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STEM Education and Critical Consciousness: Faculty Insights and Reflections

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ABSTRACT

Culturally responsive pedagogy (CRP) offers a framework for equity-driven teaching, yet its third tenet—critical consciousness—is often neglected in both research and practice. This study explored how STEM teacher educators (STEs) intentionally deepened their critical consciousness as part of their teaching and scholarship. Drawing on interviews with 10 STEs across STEM education disciplines, we used cross-case analysis to identify three key themes that highlight how STEs think about and work to deepen their critical consciousness: personal motivations rooted in lived experience, an awareness of power dynamics in education, and ongoing self-reflection. The findings provide strategies for teacher educators seeking to foster critical consciousness in both their practice and in the preparation of preservice teachers. This study contributes to the growing call for equity-centered faculty learning and offers practical implications for embedding CRP more fully into STEM teacher education.

Keywords: Critical consciousness, culturally responsive pedagogy, STEM teacher educators

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INTRODUCTION

Science, technology, engineering, and mathematics (STEM) teacher educators (STEs), who intentionally develop their critical consciousness, are more likely to address instructional barriers and challenge the status quo (Hutchison & McAlister-Shields, 2020; Killpack & Melón, 2016; Pérez, 2022). Freire (2000) defined critical consciousness as an awareness of power dynamics in a social context and the understanding of one's agency to move toward liberation from oppressive forces. STEs need to make a concerted effort to become more critically conscious by decentering dominant narratives within their teaching practices (Ciampa et al., 2022). The development of critical consciousness is vital for STEs, as it helps them notice how cultural, political, and social norms impact STEM teaching and learning (Hutchison & McAlister-Shields, 2020). This is especially important since STEM subjects are deeply embedded in cultural and societal norms (Killpack & Melón, 2016). This approach to teaching not only supports and empowers STEs but is also a crucial component in addressing political and systemic issues that reduce belonging and persistence among preservice teachers (PSTs; Bjorklund et al., 2021).

THEORETICAL FRAMEWORK

STEM education in the United States often adopts a Eurocentric perspective, emphasizing Western norms, values, and contributions (Harding, 1994; Kolovou, 2023). This bias is often rationalized by the alignment of Western cultures with positivist thinking (Mensah & Jackson, 2018). As a result, this approach tends to exclude diverse perspectives, such as ethnomathematics or indigenous science, from being recognized as valid ways of understanding the world. Consequently, Eurocentric perspectives imply that most advancements in STEM are due primarily to European contributions, whereas contributions from other cultures are often overlooked, deprioritized, or considered inferior (Harding, 1994; Kolovou, 2023).

One approach to increasing the diversity of thought and participation within STEM is through the prioritization of instruction on culturally responsive/relevant pedagogy (CRP). We use the term responsive to integrate the foundational concepts of Culturally Relevant Pedagogy and the principles of Culturally Response Teaching (Ladson-Billings, 1995; Gay, 2002). CRP is a justice-oriented framework with three tenets: academic achievement (the belief that all students can succeed), cultural competencies (incorporating students' lived experiences into teaching), and the development of critical consciousness (Ladson-Billings, 1995, 2014). CRP is not a set of rigid procedures but is contingent on teacher actions and dispositions (Ladson-Billings, 1995; 2014). As a highly

reflective approach to engaging in educational research, contexts designed to explore CRP should consider both teacher actions and dispositions. These elements influence how teachers engage with students, teach academic content, and recognize power dynamics both inside and outside the classroom (Ladson-Billings, 1995; 2014). Within teacher preparation programs, teacher dispositions are essential, as STEs model the CRP to support PSTs in adopting such dispositions in their future teaching practices.

LITERATURE REVIEW

What is Critical Consciousness?

