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Theoretical perspectives for developing antiracist teaching dispositions and practices in preservice teacher education

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Abstract

For some time, scholars who are guided by critical theories and perspectives have called out how white supremacist ideologies and systemic racism work to (re)produce societal inequities and educational injustices across science learning contexts in the United States. Given the sociopolitical nature of society, schooling, and science education, it is important to address the racist and settled history of scientific disciplines and science education. To this end, we take an antiracist stance on science teaching and learning and seek to disrupt forms of systemic racism in science classrooms. Since teachers do much of the daily work of transforming science education for minoritized learners, we advocate for preparing teachers who understand what it means to engage in antiracist, justice-oriented science teaching. In this article, we share our framework for supporting preservice teachers in understanding, developing, and implementing antiracist teaching dispositions and instructional practices. In alignment with other researchers in teacher education who emphasize the importance of anchoring teacher education practice and research in prominent educational theory, we highlight the theories undergirding our approach to antiracist science teaching. We offer considerations for how researchers and science teacher educators can use this framework to transform science teacher education.

Keywords

antiracist teaching; equity; preservice teacher education; theory

1 | INTRODUCTION

For decades, scholars who are guided by critical perspectives and theoretical frameworks have called out how white supremacy and systemic racism work to (re)produce societal and educational injustices in U.S.-based science learning contexts (e.g., Apple, 1992; Bryan & Atwater, 2002; Johnston et al., 2011). In addressing the racist and settled history of scientific disciplines and science teaching (Bang et al., 2012; Sheth, 2019; Waight et al.,

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CONFLICT OF INTEREST

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2022) and the notion that science education and science teacher education are claimed as white property (Bullock, 2017; Mensah & Jackson, 2018), critical scholars highlight the sociopolitical nature of society, schooling, and science education. Moreover, scientific and pseudo-scientific research have been incorrectly used to affirm racist theories, and those theories have driven—and continue to drive—racist science ideologies in practice in both science fields and classrooms (see #scientificracism; Brown & Mutegi, 2010; Harvard University Library, 2022). During the COVID-19 pandemic, there has been increased attention to these issues within our scientific professional and academic communities as our global public health and education crises continue to converge (e.g., #ShutDownSTEM, #ShutDownAcademia; Cronin et al., 2021; Morales-Doyle et al., 2020; Morton et al., 2022). The pandemic has been a wake-up call for some while others of us have always been attuned to the pervasive, endemic nature of racism in our society and schools.

Despite our attempts to name and address myriad forms of systemic racism and their effects on science teaching and learning in both academic and public-facing scholarship, many PK-12 minoritized learners continue to experience differential learning opportunities. If we are to transform science education for minoritized learners and mitigate the long-lasting effects of white supremacist ideologies, we must support our teachers in understanding what it means to engage in antiracist, justice-oriented science teaching. As Angela Davis told us: “In a racist society, it is not enough to be non-racist, we must be antiracist.” Racism has *always* been deeply embedded in the structures and systems of the US, especially our educational system which was designed based on white, middle-class values. As such, we must actively and intentionally push back against racist, structural inequities and pursue racial justice in our science classrooms and schools. Otherwise, we have abandoned the expressed purpose of education as a means for advancing individuals and for sustaining our democracy.

To move toward this goal, we take an antiracist stance on science teaching and learning. The purpose of this manuscript is to forward our framework for supporting preservice science teachers in developing antiracist teaching dispositions and practices. To transform teacher education for racial justice, we *must* rely upon powerful theoretical constructs and perspectives for guidance (Bartolomé, 2004; Shah, 2021; Settlage et al., 2021; Souto-Manning, 2019). By drawing upon prominent theoretical frameworks (e.g., Bartolomé, 1994, 2004; Beauboeuf-Lafontant, 1999), we emphasize the importance of anchoring science teacher education research and practice in educational theory. Importantly, we use this body of research and knowledge to provide insights into how we can engage in and sustain antiracist science teaching. We build upon prior research demonstrating that: (a) good teaching matters for student learning (Darling-Hammond, 2006, 2010); (b) it is simply not enough to just focus on shifting teachers’ beliefs and practices to move toward racial justice and centering antiracist teaching in science classrooms; and (c) the goal of antiracist teaching is to work toward mitigating systemic inequities and fostering more just, sustainable educational futures for minoritized children (Forman et al., 2021; Larkin et al., 2016; Morales-Doyle, 2017; Shah, 2021; Souto-Manning & Martell, 2019; Williams & Settlage, 2021). It is time for us to make real on our promise to educate teachers who are well-prepared to work with minoritized learners, and who also sincerely understand and commit to antiracist science teaching.

