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RESEARCH ARTICLE

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Within the walls of the classroom: How science teachers' instruction can develop students' sociopolitical consciousness

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Abstract

In this paper, we synthesize existing literature on Culturally Relevant Science Teaching (CRST), more specifically the third tenet of CRST-developing students' sociopolitical or critical consciousness. While there is research on this third tenet, our review of the literature reveals that this tenet is understudied and underutilized. We offer our conceptual framework and an illustrative example to demonstrate how teachers can practically implement the third tenet of CRST to engage and empower students in science. We hope that the ideas and examples shared in this piece will help teachers foster students' sense of sociopolitical consciousness and advocacy within the walls of the classroom and beyond. We also urge researchers to continue producing research on this important topic so that practitioners can use this information to develop students' sociopolitical/critical awareness, reflections, and actions.

KEYWORDS

critical consciousness, Culturally Relevant Science Teaching, intersectionality, science equity, sociopolitical consciousness

1 | INTRODUCTION

Calls for equity-oriented science instruction are preceded by decades of research on disparate experiences and achievement for marginalized students in science contexts. These calls often highlight the need for *all* students to be able to access rigorous and engaging science content. As part of these proposed solutions for science equity scholars and practitioners have suggested that teachers teach in culturally relevant and inclusive ways.

Several forms of critical pedagogy have gained traction in the movement towards equity and inclusion. Culturally Relevant Science Teaching (CRST) is one of the more popular frameworks associated with equity-oriented science instruction. It builds on the seminal framework Culturally Relevant Pedagogy (CRP) by Gloria Ladson-Billings (1995b). Ladson-Billings (1995a, 2014) operationalizes her framework for teachers by describing three tenets associated with cultural relevance: academic success, cultural competence, and sociopolitical consciousness. The tenets of CRST mirror those of CRP: academic success in science, cultural competence in science, and sociopolitical consciousness in science (Boutte et al., 2010; Laughter & Adams, 2012).

While the implementation of all three tenets is essential, scholars have noted that the third tenet is understudied and underutilized, particularly in science (Madkins & McKinney de Royston, 2019). For this reason, we hone in on the third tenet of CRST for this paper. We begin with a review of the literature and describe how scholars have conceptualized and promoted use of the third tenet in science classrooms. We then offer ideas for how to further understand and implement the third tenet through our conceptual framework and an illustrative example.

2 | LITERATURE REVIEW

2.1 | What is sociopolitical consciousness?

When defining her framework, Ladson-Billings (1995a) described how "students must develop a broader sociopolitical consciousness that allows them to critique the cultural norms, values, mores, and institutions that produce and maintain social inequities" (p. 162). She makes it clear that teachers must guide students on this journey to become more aware and critical of systems at every level that create and perpetuate oppression. This definition requires students and teachers to understand macro-level problems as well as the ways in which such broad issues permeate institutions and everyday life.

The need to focus on developing students' sociopolitical consciousness comes from the construct of critical consciousness coined by Paolo Friere. Freire (1973) explains that the path to liberation must be twofold. First individuals must understand the social, political, historical, and economic elements of oppression, and then they must take action to struggle against oppressive systems (Freire, 1973). Literature on critical consciousness underscores the multistep nature of this process, whereby individuals first become more aware of social and cultural circumstances and then use this knowledge to transform oppressive realities in ways that are liberating and empowering (Jemal, 2017). Thus, the first step is to acknowledge the existence of oppression and the ways in which power dynamics shape our experiences, followed by the goal of social action/change.

The third tenet of CRP reimagines the classroom as a space where individuals reflect upon the ways in which power and oppression impact society, and then engage in social action to shift reality. To do so students must position themselves as agents of change. This adds an additional layer to the process in between awareness and action. After students critically understand the world, and before they act to change it, they must identify how they fit in. Scholars have interpreted these three prongs of sociopolitical or critical consciousness as critical reflection, critical efficacy, and critical action (Watts et al., 2011). All three of these elements should occur just within the final tenet. This is potentially a heavy, but important, lift for teachers as they attempt to make their instruction culturally relevant. We now turn to the literature on CRST to share how scholars have operationalized sociopolitical consciousness in science.