Critical consciousness, one of the three tenets of the CRP, refers to one's ability to identify and recognize oppressive societal forces (e.g., racism, ableism, classism, and gender biases) and then respond in a liberatory way to empower teachers and students (Freire, 2000; Ladson-Billings, 1995; 2014). Examining any construct with a critical lens considers the interactions between an individual's privilege, access or lack of access to power and how these two factors mediate the outcomes of the individuals involved (Freire, 2000; Kincheloe, 2008). Critical consciousness is a mental framework that enables practitioners to recognize that instruction and learning occur in highly political contexts that require navigation and negotiation to fully support the academic success of all learners (Landreman et al., 2007; Leal, 2021). Therefore, critical consciousness within STEM education considers invisible barriers to students' success, such as gaps in gender participation, racial bias, and singular narratives aligned with the dominant culture (Jones & Donaldson, 2021; Jones & Taylor, 2022). The goal of criticality in STEM education is to critique structural and curricular barriers to the success of marginalized students, moving toward the liberation of all learners.

STEs' Need to Develop Critical Consciousness

Despite large opportunity gaps in STEM teaching and learning, many STEs play their roles with the intention of supporting PSTs in equitable instruction. However, good intentions alone are insufficient—and without the development of critical consciousness, STEs may unintentionally reinforce the status quo of inequity within STEM education (Killpack & Melón, 2016; Russo-Tait, 2022). Emerging research has shown that when STEM educators, including STEs, are asked to explain persistent opportunity gaps in STEM, they sometimes attribute disparities to individual student factors such as lack of motivation or preparation rather than considering structural and systemic inequalities (Hutchison & McAlister-Shields; Russo-Tait, 2022). This deficit-based framing reflects either a lack of awareness

or an underdeveloped understanding of how systems of oppression shape students' access, engagement, and outcomes in STEM (Pérez, 2022; Shimek et al., 2023).

Developing critical consciousness involves moving beyond surface-level equity commitments to deeply interrogate the ways in which race, culture, language, and power operate within educational contexts (Freire, 2000; Jones & Donaldson, 2021). When STEs rely on the assumption that some cultures value education less than others do, they risk reinforcing harmful narratives that blame students' families or communities for academic disparities—despite evidence that families of color share high aspirations for their children's STEM success (Killpack & Melón, 2016; Russo-Tait, 2022).

Structural and institutional barriers may constrain the growth of STEs in this area. These barriers could include heavy workloads, a lack of departmental support, and large class sizes, all of which limit opportunities for sustained reflection and professional learning (Parhar & Sensoy, 2011; Schultz et al., 2023). Moreover, when STEs do not feel equipped or supported to engage in culturally responsive or justice-oriented practices, they may default to dominant norms that fail to center students' identities and lived experiences (Xie & Ferguson, 2022).

Nevertheless, researchers argue that STEs who engage in ongoing reflective practice, professional development, and collaboration can deepen their critical consciousness over time (Killpack & Melón, 2016; Xie & Ferguson, 2022). In doing so, they are better positioned to support PSTs in recognizing and promoting the rightful presence of marginalized students in STEM classrooms.

Rightful Presence

The rightful presence is a pedagogical stance that centers equity, justice, and student voice in the knowledge-building process (Calabrese Barton & Tan, 2020). Extending and incorporating the concept of rightful presence into STEM teacher education can significantly deepen the critical consciousness of STEs, as it focuses beyond present circumstances and prioritizes an understanding of how systems have historically worked to produce present-day outcomes.

Calabrese Barton and Tan (2020) are credited with developing the three-tiered process of rightful presence: (1) understanding that allied political struggle is integral to disciplinary learning, (2) being intentional about making (in)justice visible, and (3) engaging in collective disruption of modes of power by amplifying diverse voices and perspectives. The rightful presence focuses on how teacher actions should move beyond practices of inclusion by sharing power within the learning space to legitimize students' presence and intellect (Calabrese Barton & Tan, 2020), and it bolsters the ideas within the CRP, particularly as they relate to developing critical consciousness.

By integrating this framework, STEs can create practices that reflect and provide a deeper understanding to counteract how systemic inequities manifest in

classroom practices. The rightful presence calls for the collective disruption of power dynamics in classrooms, positioning teachers and students as allies in the political struggle for educational justice. These efforts can be achieved through solidarity-building activities that incorporate STEM learning via ethnographic, community-led initiatives (Calabrese Barton & Tan, 2020). Such activities can breakdown barriers between STEs and PSTs by encouraging learners to explore how STEM thinking can address challenges in their own lives and by designing inquiry-based lessons around the needs they express.