As such, we situate our framework within the ongoing conversations in science teacher education research (e.g., Calabrese-Barton et al., 2022; Mutegi et al., 2022) and teacher education research more broadly (e.g., Gist et al., 2021; Souto-Manning, 2019). In offering this framework to the field, we describe efforts with university-based undergraduate and graduate-level preservice teacher education programs while acknowledging the important work occurring across a range of settings to prepare science teachers. This includes recognizing teacher educators who work with prospective teachers pursuing alternate routes into the teaching profession (e.g., teacher residency programs, Grow Your Own Programs) or alternative certification programs, and those who support inservice teachers' further professional development.

In this article, we begin by drawing upon sociocultural theories of learning to explain our onto-epistemological view on science education. Next, we share our researcher positionality statements and define the constructs we use throughout this article to support our audience in understanding how our lived experiences shape our research and practice. We then highlight the theories we leverage to advance our antiracist science teaching framework and conclude by offering considerations for how researchers and science teacher educators can use this framework to transform science teacher education.

1.1 | Our onto-epistemological stance on science teaching and learning across contexts

Our perspectives on teaching and learning are rooted in sociocultural theories of learning. Unlike some educational psychology and psychology theorists who purport that cognition occurs within the individual, sociocultural theorists view learning as socially and culturally situated activities where learning does not *solely occur* within the individual but also in connection with social others (Nasir & Hand, 2006; Nasir et al., 2006). Learning and development are intertwined processes that are mediated and facilitated by sociocultural practices, tools, and artifacts in broader ecologies (Gutiérrez & Rogoff, 2003; McKinney de Royston & Nasir, 2017; Nasir & Hand, 2006). As such, learning and development cannot be disconnected from the contexts in which they occur (Nasir et al., 2021). This requires recognizing how cultural practices, interactions with others, sociopolitical contexts, and learning environments influence human development and learning (Bang & Medin, 2010; Esmonde & Booker, 2016; Irizarry et al., 2021).

In understanding the social nature of connectivity, attention should be given to multiple forms of oppression and issues of power and racism within these intersections. Science disciplines and educational settings matter in multiple ways (i.e., contexts are consequential) for learning processes because of the power assumed in their practice (Philip et al., 2018). We argue that if we do not support the preservice teachers in our teacher education programs to understand the relationships among teaching, learning, and contexts—both collectively and intersectionally—we cannot expect them to actually develop critical and antiracist teaching dispositions and practices. Further, from our onto-epistemological position(s), we assume multiple ways of knowing and being are always grounded in learners' cultural practices, which contribute to the co-construction of science knowledge. In our continued becoming as science teacher educators, we (the authors) believe the epistemologies of science and that of learners, preservice teachers, and teacher educators are constantly in

dialogue. As other critical scholars have pointed out for some time, we view learners' ideas and ways of knowing as resources for learning that both learners and teachers can draw upon in science classrooms (Bang & Medin, 2010; Nasir et al., 2006; Warren et al., 2001).

Finally, in considering how the sociopolitical and sociohistorical realities of learners from racialized, classed, and linguistically minoritized communities are deeply connected to the contexts in which we teach, it becomes even clearer why we take this onto-epistemological viewpoint. As Bang and Vossoughi (2016) point out, if we are to work towards achieving equity with a social justice lens in science classrooms, we must ensure our efforts are distinctive from previous "equity" efforts. In other words, science education equity-focused researchers, practitioners, and policymakers must move beyond access and achievement frames if we are to affect change for minoritized learners, families, and communities (Bang & Vossoughi, 2016; Madkins et al., 2020; Madkins & Patterson Williams, 2020). By simply repackaging the status quo (i.e., strategies that potentially increase learners' access to so-called rigorous science instruction while centering assimilationist ideals), we are being disingenuous about our commitments to equity-focused work while devaluing multiple ways of scientific knowing and doing (Bang & Vossoughi, 2016).

1.1.1 | Social practice theory—We (the authors) see sociocultural theories of learning as important for understanding contexts and learning processes while social practice theory informs our work related to preservice teachers' (PSTs') varied learning pathways as they learn to teach. We look toward social practice theory (Holland & Lave, 2009) because it can help us make sense of the micro-macro structures that affect who we are and our daily work in teacher education. Holland and Lave (2009) discuss the use of institutionalized struggles, and in our case, these are the struggles we go through as preservice teacher educators and the counternarratives embedded in our stories of coming into science education. In these stories, we describe our understanding of sociocultural work with PSTs in our university-based teacher education programs and how we position ourselves in relation to our work through these experiences. Unpacking social practices in relation to micro (individual behaviors) and macrosocial phenomena (structures) allows us to see how dialectically involved these practices are and can help to create (or neglect) an antiracist science teaching lens. This relates to both authors' work as teacher educators but also for our futures as we navigate vastly different programs, spaces, backgrounds, and circumstances. Our collective sensemaking about course delivery, field placement requirements, and PSTs' reactions generate interesting opportunities to observe the how and why of equity-focused teaching, as well as possibilities to critique our efforts toward realizing more justice-oriented practice.