2.1.1 | Sociopolitical consciousness in science

When developing sociopolitical consciousness in science, teachers must think about how issues of power and oppression intersect with the enterprise of science. This means teaching about issues such as sexism, racism, classism, and other forms of oppression within science lessons (Laughter & Adams, 2012). Teachers might do this by

helping students illuminate the obstacles that have led to the underrepresentation of people from minoritized groups in science, technology, engineering, and mathematics (STEM) fields or identify dominant, exclusionary narratives that are overly masculine and Eurocentric within science texts and resources (Settlage, 2011; Taylor, 2011). Teachers also need to teach science in a way that validates students' cultures and identities while simultaneously illuminating the cultural borders erected in some traditional science spaces (Aikenhead, 1996). After highlighting these issues students should be led to consider solutions that would impact their lives, their community, and the world. Relatedly, Arsad et al. (2020) found social justice and social action to be common threads across most of the pieces in their systematic review of CRST literature.

We see similar themes surface in the CRP and CRST literature. The need to focus on issues of inequity at the macro and micro level, and the importance of critical reflection and positioning of oneself in the world, and in science, to solve problems or enact change. We further explore these concepts in our conceptual framework.

CRP and CRST require teachers to develop their own sociopolitical consciousness and as a result intentionally plan lessons and classroom experiences to grow their students' consciousness. As the field expands and more teachers implement CRST it is imperative that researchers document and analyze these attempts to develop sociopolitical and critical consciousness. It is also important to recognize that teachers need opportunities to grapple with these concepts and "develop a critical awareness of how science can be used to deepen their understanding and application of science to empower and improve their lives and the lives of students" (Mensah, 2011, p. 306). Much of the literature on CRST focuses on the preservice learning and professional development required for teachers to fully embrace critical forms of pedagogy (Kelly-Jackson & Jackson, 2011). Given that teachers are positioned as catalysts in the development of students' sociopolitical consciousness, and research yielding practical examples is limited, we use the rest of this paper to offer practical suggestions for implementing the third tenet of CRST in science classrooms.

3 | CONCEPTUAL FRAMEWORK: EXPANDING SOCIOPOLITICAL CONSCIOUSNESS WITHIN CRST

Through CRST, teachers can help students feel a sense of belonging in the world of science. Sociopolitical consciousness provides students with opportunities to be responsible for their own science learning and growth in science literacy. In essence, better understanding of the sociopolitical nature of science allows students to be active stakeholders in their communities. However, before students can begin to make impacts on a larger scale, they must be given opportunities to advocate for their own learning in their immediate environments. Science teachers should be gateways to developing and nurturing this consciousness within students. Three ways in which teachers can be conduits of learning and practicing sociopolitical consciousness is through science teaching that (a) focuses on equity issues globally and locally to empower student voice, (b) recognizes personal and student intersectionality, and (c) provides mirrors, windows, and doors for aspirational science achievement. See Figure 1 for the conceptual framework on expanding CRST and sociopolitical consciousness. We conclude this section with an illustrative example to provide support for implementation and practice.

3.1 | Instructional considerations for creating sociopolitically conscious students

3.1.1 | Exploring global and local equity issues in science to empower student voice

There are a handful of empirical pieces that share explicit ideas or examples of how to implement the third tenet of CRST by exploring issues related to equity. These pieces demonstrate the ways in which practitioners have operationalized the third tenet. Some explore issues such as scientific racism and bias, while others focus students'