STEs should be explicit in their teaching practices to recognize and address systemic inequities; this can create shifts toward a more democratic learning environment. Regular reflection and adaptation not only enhance the critical consciousness of STEs but also prepares PSTs to engage in meaningful, justice-oriented teaching practices that center the historical and present-day experiences of underrepresented individuals and ideologies within STEM. Integrating rightful presence into STEM teacher education ultimately supports the development of more equitable and responsive educational environments, benefiting both STEs and PSTs.

RESEARCH QUESTIONS AND STUDY SIGNIFICANCE

This work posits that criticality through critical consciousness development is essential in how STEs should approach their teaching practices. STEM instruction often overlooks the development of critical consciousness, despite its importance in addressing equity issues in education (Jones & Donaldson, 2021; Madkins & McKinney de Royston, 2019). For this reason, this study examines STEs whose research and teaching centers around the CRP through an operational and contextual understanding of critical consciousness. It investigates how these STEs reflect on their teaching practices, interrogates their biases, and considers power dynamics, to deepen their critical consciousness. Specifically, this study investigates the following research questions: 1) *What are STEs' motivations for deepening their own critical consciousness?* and 2) *How do STEM teacher educators enact and reflect on their own critical consciousness?*

This work contributes to the field of teacher education because STEs' "critical reflection is frequently sidestepped" (Gist et al., 2019, p. 14). Furthermore, although scholars have highlighted a need for professional development for STEM teacher educators around the CRP, very little research has been conducted on the needs and experiences of faculty as they work to deepen their critical consciousness (Prater & Devereaux, 2009; Underwood & Mensah, 2018). This study highlights the practices and perspectives of STEs, who, through their teaching and scholarship, have exemplified practices that support a more evolved critical consciousness related to their pedagogical practices. Therefore, this work has the potential to invite STEs to reflect on their teaching practices and

how they work to foster rightful presence and disrupt the status quo. Additionally, the results of this study point to practical steps that faculty can take to deepen their critical consciousness, and they can also inform professional development opportunities for STEs.

RESEARCH METHOD

The aim of this study was not to produce generalizable findings but rather to explore specific themes within a bounded context. Specifically, this study investigated how STEs who research the CRP reflect on their teaching practices and positionality in relation to the development of their critical consciousness.

Table 1: Demographic information of the participants (N=10)

| Characteristics | Variables | Number |
|---|------------------------|--------|
| Experience teaching in higher education | 5 years or less | 3 |
| | 6-10 years | 3 |
| | 11-15 years | 1 |
| | 16-20 years | 2 |
| | 21-25 years | 0 |
| | 26 or more years | 1 |
| Institutional research designation | R1 | 7 |
| | R2 | 1 |
| | Neither R1 nor R2 | 2 |
| Discipline | Math Education | 5 |
| | Science Education | 3 |
| | STEM Education | 2 |
| Ethnicity | White | 6 |
| | Black/African American | 2 |
| | Asian | 1 |
| | Native American | 1 |
| Gender | Woman | 9 |
| | Man | 1 |

Participants

We employed a purposeful sampling strategy (Merriam & Tisdell, 2016), selecting participants who could provide rich, relevant, and diverse insights into the phenomenon under study. To accomplish this, the authors identified 66 STEs from across the United States and Canada via publicly available contact information from recent scholarly publications and conference proceedings focused on the CRP

in STEM education. The inclusion criterion was that participants be faculty members involved in the preparation of teacher candidates and had published peer-reviewed work on CRP in STEM education within the past five years. This approach ensured that the participants had demonstrated expertise and engagement with CRP.

Of the 66 invited participants, 10 agreed to participate. While the response rate may appear modest, the sample size is consistent with qualitative research traditions that prioritize depth over breadth (Merriam & Tisdell, 2016). This sample enabled the inclusion of information-rich cases that support thematic saturation and nuanced analysis. Table 1 shows the participants' demographic information.