1.2 | Researcher positionality statements

We are two university-based teacher education researchers who work in distinct contexts, have vastly different backgrounds, and embody unique, intersecting identities. We want to make clear how our personal, educational, and professional experiences shape our research agendas, researcher reflexivity, and antiracist approaches to science teacher education (Evans-Winters, 2011; Jafar, 2018; Milner, 2007). To this end, we first share our individual positionality statements and then provide our common commitments to research and teaching. We do so to support our audience in not only better understanding (and utilizing)

our approaches, but to also highlight the rich theoretical frameworks and scholarship undergirding our rationale for advancing an antiracist science teaching framework.

1.2.1 | Madkins—I am a cis-gender, heterosexual Black woman researcher, teacher educator, and former classroom-based K-8 teacher who grew up in the suburbs of Atlanta, Georgia in the late 1980s. My maternal and paternal ancestors were enslaved in Louisiana and Texas (respectively), and both of my parents survived the Jim Crow era in these areas. My familial histories and experiences provide me with intergenerational and experiential knowledge of how implicit and explicit deficit narratives about Black people—especially Black children—operate within our broader society and schools. These false, deficit narratives are instantiations of how racist and white supremacist ideologies are taken up in schooling contexts (Carter & Reardon, 2014; Kendi, 2017; Patton Davis & Museus, 2019). I apply these intergenerational understandings and knowledge in how I design and carry out research projects (e.g., Madkins & Irizarry, 2021), analyze data and share findings, and in how I plan and teach my undergraduate and graduate courses in STEM education.

Further, anti-Black assumptions that intersect with other forms of deficit thinking (e.g., sexist ideologies about girls' or women's capabilities) are palpable within science and other STEM learning environments, as these narratives are communicated both implicitly and explicitly to minoritized children (Madkins & Nasir, 2019; Martin, 2013; Nasir et al., 2012; Sheth, 2019). As a young child, I was keenly aware of these narratives and vividly remember interacting with teachers and children who believed them as early as first grade. This was the first year I attended a non-Black, private K-8 school (where I was the *only* Black learner) and had to contend with teachers and staff who communicated their beliefs that I was not a competent learner simply because I was Black. Nonetheless, I loved school and learning. I especially enjoyed learning science throughout my K-12 schooling and was always drawn to biology and chemistry—though, I was unfortunately often the only or one of a few Black learners in honors and Advanced Placement (AP) courses at my high school in suburban Atlanta due to racist tracking practices.

As I pursued an undergraduate degree in biology with a pre-med emphasis at a historically white institution (HWI), Boston University, I felt isolated and undervalued while encountering false narratives about being exceptional (Madkins, 2020; Morton & Parsons, 2018; Watkins & Mensah, 2019). Instead of going to medical school, I chose a career in education. Though my parents were initially disappointed by this choice, it became clear to them that my soul's work was satisfied by working with young children in classrooms. I was also inspired to build upon the historical legacy of Black teachers, especially Black [womxn](#) teachers, by becoming a third-generation classroom-based educator in my family (Anderson, 2021; Dixson & Dingus, 2008; Givens, 2021a; Madkins, 2011; McKinney de Royston et al., 2021). During my time as a teacher in PK-8 classrooms, I primarily worked with minoritized learners and their families in Los Angeles and the San Francisco Bay Area. I also facilitated professional development experiences related to culturally relevant science teaching for K-8 teachers in the Los Angeles Unified School District (LAUSD) and was an elementary science teacher educator in the LAUSD District Intern Program.

This professional socialization and early personal experiences that supported my critical consciousness development, alongside my graduate training and research experiences as a learning scientist and teacher education researcher across STEM learning settings, inform my equity-focused research agenda and justice-oriented approaches. I recognize the ways in which my intersectional identities bring me privilege in some spaces while relegating me to the margins in other spaces. For example, I can often easily connect with some racially minoritized teachers and school staff at local public schools where I might develop research partnerships, yet am racially profiled and harassed on my university's campus or in local [grocery](#) and [department](#) stores. During the COVID-19 pandemic, I deepened my commitment to decentering whiteness in my research agenda and no longer making space to tolerate white rage or fragility (Anderson, 2017) in my university-based elementary science methods courses (see Madkins, 2021; Madkins & K. Morton, 2021). This means that I do not give space for white guilt or resistance to discussing racism in schooling and science education. Instead, I prioritize PSTs developing understandings about centering social justice issues in science classrooms. Despite the potentially lower course evaluations and other potentially negative consequences, I continue to engage in the risky work of prioritizing justice in my courses like other teacher education Scholars of Color (e.g., Mutegi et al., 2022; Souto-Manning, 2019).

By prioritizing strengths-based perspectives and learners' needs, I aim to implement (re)humanizing approaches to both my research and teaching endeavors (del Carmen Salazar, 2013; Souto-Manning & Winn, 2019). In doing so, I can better support preservice science teachers in disrupting anti-Black and other forms of racism in their future work and provide my colleagues with a model of how to pursue this study agenda.