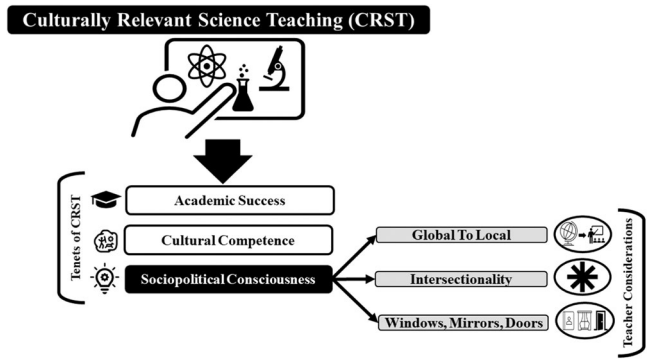

FIGURE 1 Expanding sociopolitical consciousness conceptual framework

attention on disparities related to health. In each example, the science teachers under study demonstrated the importance of introducing these topics in science classrooms to empower student thinking, discourse, and action.

One way to get students thinking about issues of equity and oppression in science is to frame scientists and scientific discoveries within their historical context. Boutte et al. (2010) encourage teachers to engage students in conversations about scientific racism and historical disenfranchisement. From critiquing and reassessing the validity of the scientist James Watson's work due to his racist rhetoric, to the purposeful inclusion of the Black inventor Charles Drew in a conversation that had previously centered White scientists, Boutte et al. (2010) offer concrete examples of how to infuse discussions of racism and oppression in the science classroom. They also discuss how students in one culturally relevant science class came to question the death of Dr. Charles Drew in light of their new, socially and historically contextualized understanding of his life and scientific contributions. These examples underscore the value of discussing the intersection of racism and scientific discovery. Such conversations get students to consider how the social context influences science and scientists' experiences (Boutte et al., 2010). Similarly, Laughter and Adams (2012) report on a series of lessons taught by Adams in her middle school science class. She used Derrick Bell's (1992) short story, The Space Traders to anchor, promote, and facilitate conversations about race and gender bias in the science field. "Adams wanted her students to understand how a scientist's individual and communal prejudices might lead to bias" (Laughter & Adams, 2012, p. 1120). Students who explore power and oppression in science classes can start to use a critical lens to recognize how these forces may manifest in science spaces. They may then use this knowledge to reduce bias in their own scientific investigations.

Boutte et al. (2010) also shared an example in which students investigated the effects of zinc levels on instances of prostate cancer in African American males. Helping students recognize health disparities across ethnic/racial and socioeconomic lines in science class is another way to develop sociopolitical consciousness. Similarly Mensah (2011) described how one teacher intentionally led her students to question why incidences of asthma were higher in cities like their own, the Bronx, NY. Her goal was to have her students connect their unit on air pollution and the environment to disparities in their local community context. In their study of one science class in Nepal, Upadhyay et al. (2020), described how one teacher engaged students in sociopolitical discourse and action around sickle cell anemia in an animal and plant cell unit. This teacher was able to foster awareness of inequities related to the disease and promote student-led action. His students ultimately petitioned the principal to hold events and modify curriculum to spread awareness and de-stigmatize sickle-cell in their community.

These studies illustrate the importance of giving students opportunities to unpack current and historical issues that impact their lives and the lives of others around the globe. As seen in the example from Upadhyay et al. (2020), building this sort of awareness can push students to use their voices for social justice in their communities and beyond.

3.1.2 | Recognizing personal and student intersectionality

First coined by Crenshaw (1991), intersectionality was introduced to our collective lexicon as part of an analysis of gender and racial confluences on three legal decisions. Crenshaw (1991) furthered the notion of intersectionality through the lens of racism and sexism and how courts rule on issues of discrimination as indivudal issues. Since those seminal works, intersectionality has been adapted in the social sciences to mostly describe the axes where identities (e.g., sexual orientation, gender, ability, class, race, etc.) intersect with each other and the experience of oppression, privilege, and/or discrimination. Intersectionality has been used to specify combined institutionalized -isms (e.g., racism + sexim) that exist in society writ large (Boveda & Aronson, 2019), the experiences of being dominated by others (Collins, 2000), and complex social and cultural interactions (Artiles, 2013; Clarke & McCall, 2013).