Data Collection

The authors invited the STEs to participate in a semi-structured interview designed to elicit in-depth reflections on their pedagogical practices and critical consciousness. The semi-structured format allowed consistency across interviews while providing flexibility to probe emergent themes. The interviews ranged from 60-90 minutes each. All STE participant interviews were conducted and recorded via Zoom.

The purpose of the interviews was to understand how the STEs engaged, reflected, and developed their own thinking and practices as related to the CRP. More specifically, the authors wanted to understand how STEs interpreted and implemented elements of the third tenet of the CRP, critical consciousness, into their personal growth and teaching practices. The interview questions consisted of a series of reflective questions that required STEs to use their personal and professional experiences as a point of reference to engage in the discussion. Sample interview questions included "*What part of your personal life experiences do you think most informs your research?*" and "*What practices do you engage in to reflect on your own personal biases?*" All participants' information was deidentified prior to data analysis, and numeric systems were randomly assigned to each STE participant. All the interviews were transcribed verbatim and entered into NVivo for analysis.

Data Analysis

The data analysis for this study was conducted in two phases via thematic analysis (Roberts et al., 2019). In phase one, the development of the codebook was performed through inductive analysis via a priori codes aligned with the three tenets of the CRP: academic achievement, cultural competence, and critical consciousness. The authors independently coded each transcript, discussed it after each round of coding, and iteratively coded the data to 100% consensus.

The second phase of data analysis focused on the subset of the data coded as relating to critical consciousness. Specifically, the transcripts were coded by guiding questions about critical thinking, bias, and power to develop subcodes and identify themes. Coding decisions were discussed until consensus was reached. Finally, the authors used constant comparison to group categories into themes, resulting in the findings of this study. Thematic saturation of data was achieved when the interview transcripts did not reveal new ideas or categories (Bowen, 2008). Exact quotes are presented as empirical evidence to support the findings.

Trustworthiness and Positionality

Establishing rigor and reliability in qualitative research involves several steps to ensure trustworthiness (Roberts et al., 2019). In this study, the authors established trustworthiness through sharing codebook development, methods of data triangulation (e.g., thematic analysis, coding to consensus), and researcher positionality. As STEs, authors are ‘insiders’ with shared identities and experiences with participants, providing unique insights (Berger, 2015). Reflexive researchers leverage subjectivity, acknowledging their positionality and role in the study to increase the reliability of findings (Berger, 2015; Probst, 2015). Given this, both authors disclose that they use culturally relevant practices in their teaching practices and research. Additionally, both authors identify as members of minority groups in STEM education (e.g., gender and/or race) and therefore have a deep understanding of these implications. These findings have led to our shared work as teacher educators explore the use and conceptualization of STEs’ critical consciousness.

RESULTS

The data analysis revealed three themes illustrating STEs’ perceptions of how they worked to deepen their critical consciousness: (1) personal motivations; (2) awareness of power dynamics; and (3) ongoing self-reflection. In the presentation of these findings, the authors draw on data from across the participants’ interviews, instead of focusing primarily on individuals or distinct groups, to collectively paint a picture of what these STEs were doing to deepen their critical consciousness.

Personal Motivations

It was evident that personal motivations were drivers of the STEs’ desire to deepen their critical consciousness. These motivations commonly originated from pivotal moments in their schooling experiences. These moments prompted a questioning of who truly belongs in STEM and, by extension, a questioning of their rightful presence within it. Faculty of Color often observed inequities and questioned their

rightful place within STEM earlier in life, whereas White STEs typically drew on observations of inequities for motivation. One White woman shared how her experiences teaching overseas, “[have] made me realize how we're not truly speaking to all students in their voice, in their language ... all of this has just made me ... critical of schooling in general.” Another White woman shared, “So the biggest growth that I have made in my own practice is incorporating what I'm learning from my BIPOC [Black, Indigenous, and People of Color] friends.” On the other hand, one Woman of Color drew from her personal childhood experiences in Pakistan, where “only like 9% of girls make it to secondary education.” She went on to discuss how gender disparities have influenced her motivation to deepen her critical consciousness within her current work on gender diversity in STEM education, aiming to “find ways to reach students who don't have access.”