1.2.2 | Nazar—My positionality begins with my experiences as a young K-12 learner and how that work developed into the question that has driven my life-long academic quest in research and teaching: How can we support teacher learning from youth voices, lived experiences, and knowledge in humanizing ways? Ontologically, this question is really “me-search”—a critical sensemaking of my own cultural, linguistic, and even religious experiences—and how science helped me to answer those questions by objectively legitimizing what I once believed were subjective views. I now recognize how I actively suppressed the cultures that defined me, especially when I knew (or was aware) that by openly discussing my cultural experiences, I could lose to succeed. My experiences, and the youth I worked with in prior research projects (Nazar, 2018), have taught me that cultures/ways of knowing and being/everyday experiences at home, with family, friends, TV shows, the past, present, and perceived social futures of youth—are crucial to how they feel welcomed, identify with, are recognized, succeed, and become in science. To me, this is the same as saying: How I/they/we experience the world influences science teaching and learning.

My name is Christina Restrepo Nazar and yes, I use both my last name and my mother's maiden name in my name, though not legally. I was born in Teaneck, New Jersey, but proudly grew up on the corner of Gregory and Passaic Ave in Passaic, New Jersey. I am an only child born to Colombian immigrants who themselves were biracial. My mother—born to a Colombian woman and Palestinian man—is a retired janitor. Most recently, she worked

as a janitor at the University of Central Florida, my alma mater, where I received both my bachelor's and master's degrees in science education and participated as a Gates Millennium Scholar and McNair Scholar to support my eventual journey to graduate school. My father, a Colombian immigrant and son of an Indigenous woman, worked as a coffee farmer on his father's nine farms. My father immigrated to the United States and worked in a factory until he suffered injuries from a car accident which left him permanently disabled. Although my parents separated when I was a child, and the relationship I had with my father was severely strained, I was fortunate to have the love and care of my family.

My maternal aunt, Sofia, helped raise me, as my mother had to work two jobs to support our household. My aunt passed away on October 1, 2020, during the COVID-19 pandemic. I was eternally devastated and still have not been able to recover from her death. My Tita—as I affectionately called her—never missed a school event (from Pre-K to my doctorate and even to my faculty meetings at my current institution) or an important milestone in my academic career and I owe her the foundations of my entire success for the academic I am today. She was a woman who lived her life understanding the bricolage of cultures that she grew up in as the oldest daughter to my Palestinian maternal grandfather.

What I learned from my aunt is that my maternal grandfather's family endured the difficulties of assimilation for various generations—a reality I did not know until I was enrolled in my doctoral program. This greatly affected my research trajectory, work, and even engagement with my science methods courses with preservice teachers because I came to realize how science can be used as a way to assimilate people into a way of knowing that do not prioritize the perspectives of the communities they affect. My grandfather, Hasan Mustafa Abed Rabbo (who took the name Jose Miguel Nazar upon his arrival to Colombia), left his native Beit Safafa (a Palestinian town now located near Jerusalem, Israel) to avoid being recruited in the Turkish Army (then the Ottoman Empire) at the eve of World War I. He left behind his culture, family, and his life—one he never returned to, and we are yet to go back to ourselves. By his family, I mean his wife, Fatima, and unborn son, my Uncle Mustafa.

Although my grandfather never spoke of his family in Palestine, he communicated with them through letters and pictures of my uncles he sent his family members while his children were growing up in Colombia (Palestine was a highly patriarchal culture). He did not talk about them not because he wanted to forget about them, which is what politics and society would have us think about Men of Color. Rather, he was in the crossroads of sociohistorical shifts and changes to his daily life that put him on the other side of the world that would not allow him to return home. For example, Catholic churches in Colombia would not register my aunts and uncles with Arabic names, which he tried to do many times—11 times to be exact with the birth of each of my aunts and uncles. It became evident that in that small village, Andes, Antioquia, Colombia in the 1940s, with a Catholic church as its largest structure in a small plaza with a handful of businesses (one of which was my grandfather's), it was frowned upon to be Middle Eastern. They were not free to take up their customs—especially their Arabic linguistic repertoires and Islam as a religion. My maternal grandmother, Mercedes Bernarda, took a great risk in marrying my grandfather, but she was in love with him. He killed his cultural and linguistic repertoires to marry her,

and that trauma eventually reached his children and grandchildren, for which we now suffer as a result. This helps me understand (1) the importance of valuing and using a range of linguistic repertoires in the science classroom, (2) how language is connected to culture, and (3) how PSTs need to learn from these perspectives, given the ways students have experienced linguistic injustices in local practice (Takeuchi et al., 2022).

As my family notes, the Palestinian Diaspora in Colombia was a very tight-knit community. But many of those men and women that immigrated decided that the best course of action was to assimilate their children into the new culture, which became the case for my family. Now, as technology and globalization are increasingly parts of our lives, the Palestinian Diaspora is struggling to find their roots—a struggle that I and many other descendants who are trying to find our families and retell our stories together endure.