Cho et al. (2013) described intersectional studies as a set of arguments that examined (a) intersectional dynamics, (b) intersectionality as a theoretical discourse, and (c) a means of political intervention. Beyond the defining intersectionality, a number of scholars have posited both the positive and negatives of the term in popular lexicon. The term intersectionality has been used to orient others to the notion that no one single characteristic or identifier encompases one's experience in any societal institution. For example, the experiences in buying a house may be significantly different for a Black female with an advanced educational degree as for White female with an advanced degree. Furthermore, both of these experiences will be vastly different than those of a White male with an advanced degree and cerebral palsy. Thus, the intersection of these identities and identifiers result in vastly different and disconnected life experiences.

It should be noted that intersectionality does not exist without debate or controversy. In fact, the term has been the focus of intense scrutiny, both positive and negative, since its introduction into the intellectual, social, and cultural spheres of conversation. A number of scholars have argued that intersectionality has been systematically used to inadvertently support positions that exacerbate racism, gender bias, sexism, and ableism (Artiles, 2013; Bilge, 2013; Carastathis, 2016; Nash, 2008). Detractors of intersectionality have attempted to place it in narratives to suggest that support for intersectionality is akin to supporting: (a) identity-based victimization or (b) purposeful societal division (Coaston, 2019). A better framing of intersectionality exists in public discourse, as suggested by Carastathis (2016), "intersectionality is a provisional concept, meant to get us to think about how we think" (p. 4). This framing of intersectionality aligns well with understanding consciousness as both critical and political. That is, aside from considering intersectionality from a narrow construct, it should be positioned as a central way of thinking or in dispositional terms. (Carastathis, 2016). As described by Crenshaw (1991), intersectionality provides an opportunity to connect the systems of oppression and privilege to our self-development and inform our social identities. Furthermore, intersectionality can guide personal experiences in the various external contexts in which we live (social, political, economic, environmental, and historical; Metcalf et al., 2018).

In relation to science, science education and STEM broadly, intersectionality is a relatively new concept to consider. In fact, Metcalf et al. (2018) found that from 1993 to 2018, the term intersectionality was the focus in 2876 peer-reviewed journals with only 77 about STEM and 52 of those focused on STEM workforce topics. In analyzing those 77 articles, the authors found that most covered intersectionality as a function of mostly gender, race, and ethnicity with little to no focus on other aspects of intersectionality such as nationality, age, socioeconomic class, religion, sexuality, or disability. A number of authors have postulated the lack of attention on intersectionality in STEM including lack of awareness (Metcalf et al., 2018) and difficulty in examining intersectionality based on methodologies (Griffin & Museus, 2011; Hancock, 2007). Science educators need to be cognizant and supportive of the intersectionality that will be present in teaching and learning. Each science classroom (formal or informal) will be a combination of personal and student profiles, experiences, and dispositions. Recognizing intersectionality, both personal and in students, can provide an opportunity to increase cultural competence and relevance for everyone. In their chapter on STEM research, Cochran et al. (2020) affirm that intersectionality "requires stepping outside of the confines and boundaries of what has been seen as STEM and broadening the notion of what is to be counted as STEM" (p. 263). Thus, science educators can examine the effects that their personal intersectionality may have on their teaching, while simultaneously acknowledging their students' intersectionality and supporting sociopolitical consciousness within the CRST framework (see Figure 2).