While many participants noted challenges in education and society, specific training through their academic studies in the CRP enabled them to identify these issues and become more intentionally culturally responsive practitioners. Approximately half of the participants cited K12 education as the beginning of their quest to understand the role and value of diverse voices, and 90% of the participants referenced their collegiate experiences as being impactful in deepening their critical awareness. For example, one white woman discussed how going to very diverse public schools at the secondary and collegiate level allowed her to value diversity and served as a source of her drive to engage in criticality within her teaching and research. She said:

All of the schools that I went to in K12 and in college have been public, large, and diverse ... many of my friends there were from Mexican and Central American backgrounds. ... Then, I moved right outside of a large metropolitan city, there were more students that identified as African American and black and Asian ... There were lots of opportunities for me to be able to see how different backgrounds bring a richness and provide different opportunities for learning and growth.

An African American woman shared how she was empowered through her graduate school experiences to advocate for the rightful presence of women of color. She attributed early career mentorship from her dissertation advisor as propelling her to deepen her understanding of racial consciousness within her teaching practice.

Awareness of Power Dynamics

STEs highlighted various ways in which they worked to disrupt the status quo to ultimately provide more opportunities for a shared sense of rightful presence

among the PSTs they taught. Within their classrooms, many STEs described their intentionality of their physical placement in the classroom, “pushing back on those traditional notions of the teachers at the front of the stage having all of the knowledge” (White woman). This acknowledges that if STEM spaces are to be a democratic place of shared power and rightful presence, learners have rights and privileges that should be honored within instruction. Another common way that STEs share power with teacher candidates is elevating PSTs’ voices by including discussion-based instruction as opposed to lecture-based instruction. STEs intentionally worked to promote rightful presence by elevating student voice. Furthermore, STEs engaged in direct conversations regarding social issues and invited students to provide their perspectives on such issues as well. For example, one African American woman shared, “to be able to have those discussions... we always delve into sociopolitical issues... that’s a part of what it means to be culturally responsive.”

STEs were keenly aware of institutional power dynamics and their implications of denying or affirming students’ rightful presence. They discussed the ways in which power is negotiated and maintained by the academic system at large, in part because:

It is about allowing [students] a means to become active participants in science. So that their knowledge contributes to science and the field itself changes ... There is a lot of fear about science itself changing and becoming less objective or whatever, to where the current experts are no longer the experts. (White woman)

The upholding of science as it has been in the past ultimately results in the marginalization and absence of some students' rightful presence.

STEs shared that although they valued their content areas, it was also a means to an end with the ultimate goal of the following:

Get them [the students] to see the bigger picture of just the importance of education, the importance of being able to have questions and being curious, which comes from science. ... That they are preparing their students for the kind of life that is out there waiting for them ... it puts you in positions where you can advance yourself or you can advance your family, your community. (African American woman)

STEs emphasized their goals of increasing their students’ social skills, critical awareness, and altruism. One hundred percent of STEs within the study stated that they were very committed to deepening critical awareness to address power dynamics that might negatively impact marginalized students' rightful presence, particularly in ways that challenged cultural and societal norms. For example, one

White woman said, “I get truly excited to think about the ways in which my practice could disrupt the status quo.”

Ongoing Self-Reflection

One of the most common practices that STEs discussed was self-reflection, including how insights from their reflection had an impact on their actions and how they considered PSTs’ rightful presence in their interactions. One African American woman said, “So it is a lot of reflection all day long, ... about what I'm hearing, what I'm listening [to], and how I am communicating with other people.” Participants used a variety of tools to foster self-reflection, including journaling, collaboratively reflecting with colleagues, reading, attending conferences, and reflecting on specific interactions or events. STEs were committed to doing the work of becoming a more culturally responsive educator that prioritized establishing rightful presence.

