"It is beyond time to teach the truth about science": Science Teachers Grappling with Racism in Science Knowledge Construction

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Though science is implicated in the construction and exploitation of racism to further scientific findings, science is viewed by many as a race-neutral subject area; therefore, many suggest discussions of racism should not be part of science classrooms (Hodson, 1994; Walls, 2014). Unfortunately, the colorblind approach to science education and science teacher education denies "dark people's existence and contributions to human progress" (Love, 2019, p. 14). Numerous studies point to the need for science teacher education programs to prepare teachers who will foster equitable and inclusive classroom environments (Stapleton, 2015; Tesoriero, 2019), since our schools are one of the first places students are imbued with the perceptions of who matters (Avraamidou & Schwartz, 2021; Ladson-Billings, 2014; Love, 2019; Misco, 2010/2017; Noddings, 2015/2017). However, the lack of restorative practices and continued race-evasive science teaching continue to show Students of Color their lack of import and further isolate them from academic pursuits (Lewis & Diamond, 2015).

Students of Color frequently face deficit stereotypes and narratives about their abilities (Gholson & Martin, 2019). Pre- and in-service science teachers often harbor a science classroom culture of objectivity, which perpetuates colorblindness within their learning spaces, and hold views that racial disparities exist due to an individual's choices rather than systemic racism (Rivera, 2022). In science, objectivity manifests as truth, evidence, and facts. By not acknowledging the biases of scientists or society and how they shape which studies are pursued or funded, how studies are designed, and how data is analyzed, the different perspectives and interpretations of 'objective information' is lost. Colorblindness in science classrooms allows teachers to feel that they are "affording everyone equality of opportunity" but they fail to reason that they are not assuring "equality of results" (Delgado & Stefancic, 2017, p. 29) Ladson-Billings (1995) pointed out that many teachers, despite the evidence, deny information regarding social inequity when they are the ones who should be fostering students' recognition and evaluation of social structures. Teachers use neutrality (colorblind ideology) as a way of avoiding being labeled racist (Lee et al., 2022). Being color conscious makes teachers uncomfortable because white children are taught early on to not notice race; when they do notice race or are asked to be conscious of race, white adults feel shame for having adopted colorblind ideology when they knew it to be a deception (Thandeka, 2009). Denial is used to escape or deflect the feelings of shame (Matias et al., 2014). Sheth (2019) found that teachers "were not prepared to engage with students' questions and ideas in race-conscious ways that validated the legitimate skepticism that Students of Color brought to science learning and that examined the racialized dimensions of science and community relationships" (p. 51). Even campaigns designed to encourage science engagement for all students, such as "Science for All," failed to attend to race and further marginalized Students of Color (Madkins & McKinney de Royston, 2019; Mutegi, 2011). We hypothesize that part of the reason teachers have not addressed racism in science is because they lack awareness of how racism has impacted the construction of science knowledge, an area of science education that has not been well studied.

Created to challenge the deficit mindsets held toward African American students, Ladson-Billings (1995) developed Culturally Relevant Pedagogy (CRP) to theorize about

teachers' practices and ways to improve teacher education. She aimed to improve teacher education to support asset-based approaches to teaching urban African American students. CRP has three tenets: students who can achieve academically, cultural competence, and critical or sociopolitical consciousness. All three elements are necessary to implement CRP and yet, it is not often that all three elements are seen in classrooms. Educators are more likely to adopt practices that support academic achievement and cultural competence and often omit sociopolitical consciousness (Ladson-Billings, 2014). Academic achievement is buttressed through established high expectations for all students and increasing student recognition (Ladson-Billings, 2014). Educators encourage cultural competence through increased student responsibility (i.e., student-directed learning where they are free to foster their own interests as well as include values from their own culture (Elam-Respass, 2018)), asset-based approaches that value student strengths, the use of familiar language, and broadening the representation of people from minoritized groups (Gay, 2002). To combat systems of oppression, students need opportunities to engage in and develop the third tenet – sociopolitical consciousness. Sociopolitical consciousness requires students to identify, analyze, and propose solutions for real-world problems (Ladson-Billings, 2014). Originally developed by Paulo Freire (2003), sociopolitical consciousness is an understanding of power structures, the analysis of systemic societal inequities, and the know-how to enact change against such structures (Diemer et al., 2016; Jemal, 2017). Riley and Mensah (2023) provide the Tuskegee experiment and the Eugenics movement as examples of how science has been misused in the past to justify and disenfranchise groups from society. These historical examples emphasize the need for students to recognize that science is a human endeavor, and therefore subjective, and be taught how to critically question (Crabtree & Titu, 2022; Sheth, 2019). By examining these historical examples, students understand and engage with science as it is situated in politics, ethics, and morality, as well as inspecting science constructs of objectivity, nobleness, and race-neutrality.

For educators working to implement CRP in science education, Dodo Siriki (2018) suggests critically examining one's own experience with power, race, and privilege and how those experiences shape pedagogical knowledge and practices within the classroom. This requires teachers to examine their unconscious bias and acknowledge their part in perpetuating racism. In science classrooms, it means examining why, historically, science has been a white, male-dominated field (Carlone et al., 2014; Riegle-Crumb & King, 2010) and how, throughout history, science has played a major role in perpetuating racism, particularly anti-Black racism. It means considering the objectivity scientists claim to have and how that objectivity has been weaponized to tout scientists' personal ideologies.

In this study, we provided professional development for teachers regarding the role that racism played and continues to play in the production of scientific knowledge. There are two research questions that guide this study:

1. Is there a relationship between teachers' historical knowledge and their beliefs and attitudes underlying culturally responsive teaching practices?
2. What are teachers' attitudes and beliefs about grappling with racism in science classrooms?

Conceptual Framework

This work uses Sheth's (2019) model of "grappling with racism" as a foundational practice and incorporates Crabtree and Titu's (2022) expansion of the model to professional development. Sheth (2019) defines grappling with racism as an essential practice for teachers to critically reflect and contend with "these contradictions [colorblind science teaching] that emerge

from racism manifested in science and science teaching to make principled decisions that disrupt persistent unequal relations of power between students, race, and science" (p. 55). Sheth's practice of "grappling with racism" consists of three contexts: *desiring*, *knowing*, and *doing.* In *desiring,* teachers acknowledge that science teaching has unequal power relations and is a component of perpetuating racialized systems (Sheth, 2019). Teachers *desire* to name, confront, and disrupt racism as a central goal (Sheth, 2019). To accomplish such goals, teachers must critically reflect on their biases (Wallace & Brand, 2012), positionality, and current teaching practices, as well as how they control power within the classroom (Sheth, 2019). Crabtree and Titu (2022) expand on *desiring*, stating that teachers seek and engage in professional development or further teacher preparation to "promote shifts in power between teacher educators, teachers, students, race, and science" (Crabtree & Titu, 2022, p. 902). In this study, teachers applied to be part of this project to be master science teachers and to develop into teacher leaders demonstrating a desire to learn and engage in educational justice for students.

