, J. R., Reyes, K., Slay, K. E. and Kamimura, A. (2018). Burdens and benefits of diversity work: Emotion management in STEM doctoral students. *Studies in Graduate and Postdoctoral Education, 9*(2), 127-143. https://doi.org/10.1108/SGPE-D-17-00041

Posselt, J. R. (2020). *Equity in Science: Representation, Culture, and the Dynamics of Change in Graduate Education*. Stanford University Press.

Prescod-Weinstein, C. (2021). *The Disordered Cosmos: A Journey into Dark Matter, Spacetime, and Dreams Deferred.* Bold Type Books.

Rodriguez, S. L., Perez, R. J., & Schulz, J. M. (2021). How STEM lab settings influence graduate school socialization and climate for students of color. *Journal of Diversity in Higher Education*, 15(1), 58-72. https://doi.org/10.1037/dhe0000361

Society for the Advancement of Biology Education Research (2021). *SABER's diversity and inclusion efforts.* https://saberbio.wildapricot.org/Diversity_Inclusion

Stake, R. E. (2000). Case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 435-454). SAGE Publications.

Stewart, D-L. (2017, March 30). *Language of Appeasement.* Inside Higher Education. https://www.insidehighered.com/views/2017/03/30/colleges-need-language-shift-not-one-you-think-essay

Thorton, R., & Nardi, P. M. (1975). The dynamics of role acquisition. *The American Journal of Sociology, 80*(4), 870-885. https://doi.org/10.1086/225897

Tierney, W. G. (1997). Organizational socialization in higher education. *The Journal of Higher Education*, *68*(1), 1-16. https://doi.org/10.2307/2959934

Truong, K. A., Museus, S. D.. & McGuire, K. M. (2016). Vicarious racism: A qualitative analysis of experiences with secondhand racism in graduate education. *International Journal of Qualitative Studies in Education, 29*(2), 224-247. https://doi.org/10.1080/09518398.2015.1023234

Turner, C. S. V. and Thompson, J. (1993). Socializing women doctoral students: Minority and majority experiences. *The Review of Higher Education*, *16*(3), 355-370. https://doi.org/10.1353/rhe.1993.0017

Van Maanen, J., & Schein, E. H. (1979). Towards a theory of organizational socialization. *Research in Organizational Behavior, 1*, 209-264.

Weidman, J. C., Twale, D. J., & Stein, E. L. (2001). *Socialization of Graduate and Professional Students in Higher Education: A Perilous Passag*e. John Wiley & Sons, Inc.

Wendler, C., Bridgeman, B., Cline, F., Millett, C., Rock, J., Bell, N., & McAllister, P. (2010). *The Path Forward: The Future of Graduate Education in the United States*. Educational Testing Service.

Winkle-Wagner, R., McCoy, D. L., & Lee-Johnson, J. (2020). Creating porous ivory towers: Two-way socialization processes that embrace Black students' identities in academia. In: J. C. Weidman & L. DeAngelo (Eds.), *Socialization in Higher Education and Early Career: Theory, Research, and Practice* (pp. 73-89). Springer.