STEs recognized the importance of taking responsibility in identifying “blind spots” and working to understand how bias impacts their perspectives and practice. One African American woman said:

[In my program,] we focus a lot on our personal biases. In addition, so I know where my blind spots are for the most part. Therefore, I try to reflect on those and try to figure out ways to adapt and to do better.

The participants also observed that it was crucial for individuals to actively take steps to remain reflective and to engage in the work of interrogating their biases. One Native American woman said:

I do not think that you will be successful as a culturally responsive person unless you're constantly trying to interrogate where you may hold biases or your own negative perceptions or misconceptions. I think everybody has bias, whether or not they are aware of them, and even whether or not they are willing to become aware of them.

One White man reflected, “I started seeing this enormous intersection and questioned, what in the world am I doing?” He described a pivotal moment in his professional career when he began to critically examine the social and societal implications of STEM instruction. He added:

It just seemed important for them [PSTs] to understand how two plus two plus four works in their world, as it is to move them toward loving people, loving math... and becoming a person who is using mathematics as a tool.

This shift marked a significant turning point in his teaching practice, supporting the cultivation of his PSTs' rightful presence. By moving beyond a sole focus on academic content, he emphasized the importance of engaging with the social dimensions of STEM—an essential step in fostering the development of critical consciousness.

In addition to addressing bias, sixty percent of the participants emphasized that becoming a culturally responsive teacher is an ongoing journey that requires continuous effort and reflection. In their commitment to professional growth, participants actively worked to challenge and confront inequalities within education as a means of establishing rightful presence—creating learning spaces where all students were recognized, valued, and empowered to fully participate. They also highlighted how they were communicating to PSTs that they were embarking on a lifelong journey of becoming more culturally responsive teachers. STEs acknowledged that one could never reach perfection with respect to the CRP and that this should not be in the way of starting the work of deepening one's critical consciousness. There is always an opportunity for teachers to reflect on their practices and to work to make changes in their thinking and teaching because “it's never too late to change your stance” (White woman).

LIMITATIONS AND OPPORTUNITIES

In this analysis, the focus was primarily on the salient themes present in the data to highlight the perspectives of faculty—specifically those who are STEs and scholars of the CRP—regarding the deepening of their critical consciousness. This focus may have led to an incomplete understanding of how intersecting factors such as race, ethnicity, gender, socioeconomic status, and other social categories collectively influence participants' thinking and practice. While the authors could draw conclusions and make interpretations on the basis of the identities of STEs, future research should adopt a more comprehensive approach to data analysis that explicitly incorporates an intersectional lens. Furthermore, additional studies should include greater gender diversity to better understand the roles that race and gender play in the development of critical consciousness.

DISCUSSION AND RECOMMENDATIONS

This study highlights the perspectives of ten STEs, which allows us to draw on their collective experiences to understand how they work to deepen their critical consciousness. In this work, there are three important practices that STEs can work to deepen their critical consciousness (and STE professional development providers can incorporate in STE development opportunities), including 1) seeking diverse backgrounds and perspectives, 2) examining and understanding one's positionality, and 3) engaging in reflective practices.

Findings from the first theme suggest that STEs' motivations to develop their critical consciousness are fostered by their desire to seek diverse ideas and perspectives. This study highlighted that STEs' personal experiences and observations of inequity were catalysts for deepening their critical consciousness. This aligns with phase one of Landreman et al.'s (2007) two-part framework for college faculty developing their critical consciousness: awareness raising (phase one) and the actualization of critical consciousness development (phase two). For example, awareness raising was evident when STEs shared experiences that shifted their worldview, exposing issues of social injustices. A hallmark of this phase is the increased intentionality in engaging with groups, ideas, and theories outside of what STEs consider normal or familiar. Landreman et al. (2007) emphasized that raising awareness "may lead to the cognitive dissonance ... required for learning to take place" (p. 294). The findings also indicate that deepening one's critical consciousness begins with exposure to diverse perspectives and ideologies, leading to and acknowledging the rightful presence of others.