Second, teachers *know* racialized systems exist and develop a historical understanding (Crabtree & Titu, 2022) of how different communities engage with science and continue to build their sociopolitical awareness (Sheth, 2019). They are aware of how racial ideologies such as colorblindness and equal opportunity oppress the interests and experiences of Students of Color doing science (Sheth, 2019). Teacher *knowing* includes critical questioning, examining power relations and knowing how to support this questioning in students (Sheth, 2019). This study investigates teachers' *desiring* and *knowing* to grapple with racism as they consider how their understanding of science knowledge construction impacts their teaching practices, which will ultimately allow the larger project to provide needed support as teachers move into *doing.*

The foundational practice of *doing* when "grappling with racism" involves the application of a teacher's *knowing.* Teachers create curricula that provide "opportunities to disrupt racism as a part of science teaching and learning rather than avoiding and silencing these opportunities" (Sheth, 2019, p. 55). Teachers also "critically reflect" on how they are examining science as a racialized system and ways they explicitly create spaces for students to engage in science experiences that are relevant to themselves and their communities (Sheth, 2019, p. 55). This study examines elementary and middle school teachers' *desiring* and, to some extent, *knowing*– their *doing* will be analyzed in a different study as the larger project progresses.

Methodology

We used quantitative and qualitative data to examine teacher understandings of the role of racism in scientific knowledge construction. In this study, the results from three histories of science knowledge (HOS) quizzes were used to predict teacher understandings of the historical context of racism and science knowledge construction. The relationship between the HOS quizzes and the Dispositions for Culturally Responsive Pedagogy Scale (DCRPS) (Whitaker & Valtierra, 2018) was used to correlate teachers' historical knowledge and their beliefs and attitudes necessary to be culturally responsive. The qualitative data included participants' responses to open-ended writing prompts that were used to explore how teachers' knowledge of racism fits with their understanding of science content knowledge and how this knowledge impacts their future teaching practices. Teachers' historical knowledge of racism and science knowledge construction was used to predict if historical understanding influences the willingness of teachers to disrupt racism (*desiring*), such as acknowledging biases, critically reflecting on science ideologies and a desire to support student questioning and sociocritical awareness, and the know-how (*knowing*) of teachers working to change teaching practices to confront systems of oppression.

Research Context

The work presented in this article occurred as part of a larger funded project that provides an institute for science teacher leaders in a southeastern state. The larger project aims to create science teacher leaders in high-need, rural schools who are well-versed in reform-based science instruction and are culturally competent. Over the course of five years, the institute will include in-person week-long summer sessions (Years 1-5), online modules (Years 1-2), classroom visits with individual coaching (Years 1-5), and synchronous online professional development (Years 1-2), beginning in the summer of 2024. This study occurred during an afternoon of a week-long summer institute, which kicked off the program.

Participants and Sampling Methods

Purposive criterion-based sampling (Merriam & Tisdell, 2016) was used for the larger project selection of participants. All 28 of the participants contributed to this embedded program study. The 28 teachers, all of whom taught either elementary or middle school science, held a master's degree and taught science for at least 50% of their teaching responsibilities. Teachers were recruited from rural, high-needs schools with high teacher turnover in a southeastern state. Applications were first sorted by eligibility and then narrowed down to include maximal variation (Patton, 2014) by geographic region in the state.

Table 1

Participant Characteristics

Participant	Teacher Group	Race	Gender	Years of Teaching (as a teacher of record)	NCES Locale
Benji	6_8	Black	Male	3 - 9	Town-Distant
Monica	6_8	white	Female	10 to 20	Rural-Fringe
Fatima	6_8	Black	Female	3 – 9	Rural-Distant
Charmaine	6_8	Black	Female	3 – 9	City-Small
Marci	6_8	Black	Female	20+	Town-Distant
Melba	6_8	Black	Female	10 - 20	Rural-Fringe
Amelia	6_8	white	Female	10 - 20	Rural-Distant
Vanessa	6_8	white	Female	0 - 2	Rural-Fringe
Elliot	6_8	white	Female	20+	Rural-Distant
Denise	6_8	Black	Female	10 - 20	Town-Distant
Gwen	K-5	Black	Female	10 - 20	Rural-Distant
Joanne	K-5	Black	Female	3 - 9	City-Small
Isadora	K-5	white	Female	10 - 20	Town-Distant
Linnet	K-5	white	Female	20+	Rural-Fringe
Selma	K-5	Black	Female	10 - 20	Town-Distant
Alycia	K-5	white	Female	20+	Town-Fringe
Candice	K-5	white	Female	10 - 20	Rural-Distant
Sarafina	K-5	Black	Female	10 - 20	City-Midsize

Allison	K-5	white	Female	20+	Rural-Fringe
Roxanne	K-5	Black	Female	3 - 9	City-Small
Kiera	K-5	white	Female	10 - 20	Town-Fringe
Marla	K-5	white	Female	10 - 20	Town-Distant
Ariel	K-5	white	Female	10 - 20	Rural-Distant
Joyce	K-5	Black	Female	10 - 20	City-Small
Lousia	K-5	white	Female	20+	Suburb-Small
Eleanor	K-5	Black	Male	20+	Suburb-Small
Trinity	K-5	Black	Female	3 - 9	City-Midsize
Zoe	K-5	white	Female	10 - 20	Rural-Distant

**Names are pseudonyms*

Data Collection

Teachers took the DCRPS (Whitaker & Valtierra, 2018) at the very beginning of the institute to assess their beliefs and attitudes underlying culturally responsive teaching practices. The DCRPS (alpha reliability value = 0.92) has 19 Likert items across three domains: Praxis, Disposition for Community, and Disposition for Social Justice, which assess teachers' beliefs and attitudes necessary to be culturally responsive (e.g. awareness of one's racialized self-identity, comprehension of institutional racism, and their perception of their role in eliminating whiteness from racial dominance; Whitaker & Valtierra, 2018). Additionally, teachers took the HOS quizzes before attending the first in-person summer institute to assess their current understanding of three historical cases (James Marion Sims' gynecological experimentations, The Tuskegee Syphilis Study [TSS], and the origin of HeLa Cells), which are the epitome of the legacy of racism in science. The HOS quizzes about James Marion Sims and HeLa Cells had four and five questions, respectively, and were researcher-designed, while the quiz for the TSS was adapted from an existing knowledge quiz (Green et al., 2011). The adapted knowledge quiz was shortened from seven questions to four questions due to the concern that three of the questions would generate or support misconceptions that would not have adequate attention during professional development and could lead to further harm.

The researcher-designed HOS quizzes demonstrate face and content validity. Two experts in history and one expert who specializes in history and science reviewed the questions to determine they accurately covered all aspects of the historical event enough to gauge teacher knowledge of the event. Quizzes were edited until all reviewers determined that face and content validity had been reached.