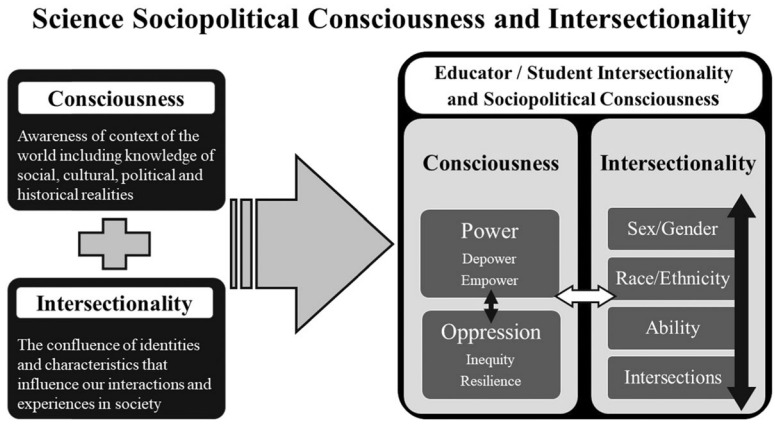

FIGURE 2 Science educator sociopolitical consciousness and intersectionality

3.1.3 | Providing mirrors, windows, and doors for aspirational science achievement

The concept of windows, mirrors, and doors was first introduced by Rudine Bishop (1990) in describing the need for children of all backgrounds and identities to see images of themselves in children's literature. Simply put, students from marginalized and underrepresented backgrounds benefit from seeing themselves in stories as relatable characters. As originally ascribed by Bishop (1990) to children's literature:

- story mirrors provide students a reflection of their culture and identity;
- story windows provide students with a view of someone else's experience that they can relate to;
- story doors provide the opportunity to enter the story world and relate to it.

These concepts have been tied to the need for students to feel a sense of belonging and acceptance in the settings and spaces they may not have traditionally felt welcome.

As Bishop (1990) originally described, children need to see themselves as part of the story to foster a sense of belonging. The need for students to feel a sense of connection (i.e., belonging) is not simply germane to the literature. Since the introduction of that seminal work, the importance of the windows, mirrors, and doors convention has been applied to a variety of educational and societal arenas beyond children's literature including math (Rezvi et al., 2020) and biomedical informatics (Unertl et al., 2018). As related to science teaching and learning, supporting student access and belonging is directly connected to the concept of windows, mirrors, and doors. For the purpose of the current paper, the authors present an application of the windows, mirrors, and doors concept that science educators can consider as sociopolitical consciousness within CRST and that they can promote for their students.

3.1.3.1 | *Providing mirrors*

As described by Bishop (1990), "mirrors" in children's literature are the opportunities for children to see themselves as characters in the books they are exposed to. We propose applying the notion of "mirrors" to science education in that students need to see themselves in science and as scientists. This would require teachers to use language and develop practices that empower students to feel and think of themselves as being a part of the science community in a meaningful way. For decades, students across multiple grades have participated in activities that give us insight into their perceptions of what and who scientists are (e.g., Draw A Scientist Test [DAST]; Finson, 2002). DAST research has shown that students generally see scientists as white men with underrepresented students reporting that scientists do not look like them (Finson, 2002). Teachers can play an active hand in changing the narrative and

perspective of students who do not feel connected to science. From a sociopolitical perspective, teachers can give students agency in seeing themselves as scientists in the language they use and their classroom practices. For students to see themselves as scientists, teachers must see them that way and provide the "mirror" to reflect that vision to them.

3.1.3.2 | *Providing windows*

Originally conceived, providing windows for students involved using literature that features diverse man characters to grant a "window" into the lives of the underrepresented group to students of the dominant culture (Bishop, 1990). The current authors would like to transform this notion to better apply to the field of science education as a practice that teachers can use and better support students. In that, we propose that "windows" be considered as a means for students to see individuals (i.e., role models) in science that look like them working in and doing science-related activities. The need for students to view individuals they can recognize in science has been well-documented in research of students with a variety of backgrounds (Archer et al., 2012, 2013, 2014; Riegle Crumb et al., 2011). In their review of STEM role models for students, Gladstone and Cimpian (2021) define role models as exemplars in the STEM field that have no prior relationship with the students they are working with. Previous research has found that students who have role models that are similar to them experience positive effects (Bagès & Martinot, 2011; Conner & Danielson, 2016; Plant et al., 2009; Ziegler & Stoeger, 2008). By providing that "window" into the science field from role models, teachers can support students' sociopolitical consciousness about science and its possiblities.