The second theme highlighted how an awareness of power dynamics highlighted the importance of examining and understanding one's positionality. STEs in this study engaged in deep exploration of their positionality, which included various identities (e.g., race, gender, class, religion) that informed their agency (Mensah, 2012; Rivera Maulucci, 2013; Teo, 2015). Positionality involves awareness of social identities and the realization that these identities are framed around power and privilege (Fasavalu & Reynolds, 2019; Jacobson & Mustafa, 2019). Awareness of positionality foregrounds the establishment of rightful presence by levelling the power dynamics to communicate to PSTs that their ideas are valued within institutions. While this study did not explicitly code for intersectionality, participant narratives repeatedly revealed the influence of overlapping social identities on how STEs engaged with the CRP. The faculty of Color often cited their racial identity alongside other salient identities—such as gender or immigration background—when describing their awareness of inequities in STEM. Faculty of Color also often drew on their lived experiences to contextualize and understand how power dynamics can have impacts on STEM teaching and learning. In contrast, White faculty tended to require more structured opportunities (e.g., graduate study, professional development) to recognize how their own race, gender, or class shaped their perspectives.

STEs' reflective processes are also shaped by their positionality. For example, the STEs of Color did not seek awareness-building experiences; instead, they critically examined how systems have either supported or failed to support their rightful presence within STEM. In contrast, White STEs more often described the processes of learning and unlearning they were engaged in to help establish the rightful presence of their students. Furthermore, it is possible to hypothesize that the White STEs did not question whose presence was missing during their K12 education because they navigated the schooling system with a sense of rightful

presence. In contrast, the STEs of Color identified instances that challenged their rightful presence in STEM, resulting in earlier life opportunities to develop their critical consciousness. These findings align with intersectionality theory, which posits that individuals experience oppression and privilege in multidimensional ways (Crenshaw, 1989).

The third theme highlighted how STEs' ongoing self-reflection was essential in their development as culturally responsive educators and promoted rightful presence within their instruction. While many STEs were first introduced to critical consciousness through formal professional development in graduate or postgraduate programs, they emphasized that becoming more critically conscious required continual, intentional reflection beyond those settings. STEs further exemplified ethos toward the rightful presence of making the invisible visible through introspective practices. For example, the STEs in this study engaged in various forms of self-reflection, such as self-studies, which create opportunities for systematic reflection (Han et al., 2014; Ragoonaden, 2015). Self-studies also support intentionality in designing or redesigning readings and assignments centered around culturally responsive practices to establish rightful presence among their PST populations (Shimek et al., 2023). Some STEs find the use of rubrics and tools helpful in their self-reflection process, such as the math teacher educator reflective framework (Nolan & Keazer, 2021). Ultimately, the findings underscore that critical consciousness is not a static achievement but a dynamic, ongoing process—one that is most powerfully sustained through regular, purposeful reflection with the central goal of establishing the rightful presence of learners of all backgrounds.

CONCLUSION

There have been calls to increase diversity among educators; however, 80% of the teaching workforce identifies as White women (National Center for Education Statistics, 2019). To address this lack of diversity, researchers argue that STEM teaching at the college level needs to shift to recruit and retain diverse student populations (Ciampa et al., 2022). Furthermore, teacher education programs committed to preparing culturally responsive teachers need teacher educators who are working to deepen their own critical consciousness (Gist et al., 2019). Culturally responsive pedagogy (CRP) is a practical perspective on teaching, and when fully adopted, it can be transformative when taught within teacher preparation programs. STEs play a critical role in supporting PSTs in adopting the CRP; however, to establish the rightful presence in their classrooms, STEs must first internalize and embody all three tenets of the CRP within their own teaching philosophy. Due to the underutilization of the third tenet, the development of critical consciousness, this work has focused its efforts on examining the ways in which culturally responsive STEs have continually deepened their critical

consciousness. As this work is qualitative and by nature not intended to be generalizable, our hope is that the findings from this study can provide deeper insight, actionable steps, and a broader perspective to other STEs who desire to deepen their critical lens as educators.

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