The HOS quizzes contain True/False factual questions. For the Henrietta Lacks/ HeLa Cells and James Marion Sims quizzes, two screening questions were asked, one regarding events and one regarding an individual; for TSS, one screening question was asked about the event only as a means of identifying which teachers have heard of these historical events. If teachers marked that they had not heard about the historical event, the survey skipped the True or False questions. If the teachers answered one or both screening questions as Yes, they are familiar with the event, the True and False items were asked. The quizzes were administered via Qualtrics at the same time as the DCRPS.

Responses to writing prompts for this study were collected during one day of the first summer institute, after participants learned about the TSS, Henrietta Lacks, and J. Marion Sims. The writing prompts included the following questions:

1. What do you think about the relationship between racism and science content knowledge production?
2. How does this knowledge reconcile with what you previously understood about science?
3. How will you incorporate this knowledge into your teaching moving forward?

Through the reflection questions, teachers were provided an opportunity to consider how these histories might impact their teaching and "support students' awareness of inequities linked to race and racism" (Crabtree & Titu, 2022, p. 900).

The Professional Learning Session

Sheth's (2019) foundational practice of grappling with racism was used as a conceptual framework guiding the development of a professional learning session within the larger project. Crabtree and Titu (2022) argue that teacher educators should name and address racism as a central project goal. The overarching goal of the larger project is focused on supporting and developing science teacher leaders in rural, high-needs schools in a southeastern state. Part of being a science teacher leader is being socio-politically cognizant and culturally relevant (Ladson-Billings, 1995). To this end, the second author, a professor of social studies education, two science education professors (third and fourth author), and a science education doctoral student (first author) deliberately sought to build teacher understandings of the role of racism in the construction of science knowledge as a first step toward dismantling dysconscious racism (King, 1991).

During this first summer institute, teachers were engaged in Science and Engineering Practices (SEPs), crosscutting concepts (CCCs), and culturally relevant teaching practices. On the third day of the week, teachers were asked to consider who could be a scientist and how educators might support student belonging in science. They engaged in a facilitated group discussion about the sociopolitical realities (Crabtree & Titu, 2022) of Black and Brown Americans' inequitable treatment of COVID-19 at healthcare facilities; the pulse oximeter was used as an example of medical advancement that failed to be designed for or tested on skin with more melanin, leading to misdiagnosis and life-threatening health complications for Black and Brown individuals. The second author, who facilitated the discussion, worked to shift the teachers' perspectives from individual racism (the care provided to patients was inequitable) to systemic racism (while the doctors used the equipment they had at their disposal, the larger system that benefits whiteness failed to consider the need to test equipment on multiple skin tones). Teachers also discussed how science is a human endeavor and the importance of questioning the use and application of science (Who is considered? Who does the considering? Who benefits?; Crabtree & Titu, 2022; Sheth, 2019). According to Crabtree and Titu (2022), "to promote shifts in power, teacher educators would provide opportunities for teachers to co-create curricula that explore intersections of disciplinary content and race" (p. 903). To move the onus on teachers, table groups discussed how the historical context of COVID-19 and the use of a medical device could be central to learning goals in an elementary and middle school science class alongside SEPs and disciplinary core ideas (DCIs).

To provide context for systemic racism in medical science, the second author then taught about three historical instances (James Marion Sims' gynecological experimentations, The TSS, and the treatment of Henrietta Lacks, which led to the discovery of HeLa Cells). The second

author modeled culturally relevant teaching practices for teachers by having teachers examine historical documents regarding the TSS and generate their own questions as well as outline the ethical dilemmas that arose for them after reading the documents. These questions and the defining of ethical problems were valued as scientific thinking. The professor also utilized discourse strategies, such as pressing (Windschitl et al., 2021), to model productive discussions around the ethics of consent and using knowledge gained from individuals who were denied their own bodies.

The 1.5-hour facilitated discussions adopted *grappling with racism* as a core practice. The research team designed and implemented teacher learning within the context of *desiring, knowing*, and *doing*. Naming and addressing racism within the context of medical science was central to the goals of professional learning—representative of *desiring*. The team and the participating teachers worked within the context of *knowing* as they discussed questions of power and access (Sheth, 2019) and explored how race and racism are interconnected with their disciplinary content (Crabtree & Titu, 2022). The second author engaged in the construct of *doing* by modeling CRP (e.g. the professor was aware of the context in which teachers taught; the professor exhibited the social awareness teachers need to have regarding the systemic barriers faced by their students; the professor valued participant thinking as science thinking; Crabtree & Titu, 2022).

Data Analysis

The primary focus of this study is to examine teachers' knowledge of historical racism in science, to determine if that knowledge is related to their attitudes and beliefs regarding culturally responsive teaching practices, and whether these attitudes and beliefs impact their desire and know-how to grapple with racism with their science classes. We used linear regression to examine the relationship between the HOS quizzes and the DCRPS. We scored the HOS quizzes by giving 1 point for each correctly answered question for a total of 13 points (scores range from 0-13). We also analyzed the quizzes qualitatively, grouping scores for each quiz into knowledge levels of no knowledge (0), low knowledge (1-2), medium knowledge (3), and high knowledge (4-5). For teachers who indicated that they had not heard of the historical event or person, we used logical imputation to include teachers in the "no knowledge" category by assuming that teachers would not have specific knowledge of something they had generally never heard of. To keep their responses on a 5-point scale, we averaged teachers' responses to the DCRPS. The first author open-coded (Merriam & Tisdell, 2016) the writing prompts to summarize segments of data. In the second cycle, the first author pattern coded (Miles et al., 2020) to group summaries into recurring concepts and themes. The first author met with the third author after both cycles of coding to review codes and patterns until an agreement was reached. After pattern coding, the first author examined the data for themes aligning with the framework guiding the study (Braun & Clarke, 2006).

The themes aligning with the framework were *desiring* and *knowing*. Teachers categorized as *desiring* had to be consistent across the three open-response questions in wanting to name or confront racism within their science classes on a regular basis or critiquing and critically reflecting on their current teaching practices with a desire to alter these practices to support students in questioning and examining racism. If their answers only indicated a desire to increase representation or inclusion or if the desire was not named within their science classes but was additive, such as during Black History Month, or as an extension for students who finished planned lesson work early, they were categorized as not yet desiring. In a conservative procedural decision, if their answers to the open-response questions were contradictory, they