As my Colombian aunts and uncles grew up and began setting their eyes on new opportunities, it became clear they needed to seek economic, social, and political changes. My grandfather no longer had his businesses, so my family struggled financially at that time. Just as my grandfather did decades before, my aunts and uncles also decided to leave it all behind and immigrate to the United States. However, there was another dilemma: They grew up not knowing or learning about their Arab culture, and in the US, they began to experience the assimilationist practices that forced them to leave behind their Colombian culture, too. During my childhood in the 1990s, I witnessed Colombian immigrants, especially my aunts' and uncles' friends in New Jersey, holding reunions and societies (called *cofradías*) mainly based at churches to maintain their cultural traditions. At times it felt like we were hiding. Others talked about sending their children back home so that they would not “lose their Spanish,” which was the decision my mother made, and as such, I traveled to Colombia every summer. My parents immediately gave me Colombian citizenship to avoid paying penalties for my stay as an American citizen in the country. I identify as a Latina in my current academic spaces, as it is difficult to say and further explain that I am Arab Colombian American or the experiences that made me who I am. Although I look like I am Latina—and that is how I am perceived by others in the US—in Colombia, I do not look Colombian, I don't look Latina enough. Furthermore, in my communication with my cousins in the Middle East, I don't know the language or the culture and religion—then who am I?

The simple answer to this existential reality is based on my love for science. Science allowed me to search for the his/her/they stories and answer important questions such as: Why didn't my dad inherit his father's land if he is his son? How did this contribute to MY poverty? Or why do I look the way I do and why is it important for me to know who I am (genetically alongside culturally) so that I can relate to the world around me? As I grew older, I noticed that law, medicine, nor any other field except science itself could answer these questions of race and racism. As such, my interest in science teacher education evolved. This is why my work now delves into unpacking how PSTs can bridge the multiverse of positionalities and perspectives of the youth they teach in their science classrooms.

1.2.3 | Our commitments to centering justice in our research and teaching—

We advocate for antiracist science teaching and learning because it provides a powerful

opportunity for teachers to address the racist history of scientific disciplines and science education (Bliss, 2012, 2015; Morales-Doyle, 2017; Sheth, 2019). Furthermore, justice-oriented science learning is a right for minoritized learners and provides opportunities for us to make real on our promise to acknowledge and celebrate learners' full humanity and dignity (Espinoza et al., 2020; Espinoza & Vossoughi, 2014; Sheth, 2019; Waight et al., 2022). In so doing, educators can facilitate learning experiences where learners bring their full selves to all science classrooms. To achieve these goals, we cannot use an equity lens focused solely on access (i.e., equal access to resources, high-quality instruction, and qualified teachers) or achievement (i.e., decreasing disparate student outcomes across racial and ethnic groups). Instead, our equity lens should center justice-oriented approaches (Madkins et al., 2020; Madkins & Patterson Williams, 2020; Morales-Doyle, 2017; NASEM, 2022; Varelas et al., 2015). Using this lens requires researchers, practitioners, and others to acknowledge and address how structural, anti-Black, and other forms of racism influence minoritized learners' differential opportunities to learn across science learning environments (i.e., opportunity gaps; Carter & Reardon, 2014).

This approach also requires an acknowledgment and rejection of dominant deficit narratives (see Patton Davis & Museus, 2019 or Valencia, 2010) about minoritized learners and their communities that are rooted in racist ideologies (Kendi, 2017). Through these implicit and explicit deficit narratives, some educators view minoritized learners as deficient and/or in need of repair as related to their abilities, how they traverse schools and social systems, and who they are as people (Madkins, 2021; Nasir et al., 2012; Patton Davis & Museus, 2019; Valencia, 2010). To push back against these narratives, we are dedicated to using strengths-based approaches, and draw and build upon minoritized learners, families, and communities' repertoires of practice (Gutiérrez & Rogoff, 2003) as resources for learning.

In alignment with these viewpoints, we use terms in this article (and in our work more broadly) that are representative of our personal, educational, and professional lived experiences as members of and our work with minoritized communities. We refer to learners' identities and experiences based on our desires to decenter whiteness, push back against dominant narratives, and position children—and in turn, their families and communities—as capable learners. For example, our use of *minoritized learners* signals the power dynamics that influence how those who are of the global majority (Lim, 2020) are *minoritized* in dominant narratives (e.g., *racial minorities*, *underrepresented students*). We intentionally use *learners* to serve as a reminder: (1) that *all* children, *especially minoritized children*, are *always* learning whether at home, in their communities, or in a school setting and, (2) to push back against traditional notions of how we define *students* (Adair & Sánchez-Suzuki Colegrove, 2021; Madkins & K. Morton, 2021). Relatedly, we use *multilingual learners* rather than English Language Learners (ELLs) for learners from various racialized and ethnic backgrounds who are developing linguistic repertoires in multiple languages (González-Howard & Suárez, 2021; Takeuchi et al., 2022).