3.1.3.3 | *Providing doors*

The "doors" in children's literature that students can experience involve reflection on stories that can lead to understanding perspectives of others that they may not have considered before (Bishop, 1990). As a sociopolitical science teacher practice, we assert that "doors" are to be opened to let students "in" to experience science beyond the educational learning experience. Similar to "windows," students from underrepresented groups benefit from mentor and mentorship, particularly when it is paired with those in the field with similar backgrounds and experiences (Finson, 2002). Teachers and students with few diverse experiences may not have the depth of knowledge to support the variety of students they have in the classroom. However, by providing a "door," teachers can increase their personal knowledge around diversity in science and give a broader range of students access to science mentorship.

See Figure 3 for a summarized visual of science education mirrors, windows, and doors.

4 | ILLUSTRATIVE EXAMPLE: APPLYING THE CONCEPTUAL FRAMEWORK IN THE CLASSROOM

We use the following scenario to offer some practical examples of how to develop students' sociopolitical consciousness using the themes explored in our conceptual framework. We offer a scenario and follow it with suggestions for classroom practice.

4.1 | Vignette: Mrs. Thomas's seventh grade general science class

Mrs. Thomas, a seventh grade general science teacher, wanted to be sure that she was developing students' sociopolitical consciousness in her classroom. She decided to intentionally address this tenet of CRST during her upcoming unit on Food Science. A large portion of this unit is traditionally spent getting students to understand that different substances (fats, carbohydrates, vitamins, proteins, minerals, and water) can be found in different foods,

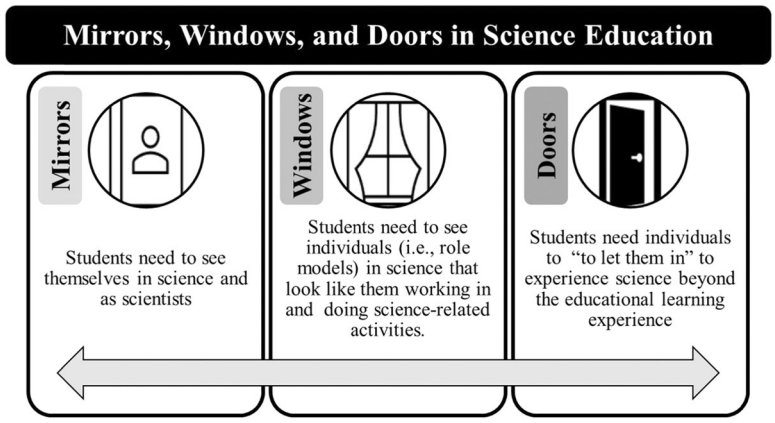

FIGURE 3 Science education mirrors, windows, and doors

and scientists can use different chemicals to test foods to find out about their contents. The culminating assessment traditionally involved students using their knowledge of food contents to create and justify a balanced meal plan.

4.1.1 | Application to conceptual framework: Global to local focus on equity issues

Mrs. Thomas modified her lesson to consider the themes that empower students and focus on equity related to food science both globally and locally. She focused on equity issues related to access and availability of food (i.e., food deserts). For example, she asked students to consider why it might be harder for some people to have balanced meals versus other people. She also used a virtual map to track the locations of different grocery stores or famers' markets in different neighborhoods. Mrs. Thomas enhanced her assessment to include a component in which students created a campaign or petition for greater access to quality food sources, citing their scientific knowledge of food composition as a rationale. This gave students the opportunity to discuss equity issues related to food and socioeconomic status, as well as the chance to advocate for change. Mrs. Thomas also encouraged students to investigate food-related issues throughout the school (i.e., cafeteria menu; vending machines) through research surveys and interviews of other students and school staff. Empowering students to ask and advocate for changes themselves.