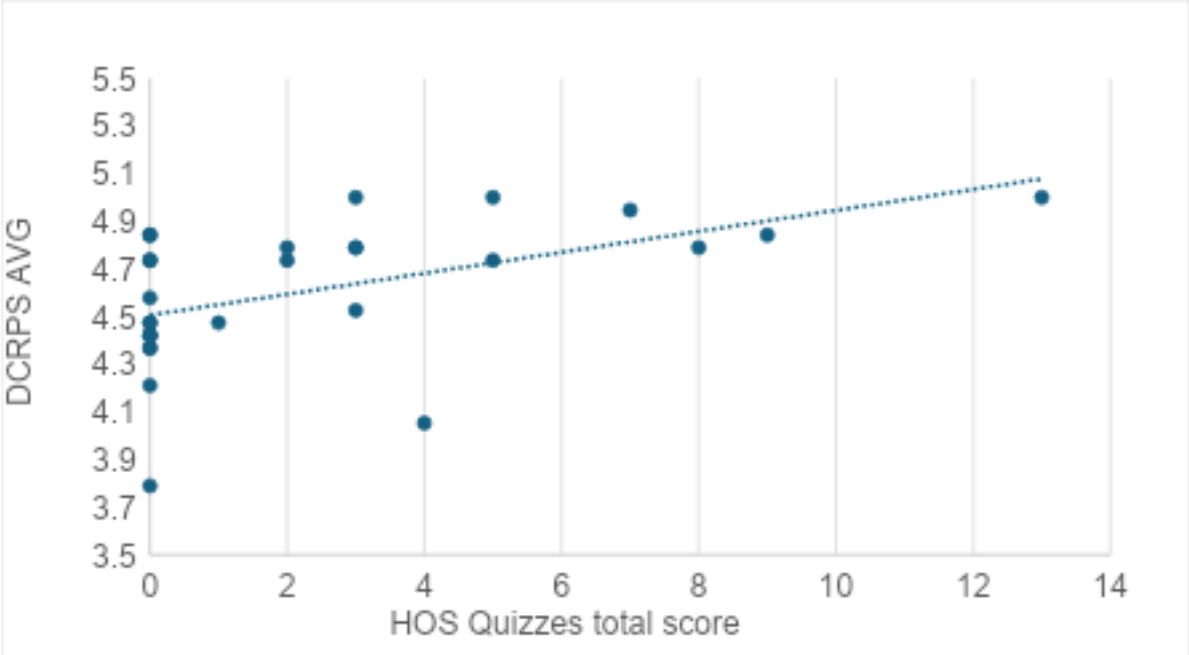
were categorized as not yet desiring. Teachers categorized as *knowing* had to also demonstrate *desiring*. We treated the categories as hierarchal, meaning to be categorized as *knowing* the teacher also had to be *desiring*. In addition to *desiring*, teachers identified as *knowing* indicated awareness of how racism in science has impacted student or community engagement with science. After coding aligned with the framework and examining the pattern codes within the framework codes, the first author integrated the data (Creswell & Plano Clark, 2018), allowing for the association between teachers' historical knowledge and their attitudes toward culturally responsive teaching to be compared to their stated desires to incorporate topics such as racism in their science teaching and the importance of incorporating how science knowledge is constructed into science education.

Findings

We started by exploring the distribution of HOS scores and DCRPS average scores. The HOS scores were heavily skewed right, with a median score of 0.5 and interquartile range (IQR) of 3.75. The DCRPS average scores were skewed left with a median score of 4.74 and IQR of 0.408. There was an outlier in the HOS scores of 13, indicating an individual with the highest knowledge of the history of racism in science knowledge construction, and a median of 0.5, indicating that many participants have low to no knowledge. There was also an outlier in the DCPRS average score of 3.8. We kept the outliers in the analysis and findings because we wanted a representative snapshot of teachers' historical knowledge as well as their self-indicated dispositions toward cultural responsiveness.

We utilized a linear regression analysis to test the correlation (Tintle et al., 2020) of HOS scores on DCRPS average scores. The correlation of HOS scores on the DCRPS was found to be significant ($p = 0.0063$) with an R^2 of 25.40% (SE of residuals = 0.26), meaning 25.40% of the variation in teachers' average DCRPS scores can be explained by teachers' historical knowledge. We were concerned about equal variance, so we did a randomization test and significance was confirmed ($p = 0.008$). The equation for the line is DCRPS total average = 4.5058912 + 0.0440138*(HOS Total score), where the y-intercept ($\beta 0$) indicates that when the HOS score is 0, the predicted DCRPS score is 4.5059. The slope (β_1) indicates that for each additional point on the HOS score, the DCRPS is predicted to increase by 0.0440138.

Figure 1
Historical Knowledge of Science Quiz Scores on Average DCRPS Scores



**The light blue points align with the knowing context of the grappling with racism practice. The green points align with the desiring context of the practice, and the points in dark blue do not align with any of the three contexts of the grappling with racism framework.*

We then used a one-way ANOVA to explore the collinearity of Race with HOS. The t-ratio was 2.28 ($p = 0.0309$). We did not need race in the model because race is so correlated with HOS meaning it does not add additional explanations of the DCRPS average scores.

We examined the screening questions for each historical knowledge quiz by race. Of the 14 white teachers, 14% (n = 2) self-reported having heard of Henrieta Lacks, compared to 64% (n = 9 of 14) of Black teachers. When asked if they had heard of the TSS, 86% (n= 12 out of 14) of Black teachers had heard of the study, while only 21% (n =3) of white teachers. When asked if they had heard of J. Marion Sims and/or the founding of gynecological medicine, only two of the 28 teachers had heard of how gynecological medicine was established or its founder J. Marion Sims. While the screening questions allowed us to see who was aware of these historical instances, most teachers, regardless of race, knew few to no factual details. For the historical knowledge quiz containing five common facts about Henrietta Lacks and HeLa cells, teachers, on average, answered a little more than one (1.22) question correctly (no to low knowledge n = 20). Out of the four questions about TSS, teachers answered about one (1.12) question correctly (no to low knowledge n = 22), on average. For the four questions about J. Marion Sims, teachers, on average, gave less than one correct answer (0.26), (no to low knowledge n = 26).

Participants identified as *knowing* (3) from the qualitative analysis had the highest HOS quiz scores compared to those *desiring* or not yet desiring and had some of the highest DCRPS averages. Those teachers identified as *desiring* (6) did not show as clear of a pattern as those *knowing.* While 4 of the 6 teachers had more than no knowledge, their factual knowledge was low, and the DCRPS scores ranged from the first quartile to the third quartile. As will be seen in the qualitative analysis, some of the *desiring* teachers who indicated disagreement with some of the DCRPS prompts (i.e. lower scores) now agree with these statements after the professional learning session, indicating their DCRPS averages would be higher than what is reflected in the

recorded data. The not yet desiring teachers had an overall pattern of low to no historical science knowledge and had a range of DCRPS average scores slightly skewed left of the median (4.74).

Open-response Findings

Through this analysis, we aimed to determine teachers' attitudes and beliefs towards grappling with racism and its place in the science classroom after participating in a professional learning session. The learning session supplied teachers with three historical examples of how racism has shaped science knowledge and how racism continues to shape modern knowledge through the phenomena of COVID-19 outcomes and the inaccuracy of pulse oximeters on blood oxygen levels in individuals with more melanated skin. Using the contexts of "grappling with racism" (*desiring, knowing, doing*), our analysis determined that many teachers had a shift in attitude regarding how science knowledge was created and desired to change their teaching practices but that a majority of teachers were not yet *desiring* to grapple with racism in their science classrooms because they were not yet able to articulate or envision how such knowledge could be implemented in elementary and middle school science classrooms. Thirty-two percent desire to grapple with racism now that they are aware of the role that race has played in the production of science content knowledge. However, this desire did not translate into knowing 21% of the time, which indicates that teachers will need further support. Most teachers, when discussing how it would impact their science instruction, were either unsure, concerned about age appropriateness, or focused on the historical role of racism rather than the current structural inequities. Teachers who proposed ways to implement change did so through a teacher focused lens where students would be told this happened in history rather than allowing students to question or sense-make, demonstrating a lack of teacher *knowing*, with a few exceptions. The qualitative findings confirm the quantitative findings in that those with high historical knowledge had higher DCRPS scores, and these teachers, after the professional development, had greater desiring (32%) and/or knowing (11%) of how to begin addressing these concepts in their classes.