2 | ANCHORING ANTIRACIST SCIENCE TEACHING IN THEORY

In the following section, we provide an overview of the theoretical frameworks and constructs we draw upon to support our antiracist teaching framework, including: *political*

clarity (e.g., Bartolomé, 1994, 2004; Beauboeuf-Lafontant, 1999); *teaching dispositions and practices* (e.g., Villegas, 2007); and *justice-oriented science teaching* (e.g., Calabrese Barton & Tan, 2020; Morales-Doyle, 2017). We mainly focus on outlining political clarity since it has been the least emphasized in the science teacher education literature and we view it as central to developing antiracist science teachers.

2.1 | Political clarity

To develop an antiracist teaching disposition, a teacher must understand the political nature of teaching (Beauboeuf-Lafontant, 1999), which is a profession that has always been viewed as engaging in a political act. This is especially true for teachers' work with minoritized learners and their efforts to acknowledge and address anti-Black and other forms of systemic racism in classrooms (Anderson, 2021; Givens, 2021b; Madkins, 2011; McKinney de Royston et al., 2021; Todd-Breland, 2015). However, scientific disciplines—and by proxy, science education—are often considered apolitical and culture-free (Cochran et al., 2020; Sheth, 2019). Critical science education scholars resist this apolitical characterization of PK-12 science teaching and learning in their research and practice (Madkins & Morton, 2021; Morales-Doyle, 2017; Mutegi et al., 2022; Patterson & Gray, 2019; Riley & Mensah, 2022; Vossoughi & Vakil, 2018).

Coming to this important understanding of teaching as a political act is an important first step in a teacher's ongoing development of *political clarity*. Political clarity (Bartolomé, 1994, 2004; Beauboeuf-Lafontant, 1999) is one's understanding of the sociohistorical, economical, and sociopolitical factors shaping minoritized learners' material realities and lived experiences, as well as how systemic racism influences educational opportunities for minoritized learners. Beauboeuf-Lafontant (1999, p. 704, emphasis added) argues that a teacher's "*political* understanding of education" is what undergirds their "sensitivity to and support of antiracism" work in classrooms. Simply put, a teacher cannot engage in antiracist science teaching without (further) developing their political clarity (we use further here to remind our audience to acknowledge that many individuals—both teachers and learners—have already begun their political clarity development but need to *keep* developing it). This consistent, intentional, and lifelong process to develop and use political clarity also involves grappling with how macro-level issues (e.g., educational inequities in the United States) influence learners' day-to-day experiences, as well as countless school- and classroom-level interactions (Bartolomé, 2004) A teacher with political clarity deeply understands:

- a. the range of social injustices (e.g., environmental injustice, raciolinguistic racism) by having an awareness of, witnessing, and/or experiencing them in society and schooling. This might include understanding how the presence of lead in water and soil within urban areas, such as the Flint Water Crisis (see Pauli, 2020), disproportionately affects racially minoritized communities in the United States;
- b. the sociopolitical nature of schooling, and various sociopolitical issues relevant to the local communities they work with (e.g., police brutality, food apartheid), as well as those relevant to minoritized communities nationally and globally communities; and

- c. their important role as an advocate for their learners, their families, and community members—within and outside of the school—and the possibilities they can create in the classroom for learners’ educational futures (Beauboeuf-Lafontant, 1999; Jensen et al., 2018).

Along with other scholars, we see political clarity development as a necessary, intentional, and continuous process for promoting social and racial justice in science classrooms (e.g., Madkins & McKinney de Royston, 2019; Mensah, 2019; Morales-Doyle, 2017; Sheth, 2019). We also recognize how few examples appear in the science teacher education literature. In contrast, much of the historical and contemporary research on how teachers use their political clarity highlights Black teachers’ work related to racial solidarity and uplift with Black children, families, and communities in both segregated and so-called desegregated schools (Beauboeuf-Lafontant, 1999; Givens, 2021a; Madkins, 2011; Siddle Walker, 1996; Todd-Breland, 2015). We point our audience to this body of research to illustrate the importance of political clarity as science teachers develop antiracist teaching dispositions and practices—as well as to further emphasize the variation in teachers’ embodied understandings of political clarity across time and content areas. In science education specifically, we *cannot* ignore the racist and settled past (and present) of science education if we are to engage in antiracist science teaching. Instead, we *must make visible* the varied forms of systemic racism and come to understand how our science learning goals are inextricably linked to our political goals (Gutiérrez & Calabrese Barton, 2015; Rodriguez, 2015; Rosebery et al., 2016). This development will not look the same across preservice science teacher education and cannot be predetermined by teacher educators or preservice teachers. Rather, teachers must pursue justice in ways that are aligned with that of the school communities they serve (e.g., focusing on raciolinguistic justice and addressing anti-Blackness in a community with Black multilingual learners; see Takeuchi et al., 2022).