4.1.2 | Application to conceptual framework: Personal and student intersectionality

Mrs. Thomas led students to think about how identity might influence perspective or interest in the topic of food science. She began by sharing her experiences and intersectionality with food. For example, she discussed her and her family's issues with food, related to health and safety (e.g., brother is allergic to nuts; aunt is a vegan). She disucssed how her favorite foods were related to her ethic background, where she grew up, and places she had traveled to. She then included an essential question asking students to consider which aspects of their identity are relevant to this particular conversation. Each student was asked to identify three elements or chracteristics of their identity and describe how that might influence what they would consider their favorite foods.

Mrs. Thomas also had students do a survey of their neighborhood and the neighborhood where their parents or guardians or family members grew up, to see what options people had for food. She encouraged them to compare their findings and led her students to consider how cultural identity, socioeconomic status, and other demographic or identiy related factors might have infleunced the variation they saw in food options. Mrs. Thomas encouraged

students to explore countries beyond the borders of the continental United States. Students were asked to compare typical meals or popular food items from different cultural/ethnic backgrounds and consider once again the infleunce of the aforementioned factors.

To better connect the lesson to students' understanding of intersectionally, Mrs. Thomas had the students complete extension activities and consider additional questions. She had her students compare dishes they identified from their respective cultural backgrounds and create new cross-cultural dishes or fusions (e.g., cheesesteak eggrolls; lamb-infused lasagna). Mrs. Thomas also asked students to think or write about the historical origin, nutritional value, production, and/or health trends related to the foods they identified and the fusions they created. She also asked her students how they felt about their food choices and coached them to consider how culture, identity, experience, and scientific knowledge informed their responses.

4.1.3 | Application to conceptual framework: Mirrors, windows, and doors

To help students develop and aspiration, equitable, and empowered lens towards food science, Mrs. Thomas intentionally provided opportunities to see themselves ("mirrors") as scientist of food-related topics. She found stories via books, articles, podcasts, and videos that reflects the students in her classroom who spoke about food science in as many contexts and from as many diverse backgrounds as possible. This included stories from students in other locales (e.g., Hawaii, Puerto Rico, Ireland, and Nigeria). For students to see others in the field, Mrs. Thomas also incorporated videos of food scientists at work and invite guest speakers from the field ("windows") into the classroom (e.g., food inspector, local chef, and district lunch supervisor). Where she found limited representation of scientists that reflect her students' identities, she highlighted this and engage students in discourse around it. She used potential instances of underrepresentation as justification for students to pursue science careers by empowering students to find someone in the field they would like to work with ("doors") and encouraging them to reach out them via communication (i.e., email, letter, phone call, or social media). Mrs. Thomas even assisted each student in crafting an outreach message. In providing equitable mirrors, windows, and doors to students via practice and conversations, Mrs. Thomas helped *all* of her students feel empowered and validated in science spaces and in their knowledge of food sciences, especially those from marginalized identities.

5 | CONCLUSION

Before teachers can reach sociopolitical consciousness and by extension guide students to that understanding, a thorough understanding of CRST and all of its tenets is required (Jones & Donaldson, 2022). Once a strong commitment to CRST has been established, reflection on what and how science instruction occurs is critical. Teachers need dedicated time and space to grapple with the implementation of each tenet (Mensah, 2011). Since the research shows that the third tenet is usually the most elusive (Madkins & McKinney de Royston, 2019), we used this paper to explore what it looks like in practice. When teachers teach with the development of sociopolitical or critical consciousness in mind they can make science classrooms critical, empowering, and equity-oriented spaces.

We offer three themes to help elucidate the third tenet of CRST. We believe that if teachers can help students discuss critical issues related to equity, while also guiding them to consider the intersections of their identity and how they fit into science, they will be able to deliver science content that is relevant and sustaining for all students. Most importantly, making the shift to teach science in this way should have a lasting impact on our world, giving students the power to be agents of critical change.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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