Desiring

Of the 28 teachers, nine demonstrated a desire to name and confront racism in their science classrooms. Six of the nine exhibited solely the practice of *desiring*, while three of the nine presented a complex of *desiring* and *knowing*. The following section will focus on the six solely within the desiring context.

Theme 1: Shift in perspective regarding science after gaining contextual knowledge. Linnet, a white elementary teacher with 20-plus years of teaching experience, provides an example of a teacher whose gained understanding regarding how science knowledge has been constructed shifted her perspective of science as a discipline. Linnet describes this shift in perspective in the following way:

> Horrible atrocities were committed in the name of "science" that were rooted in hatred and bigotry. . . Now that I know this, some things that I once believed about science are incomplete and, unfortunately, untrustworthy. I had always believed that all science, at its center, was for the betterment of mankind.

Linnet held the view that science was noble (Cooke et al., 2024). This view of science is often associated with science as apolitical and does not consider science knowledge to be affected by society and culture or personal ideologies as science is a human endeavor (Abd-El-Khalick & Lederman, 2000; Lederman, 2019). She states that her knowledge is incomplete, and therefore, she no longer trusts her previous notion of science. While her perspective on science shifted, her previously held belief "that hot topic conversations (e.g., race, gender, sexuality, religion, etc.) should be had in class when necessary and/or relevant," as indicated by agreeing with the

statement on the DCRPS, was fortified by her increased understanding of the construction of science knowledge. She stated her desire to "move forward and work toward a lasting change."

Marla and Joyce are exemplars of teachers whose expanded understanding regarding how science knowledge has been constructed shifted their view on holding "hot topic conversations" in their classes. Both Marla and Joyce originally disagreed with the DCRPS prompt, "hot topic conversations (e.g., race, gender, sexuality, religion, etc.) should be had in class when necessary and/or relevant." After the professional learning session, Joyce, a Black K-5 teacher with over a decade of teaching experience, reflected on her attitude toward teaching about race:

> I'm guilty of turning a blind eye to the injustices against black Americans because it saddens me. I just looked at science for what it was in that moment; plants, animals, the solar system, cells etc. Moving forward, I will stop avoiding the topic of race with my students. I will make a conscious effort to show my students people of color who are scientists, engineers, and researchers. Positive and age appropriate discussions about race will become a routine in my classroom.

Within this statement, Joyce reflects on her previous race-evasive stance, choosing to view science as objective, apolitical facts ("science for what it was in that moment"). The professional learning session supported Joyce in *desiring* to change her teaching practice to consciously increase representation and not avoid discussions of race with her students. Likewise, Marla also reflected on her previous beliefs and expressed her new desire to engage with science histories:

> I truly believe, just like with the case of Lewis Latimer and Thomas Edison, that ALL background knowledge NEEDS to be shared with our students. I do believe we need to take into consideration the age of our students when we are sharing certain details of the backgrounds of science discoveries. Before today and the survey [HOS quizzes] we had to take before today's lesson, the ONLY background I have known about is the Lewis Latimer and the Katherine Johnson areas. So, today's discoverings, for me were major eye-openers. If I put myself in those people shoes [the Black men], I would have believed the same things that they believed of the medical teams [the TSS medical staff contributing to the study]. From this day forward, I will make sure to share and dive deeper into the scientists and the discoveries that are made - to not only help my students to see and understand, but to further my understandings and discoveries of the science world.

Marla's attitude toward contentious topics shifted after learning about and empathizing with the men in the TSS whose treatment was withheld without their knowledge. The professional learning supported Marla's critical reflection on her lack of awareness and desire for greater contextualized knowledge for both herself and her students. Marla started to see herself as a science learner who could learn alongside her students. Marla still views this science learning as factual and does not yet view her students as contributors to her learning, the attitude needed to support her transition from *desiring* to *knowing*.

Both Joyce and Marla make comments regarding their concern for age-appropriate discussions. While age-appropriate conversations are a logical concern for K-5 educators, both Joyce and Marla now appear to realize that age-appropriate conversations do not mean avoiding the conversations altogether.

Theme 2: Awareness of systemic racism. Three of the six teachers who desired to grapple with racism were previously aware of systemic racism before the professional learning. For Joyce, her awareness contributed to her race-evasiveness discussed in the previous section, because racism is just the status quo. She states, "I know that racism exists in every aspect of

society but quite honestly, it's come to a point where it feels 'normal'." Joyce is aware of systemic racism and has accepted it as her lived reality. After the professional learning, she desires to begin to change that reality. Sarafina and Melba were also aware of systemic racism within science. Sarafina's awareness came from her parents, "who lived through and experienced it." Melba, a Black middle school teacher with over a decade of teaching, demonstrated her awareness through an example that was not provided in the professional learning session:

> Science has long been used a weapon for racism, as a way to justify racist stereotypes, and to continue the practice of discrimination. There is the incorrect belief amongst racists that blacks are not as smart as their white counterparts. James Watson, a Nobel laureate biologist and half of the duo Watson & Crick, who discovered the structure of DNA, stated in a PBS documentary that black people are intellectually inferior to white people. You have a well-known contributor to the area of genetics release an inflammatory statement that demeans an entire race…we have to teach what is correct and right, because our students deserve to be educated and not indoctrinated.

Melba's response demonstrates her contextual understanding of how science has been abused to further personal ideologies. Melba also appropriates the fear language of conservatives who cry that educators are indoctrinating their students and uses this language to emphasize that by silencing history and not teaching the relationship between racism and the construction of science knowledge we are indoctrinating students with a whitewashed knowledge of science and ignoring how science has been experienced by non-white communities.

Theme 3: The importance of questioning as a mechanism of doing science. In her reflection, Linnet voiced the importance of student agency in her teaching practice. She wrote, "science must be made available to all students in an environment that allows for discovery, questioning, experimenting, and developing conclusions." Part of being a culturally relevant teacher is supporting student questioning and reasoning (Mensah et al., 2018), which values students' thinking as science thinking (Sheth, 2019). Linnet's reflection makes clear that she desires an engaging classroom for her students and wants them to think critically about the science content in order to draw their own conclusions. However, her response does not make it clear if she is moving beyond the SEP of Asking Questions And Constructing Explanations about science disciplinary core ideas to also questioning power structures or how science is used and viewed in communities. Denise, a Black middle school teacher with over a decade of teaching experience, is more direct that her reason for supporting student questioning and drawing their own conclusions stems from bias within the science community. Denise wrote:

> Much of the information that science is built on has bias. I think it is important to be aware of these biases as we teach and so that when misconceptions arise, we are able to inform students to make their own observations.