2.2 | Teaching dispositions and practices

A *teacher’s disposition* is characterized by their (a) interconnected attitudes, such as their feelings about their work in the classroom with minoritized learners; (b) beliefs, like their beliefs about minoritized learners or teaching science; and (c) observable behaviors, which is *how* they work with minoritized learners and organize their classrooms for learning (Amos, 2011; Haberman, 1991; Villegas, 2007). Teacher education researchers have found that a teacher’s disposition towards equity-focused work is especially important for supporting minoritized learners’ success (Amos, 2011; Darling-Hammond, 2006; Whitaker & Valtierra, 2018). This is true because a teacher’s disposition—or their orientation to or mindset about their work as educators—informs how they will interact with learners and enact what they have learned in their teacher education programs. These interactions include the instructional decisions a teacher makes at any given moment related to their instructional practices, classroom management strategies, and/or modifying curricular materials.

Science teachers who hold antiracist teaching dispositions are aware of and empathize with learners’ sociohistorical and sociopolitical realities. Further, such science teachers recognize how structural, anti-Black, and other forms of racism influence minoritized learners’ differential opportunities to learn. Both in and outside of science education, it takes time for all teachers to develop such a disposition (Achinstein & Athanases, 2005;

Butler et al., 2021; Larkin et al., 2016; Mensah, 2013, 2019). As such, science teacher educators must support PSTs in developing antiracist teaching dispositions to strengthen minoritized learners' school success and educational futures. And yet, we know dispositions alone are insufficient. One can have an understanding of what it takes to be an antiracist teacher, but also needs to be skilled with teaching practices to engage them in classrooms with minoritized learners (El Kadri & Roth, 2015).

2.3 | Justice-oriented science teaching

Although there has been less of a focus on antiracist science teaching in the literature, several scholars have prioritized justice-oriented teaching (e.g., Calabrese Barton & Tan, 2020; Morales-Doyle, 2017). These teachers keep justice at the center of their instructional practices in science classrooms with young people. For example, Morales-Doyle (2017) introduced the *justice-centered science pedagogy framework*, which connects culturally relevant pedagogy (Ladson-Billings, 1995) and critical pedagogy (most often credited to Freire, 1970/2001). In using these pedagogical practices to pursue social change, learners are positioned “as transformative intellectuals who exhibit complexity, commitment, and credibility” (Morales-Doyle, 2017; p. 1055). The development of curriculum grounded in standards-based science concepts must be guided by the tenets of pedagogy (i.e., critical consciousness development, social justice issues). In doing so, learners' critical consciousness is (further) enhanced while minoritized learners are held to high academic expectations and seen as co-creators of knowledge. Relatedly, Calabrese Barton and Tan (2020, pp. 435–436) elaborate their *rightful presence framework*, which is “a justice-oriented political project” centering youth's sociopolitical realities in and outside of classrooms. The tenets of this framework include: (a) disciplinary learning is inextricable from political struggles; (b) in/justices are made visible by acknowledging them and supporting learners in working to disrupt the status quo; and (c) collective disruption of white norms in classroom settings.

In offering these two examples, we aim to share what is common across justice-oriented science teaching so that researchers and teacher educators understand these principles. In turn, PSTs can be supported in embodying these practices as they endeavor to become antiracist science teachers. Justice-oriented science teaching means minoritized learners have their capabilities and potential are affirmed, have opportunities to engage in rigorous and meaningful instruction, and engage in content learning that is connected to challenging and addressing systemic inequities. To accomplish these lofty goals, teachers *must* have and use political clarity to inform their classroom organization and instructional practices (Calabrese Barton & Tan, 2020; Madkins & McKinney de Royston, 2019; Morales-Doyle, 2017).

3 | ILLUMINATING THEORY WITHIN ANTIRACIST SCIENCE TEACHING EDUCATION

The goal of this article is to advance our antiracist teaching framework, which we see as a necessary approach to science teaching and learning, especially when working with minoritized learners (e.g., Black multilingual learners in working-class neighborhoods). We

argue that the educational theories undergirding this framework should not only guide our understanding of antiracist science teaching but should also be integrated into how we organize and implement science teacher education programs. This obviously includes our science methods courses where we support PSTs in content-based learning, in understanding pedagogical and assessment practices, and more—but also field experiences, milestones, and other professional development opportunities in our programs. In this way, we can support PSTs in understanding theories of learning *and* theories that inform our teaching practices. Science teacher educators should embrace theory to affect shifts in concert with more practical skills. To be clear, this is not a novel idea, namely, to integrate theory with practice in teacher education (e.g., Grossman et al., 2009; Hill & Chin, 2018; Souto-Manning, 2019). But it is one that has become even more necessary than ever and can provide valuable insights into our work in both university- and school-based classrooms. As such, we grounded our antiracist work in teacher education in prominent theoretical perspectives to move away from “academic agnosticism toward white supremacy” (Crenshaw, 2022; p. 1723) and the inherently racist practices so common in teacher education programs (Souto-Manning, 2019).