Denise values students working through their own misconceptions by making their own observations. Students making their own observations allows for critical reflection on how their new findings coincide with their original thinking. Teaching her students to critically reflect on their understanding of science supports their development of questioning and reasoning on existing science knowledge that contains bias.

Knowing

Three of the 28 teachers demonstrated *knowing.* Unique to these three teachers' reflection responses was the inclusion of how they became aware of their understanding of the relationship between racism and science knowledge construction. Marci, Candice, and Gwen developed an understanding through coursework at an HBCU, self-guided research, and through home and

church, respectively. Marci, Candice, and Gwen each indicate ways in which they continue to develop their understanding of scientific knowledge. Through reading, discussions within home and community, and the iterative process of researching and self-reflecting, these three teachers demonstrate that nuanced understandings of the production of scientific knowledge, social conditions, and political agendas are continuous. Also unique to these teachers is their language of intentionality.

In her reflection, Marci, a Black middle school teacher with 20-plus years of teaching experience, indicates how science was advanced by the intentional exploitation of Black bodies and how this exploitation continues today as the contribution of Black scientists is intentionally hidden. Marci wrote:

> Without black people being used as subjects of experiments, science wouldn't be as advanced as it currently is. Manipulation and exploitation of the Black race has been hidden as data was collected. Many adults, including teachers, doctors, and current scientists, don't know the history of what they are using, teaching, and practicing. I also research and learn about how Black scientists and their contributions have been conveniently left out of school books.

Marci provides an example of a teacher who has a historically contextualized understanding of science knowledge. She demonstrates the negative feedback loop that Black Scientists and their contributions are not included in teaching resources, and therefore, teachers, doctors, and other adults do not know the contributions Black individuals have made to science knowledge. Marci indicates her intentional inclusion of Black scientists, stating, “My students research items that are used everyday and are surprised to learn that most of the items that we depend on in our everyday life were invented by Black scientists.” Her inclusion of Black scientists is not additive nor is it tokenistic. Because she allows students to choose what items they would like to research and share, students are organically exposed to many different scientists, several of whom are Black, supporting students’ understanding that these contributions are the norm and not the exception. Marci fills the void of missing Black contributions that textbooks leave out of the science classroom.

While Marci demonstrates awareness of systemic racism and how it impacts science representation and is intentional in her own inclusive representation within her science classroom, she voices concern regarding the teaching of mistreatment, stating, “at the elementary level, I can't go into detail about a lot of the mistreatment, but I do introduce and teach everything that is age-appropriate.” Like Joyce and Marla, Marci is concerned about how to teach the harm that has been done in the name of science and how this harm impacts the experiences of students from different communities engaging with science. While Marci shows hesitancy in how to incorporate this knowledge into her teaching practice, Gwen shows conviction that discussions around how racism has shaped science are part of science teaching. Gwen, a Black elementary teacher, wrote:

> I think that it is important to recognize and address the ways in which racism helped shaped science. This knowledge has reconciled with what I previously understood about science because these things have always been discussed in our homes and churches. I will and have been incorporating this knowledge in my science lessons by having these discussions with my students on their level of understanding

Unlike Joyce, Marla, and Marci, who used age-appropriateness as a reason to avoid discussions around systems of oppression and questioning power, Gwen creates opportunities to disrupt racism in her class. Her lived experience of “these things have always been discussed in our

homes and churches" has provided her with a model of how these topics can be examined and discussed at varying ages.

Candice also uses language intentionally. Candice is a white elementary teacher who taught herself about the historical connection between racism and science knowledge construction as a means to support her students' social studies and science learning. She critically reflects on her knowledge and teaching practices, saying, "I have tried to incorporate my learning into my teaching by checking my own biases and misconceptions before teaching and by thoroughly researching the history and social impacts of my content before teaching." Aware that her narrative is different from some of her students. She is intentional about the narrative she presents to students and is conscious of whose voice is being amplified and shown to matter. In her reflection, Candice wrote:

> to present information in a way that is respectful to the communities that were harmed…I try to make sure that my sources are written/created by authors that are a part of the population that has been most impacted by these tragedies to ensure that my information is correct and truly represents the impact on their community.

Candice is sociopolitically conscious of the need for perspectives from the communities denied the privilege of possessing and wielding science knowledge and who experienced racist action in the name of science; she is also conscious of the epistemological ramifications to science knowledge if these perspectives are silenced.

Not Yet Desiring

Nineteen of the 28 teachers had not yet reached the desiring stage of grappling with racism. Many of the teachers had not been exposed to the historical examples provided in the professional learning session and had emotional reactions to the knowledge stating in their reflections that they were "shocked," "angered," "saddened," and "appalled." When asked *how will you incorporate this knowledge into your teaching moving forward*, a majority of teachers reflected that they would like to include more "background information and positive representations" (Monica) and feel "it is imperative that we teach our students about past events so that history doesn't repeat itself" (Isadora). Others, like Selma, felt such historical events supported teacher mindfulness, stating, "This knowledge will be used in my teaching in ways that help me to ensure that I continue to be reminded of the actual truths about science and the content that is being taught. Remembering to be mindful of all that has happened in the name of science on the backs of African American men and women." Selma's response demonstrates that she viewed the history of how science knowledge was constructed as important for teachers to be aware of moving forward and that as a teacher she is "reminded of the actual truths about science" rather than the objective facts or sanitized tellings of science written in textbooks and other curricular materials. However, Selma does not elaborate on how students will benefit from their teacher being "reminded of the actual truths," nor does Selma mention a goal of tackling such history with her students.

Trinity, a Black elementary teacher, was unique in that her responses seemed to indicate a level of knowing and a desire for things to change in science education:

> I think that it is beyond time to teach the truth about science and its history. We can not expect full change if we are not honest students don't know the truth about the past. We have to educate students so that they can be the change.

However, Trinity feels this change is not the responsibility of teachers, but rather those who dictate the content and curriculum teachers use to support and justify how and what they teach. Trinity states, "that the change has to come more so from textbook writers and those who

approve standards. We can't continue to tell [or] teach half the story if we want to see a change in science and education." Trinity does not desire to grapple with racism within her classroom despite her desire for "a change in science and education." When asked *how will you incorporate this knowledge into your teaching moving forward*, Trinity responded, "I teach K-2 so there isn't much that I would need to teach my students. I would only be able to give surface level information." From this assertion, it would appear that "the truth about science and its history" must wait for later grades, delaying the grounding students need to engage with complex ethical and social science issues.