To this end, we conclude this article by offering a few considerations for science teacher educators (and the researchers who might examine these shifts in approaches and how they are taken up within and across teacher education programs) to engage in the risky and difficult work of antiracist teaching. It is our hope that science teacher educators and researchers will recognize their important role as change agents and advocates for justice-centered science education (Anderson et al., 2022; Beauboeuf-Lafontant, 1999; Madkins & Morton, 2021). If not, there is great potential to continue fostering oppressive instruction and curriculum with novice teachers who are viewed as technicians rather than role models, voices of reason, and critical junctures for transformation. Finally, we remind our audience that contexts matter and are consequential for learning. As such, we do not offer prescriptive solutions and can instead *only* offer considerations that each teacher educator will have to apply to their local context. Importantly, *all* science teacher educators will have to continuously interrogate their identities and positionalities before and during their work to support PSTs in becoming antiracist teachers. For some (including the authors), this will mean a shared history and experiential understandings of the effects of systemic racism in and outside of schools and classrooms. This can support our day-to-day work with PSTs and/or research without essentializing the experiences of minoritized individuals (Mensah, 2019). For others, it will mean making sense of the ways in which they experience privilege based on their sociocultural identities (e.g., being a White, middle-class man) and how their lived experiences are different from and similar to that of their preservice teachers—and the learners, families, and communities the PSTs will work with over time. For all, it will mean a commitment to (further) developing their political clarity. Below, we provide five considerations for science teacher educators as we move towards enacting theory in practice and preparing antiracist science teaching teachers.

- a. *How can you support PSTs’ political clarity development?* To engage in antiracist teaching, a PST must continue to develop political clarity, which is ongoing, daily work that requires (un)learning and (re)learning. We encourage

science teacher educators to consider how they can communicate to PSTs the importance of developing and using political clarity.

- b.** *In what ways do you employ strengths-based perspectives (or not)?* Within and across teacher education courses, field experiences, and related professional learning experiences, teacher educators should have strengths-based orientations to science, educators, and minoritized children, families, and communities. This begins by identifying, confronting, and rejecting deficit perspectives (Patton Davis & Museus, 2019) that may be implicit or explicit in course readings, PSTs' journal reflections, in-class or online discussions, or elsewhere. One simple way to begin this journey is by shifting the terms we use and supporting PSTs in understanding how they align with strengths-based perspectives (or not). For example, conversations and readings about opportunity gaps—rather than achievement gaps—can be powerful tools for identifying how PSTs view minoritized learners while bringing attention to systematic oppression and racist assumptions about what counts as educational success. In so doing, teacher educators support PSTs in understanding why we do not place blame on or view children and their families as deficient when discussing racialized disparate outcomes. Similarly, unpacking the power dynamics in using terms like minoritized learners or *learners from nondominant communities* (Gutiérrez & Rogoff, 2003) instead of minorities is also useful.
- c.** *In what ways can you explicitly connect social justice issues to national or local science standards?* Preservice teachers must understand and learn how to address structural inequities within science classrooms, schools, and society so minoritized learners can have more just educational futures (Jones & Donaldson, 2022; Madkins & Morton, 2021; Mensah, 2019; Sheth, 2019). Unfortunately, frameworks on how to teach science (e.g., NRC, 2012) and/or local and national science standards [e.g., *Next Generation Science Standards* (NGSS)], often do not make this explicit connection for teachers (Madkins & McKinney de Royston, 2019; Rodriguez, 2015). As such, teacher educators should consider the ways they can make visible the various injustices occurring over time across science disciplines and in scientific research. They must also support PSTs in pursuing justice and thinking through how to make connections to social justice issues and disciplinary core ideas.
- d.** *How do your course readings and materials prioritize justice-centered science teaching?* Teacher educators must review course readings and other materials they use in their virtual or in person courses to ensure they do not reify stereotypes or perpetuate deficit narratives about minoritized communities. They should also incorporate readings by Scholars of Color in teacher education and other fields who prioritize strengths-based perspectives such that PSTs do not experience an overrepresentation of white scholars and/or perspectives centering whiteness.
- e.** *How will you be mindful of fostering a brave learning space?* Learning processes related to antiracist science teaching require us to foster and maintain brave

learning environments. As Scholars of Color, we know there are not (m) any so-called safe spaces—rather there are spaces where we can be brave because we cannot assume everyone has good intentions. Teacher educators must be aware of the (un)intentional harm that can occur in classroom or online discussions (Larkin et al., 2016; Philip et al., 2017), even when norms are established about being honest, respectful, and open to critique as we endeavor to become antiracist educators. Furthermore, race is a socially constructed concept that is difficult to understand (Guinier, 2004), especially within scientific communities where it has been and continues to be considered a biological concept (Bliss, 2012, 2015). As such, teacher educators have a great responsibility to anticipate the successes and challenges they will undoubtedly encounter with PSTs and think through how they will respond in these critical moments.

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