Theme 1: An additive approach. Ten teachers took an additive approach to equity. For example, Benji, a young Black male middle school teacher, discusses teaching facts about Henrietta Lacks and the Tuskegee syphilis study. He wrote:

> when I talk about cells with my students, I could refer to the famous story of Henrietta Lacks. When teaching about bacterial diseases, I could have students research what happened with the Tuskeegee [sic] men. Also, I think having students present this information at our Black History school program would be a great idea.

Benji's approach to equity is to include more historical examples and have students research 'facts' about these events. While students might find these examples interesting, being taught historical facts will not teach students the sociopolitical consciousness needed to be change agents. Having students learn this information for Black History Month is additive and not inclusive for Black students in science. Other teachers discussed teaching the history of science as additional facts similar to Benji, and suggested inviting guest speakers to their classes to share their experiences working in the science field.

Theme 2: Race-evasion. Seven of the 19 teachers demonstrated race evasion in their reflections. Often these teachers portrayed a view of equity as equality. Louisa is one such teacher. She wrote, "I will move forward by continuing to teach my students to always treat everyone fairly and respectfully." By stating she will treat everyone fairly, she wipes away the individual differences and needs of students. She also fails to acknowledge how racism continues to impact science and the teaching of science. Research has shown that even when educators think they are treating all students the same (Russo‑Tait, 2023), historically minoritized students do not have the same experiences in science classrooms as their white peers (Kang & Zinger, 2019; Sheth, 2019; Tate, 2001).

Amelia, a white middle school teacher, is an example of a teacher who did not see the science classroom as a place for equity work. Amelia wrote in her reflection, "I could see possibly doing some cross curriculum lessons. Our social studies teacher may find incorporating some of this information into her content. I could possibly see a little mini-lesson on ethics being tied in." Amelia views equity as extraneous to science education goals. She feels that social studies would be a more appropriate place to learn about the relationship between racism and the construction of science content knowledge. This sentiment is shared among other science and math teachers who "frequently misperceive culturally relevant teaching to be appropriate for language arts, social studies, and fine arts, but not for the so-called 'hard sciences' " (Boutte et al., 2010, p. 2).

Theme 3: Through the teacher's lens. Lastly, all 19 of the teachers who were not yet desiring discussed incorporating historical facts or including equity through a teacher-driven lens. These teachers approached the topic as increasing the content students would learn, perhaps increasing their contextualized knowledge of science, but lacking the sense-making and agency needed for students to develop sociopolitical consciousness and propose real-world solutions.

Joanne wrote, “I plan to inform my students on the historical events of the past that have and still are impacting science today.” Joanne understands the need to contextualize science knowledge but has not grasped that students must develop sociopolitical consciousness and grapple with these ideas rather than being "informed." Teacher-led instruction supports the teacher's interpretation of this knowledge and its impact on science rather than legitimizing how students contextualize these events with their current understanding and experiences with science. Monica similarly stated, “I will try to include more background information and more positive representations in my lessons.” Elliot sees historical facts as additional information students can learn to enhance a lesson. He stated, “This information can be used to enhance lessons at the appropriate times with additional information.” These teachers value the inclusion of historical facts as background information, and some teachers, such as Joanne, are taking it a step further to connect these past events to current science. However, these teachers are not yet utilizing science and engineering practices such as asking questions, identifying and defining problems, analyzing and interpreting data, constructing explanations, argumentation, or obtaining and evaluating information or sources as a means for students to examine and connect their own experiences, interests, and concerns around their developing understandings of science and how racism has contributed to science knowledge.

Discussion

The purpose of this study was to gauge teacher awareness of how racism has impacted the construction of science knowledge and if such awareness impacts teachers' attitudes toward addressing racism in the science classroom. For the historical knowledge quizzes on Henrietta and TSS, teachers, on average, answered a little more than one question correctly. For the quiz on J. Marion Sims, teachers, on average, answered less than one question correctly. These findings indicate that most teachers knew little about these historical examples, which encapsulate how racism has contributed to the construction of science knowledge. The findings support our hypothesis that part of the reason teachers have not addressed racism in science is because they lack awareness of how racism has impacted the construction of science knowledge. Lack of knowledge about these events risks perpetuating the myth that science is colorblind and objective. Teachers who scored highly on historical knowledge quizzes all had high DCRPS averages and were identified as displaying *knowing,* offering those providing professional development or teaching pre-service teachers an entry point to combat race-evasive stances toward science teaching.

The literature demonstrates that of the three tenets of CRP, teachers are less likely to foster sociopolitical consciousness (Ladson-Billings, 2014), where students would attend to systemic inequities (Sheth, 2019). This held true for our study, where a majority of participants moving forward wanted to reconcile historic racism with inclusion and representation. This is understandable, as teachers negotiate the different definitions of equity in teaching (Morales-Doyle et al., 2021) and often return to the teaching methods they learned in teacher preparation with which they are most comfortable (Roehrig & Luft, 2006). Through inclusion, teachers feel that they are developing equity and do not have to challenge the existing inequitable structures (Rodriguez, 2015).

The NGSS espouses that all students should be provided with equitable opportunities to learn and engage in science while taking a colorblind approach to inclusive science instruction. A colorblind approach perpetuates the false belief that science is a race-neutral field and depends on educators to address systemic racism as they implement science standards (Parsons & Thompson Dorsey, 2015). The few teachers who demonstrated *desiring* and *knowing* want to

address systemic inequities despite the lack of support in standards, but most were unsure of how to do so and were even more unsure of how to be age-appropriate in doing so. Or in the case of Trinity, a teacher who had historical knowledge and felt science education needed to change, "grappling with racism" in her classroom was not her responsibility until standards and curriculum reflected such change. This finding is consistent with Wade-Jaimes et al. (2021), who argued that without explicit standards examining institutional racism within science, science teachers "will have trouble developing relevant learning experiences for Black and Brown students" (p. 859).

To the authors' knowledge, this is one of the first empirical studies to utilize Sheth's foundational practice of "grappling with racism" as an analytical framework. Nine of 28 participants demonstrated a clear *desire* to incorporate their new understanding into their science classrooms. Science teachers have shown resistance to learning to teach for diversity (Rodriguez, 2005). Therefore, nine teachers demonstrating a conscious desire to take action within their classroom is notable. Rodriguez (2005) argues that resistance to "teaching for diversity" can be due to a lack of "awareness, confidence, and/or knowledge and skills to implement more culturally responsive and socially relevant curriculum" (p. 5). The findings of this study support these reasons for resistance as a majority of the teachers were unaware of how racism had shaped science knowledge and current science culture and practices, indicated both by their HOS quizzes and by statements made in their reflections, such as Marla indicating "today's discoverings, for me were major eye-openers." Teachers' lack of knowledge and skills to "teach for diversity" were indicated by vague answers that did not articulate how such teaching could be accomplished, such as, "I would like to teach some of this in my science classes (Vanessa), or were more directly communicated through statements like "as far as incorporating this knowledge into my lessons, I am going to need some help with this one" (Eleanor).

Three of those nine teachers also demonstrated *knowing*. The major theme that developed from the response of teachers who demonstrated *knowing* was the language of intentionality. This finding emphasizes that teachers who want to support equity and disrupt inequity in science education must be intentional about how they do so (Mensah & Jackson, 2018). These three teachers also recognize that the development of critical and social consciousness is an ongoing process (Boutte et al., 2010) in which they continue to engage to better support and care for their students (Mutegi, 2011). While some of the *desiring* teachers wanted to support equitable classrooms through high expectations and the inclusion of inquiry practices, the teachers who displayed *knowing* understood the importance of being critically aware of historical racism and how it shapes racist ideologies and science practices today. These findings agree with Boutte et al. (2010), who state that "a key distinction between scientific inquiry and culturally relevant science is the degree of emphasis on sociopolitical and critical analysis" (p. 4).

Another key finding from this study was teachers' occupation with age appropriateness, regardless of context (not yet desiring, *desiring*, *knowing*; and elementary and middle grades). This is consistent with a majority of U.S. adults who "advocate that conversations about race should be developmentally appropriate" (Sullivan et al., 2022, pp. 395-396). U.S. adults substantially overestimate the age, by about four and a half years on average, at which children are capable of processing social ideas of race compared to the age suggested by scientific literature. Sullivan et al. (2022) note that "the strongest predictor of the age at which adults were willing to talk to children about race was their (misplaced) beliefs about when children develop capacities for processing race" (p. 399). Children begin to develop their racial and gender identities starting at age two (Hilliard et al., 2021). "By age two to four, children begin to

internalize racial bias," and by age 10, children can become set in their beliefs (Lingras, 2021, p. 10). Therefore, teachers do need to grapple with racism in science classrooms in early elementary grades. For a teacher like Marci, who has a historically contextualized understanding of science knowledge, to progress to the context of *doing*, she needs the knowledge of age appropriateness and competence to engage her students in a way that they, too, can develop an age-appropriate understanding.

The findings in this study indicate that teachers need more knowledge about how to address race in age-appropriate ways. Many hold a misunderstanding of how students experience and perceive race from a young age and use an argument of age-appropriateness to remain race-evasive. For example, Trinity stated," I teach K-2 so there isn't much that I would need to teach my students;" however, Essien and Wood (2021) indicate that Black girls in early elementary education experience negative treatment from peers and educators regarding their hair (both the styles in which the hair is worn as well as the natural traits). These negative messages about Black hair early in these girls' development have a formative influence on their identities and their perceptions of what is valued (Essien & Wood, 2021). Children are natural pattern seekers and notice differences around them and whether those patterns are ascribed value (Hilliard et al., 2021). Children will continue to notice differences and differential treatments of individuals, coming to essentialist explanations for those differences if they are not provided opportunities to discuss, ask questions, build relationships, and be exposed to others' points of view (Hilliard et al., 2021). Counter to Trinity's belief, there IS much she needs to teach in the K-2 grades, proactively addressing stereotypes, so that as students notice differences, they embrace and celebrate those differences while feeling valued (Essien & Wood, 2021). While some teachers, such as Isadora and Louisa, felt that it was better to emphasize similarities rather than differences, colorblind approaches are ineffective at decreasing stereotypes or challenging biases (Vittrup & Holden, 2011).

Implications and Conclusion

This study chips away at the race-evasive stance of many science educators. Teacher reflections, following the professional learning, indicated greater awareness and a desire to increase representation and the visibility of these historical instances. The professional learning session and the open-response questions supported many teachers in reflecting on their teaching practices and how they would like to shift their practices, a step toward dismantling dysconscious racism (King, 1991). While the PD was able to shift many teachers' perspectives, most teachers were not yet able to articulate or envision how such knowledge could be implemented in elementary and middle school science classrooms. Therefore, to move teachers beyond additive inclusivity approaches, which still maintain hegemonic practices in science education such as meritocracy and colorblindness, to embedding critical questioning and exhibiting awareness of relevant systemic barriers faced by students, we recommend teacher education programs and in-service teacher professional learning programs include the role(s) racism continues to play in students' and the greater public's understanding of scientific knowledge. As well as excavate ways racism and harmful ideologies maintaining racism remain embedded in their own classrooms (or cooperating teachers' classrooms for pre-service teachers).

Ideologies such as meritocracy and colorblindness are dangerous. Meritocracy perpetuates perceptions that individuals are responsible for their situations, rather than institutional racism, releasing teachers from the responsibility of developing skills to examine race and other inequitable structures impacting students (Picower, 2009). Colorblindness prevents conversations from happening, thereby preventing change. Recent *Divisive concepts*

legislation (e.g., Aldrich, 2021; Anderson, 2023; Florido, 2021; Schwartz, 2021) makes having conversations around race and racialized inequities even more formidable for K-12 educators. This is likely to become more challenging for teachers as Diversity, Equity, and Inclusion (DEI) faces further attack from President Trump, evidenced by his executive order banning DEI programs in the federal government, which resulted in the removal of the story of the World War II Tuskegee Airman and the Women Airforce Service Pilots from Air force training courses (Pomeroy, 2025).

We recommend allowing teachers and teacher candidates time to collaborate in order to consider how they can increase their contextualized understanding and practice asking and answering critical questions such as: For whom is this relevant? Who is benefitting? What perspective is being amplified? Who is omitted? at an age-appropriate level. These collaborations, while supporting teacher learning, might also help them become more comfortable in having such discussions with their students. The ability to collaborate on lesson planning, collaborate by co-teaching, and collaboratively reflect has consistently been identified to support teachers in understanding and implementing a reform (Mensah, 2011; Mensah et al., 2018; Reiser, 2013; Richman et al., 2019). Finally, we recommend that teacher educators and professional development and learning facilitators develop teachers' competence to incorporate race in their teaching in age-appropriate ways and not allow age-appropriateness to become a barrier that defeats all dialogue and engagement regarding race and racism in science knowledge construction. For examples of ways to have age-appropriate conversations, see Lingras (2021), and for examples of resources and programs see Hilliard et al. (2021).

In addition to these recommendations, we suggest that future research should explore the experiences of teachers in learning about historic racism and its impact on science knowledge construction as well as current science education. It would also be interesting to explore how teachers navigate gaining culturally relevant knowledge and if such knowledge and reflection support a shift from *desiring* to *knowing*. While this study examined how teachers might theoretically incorporate knowledge of historical racism in science, it would be helpful to investigate what discussions of race and racism in their classroom might actually look like in practice. This may illuminate how and if teachers shift from *desiring* to *knowing* or *knowing* to *doing*. It could also be useful to potentially engage teachers in design-based research as a means of studying age-appropriate science lessons that grapple with racial inequity and sociopolitical issues.

This study has provided insight into teachers' awareness of racism in the construction of science knowledge and whether their awareness impacted their dispositions toward culturally responsive teaching practices as well as their willingness to grapple with racism. This study has shown that awareness of historical racism in science spurred *desiring* and *knowing* in some teachers and shifted the perspective of some teachers about having discussions in science around topics often deemed controversial; an important shift as these controversial topics, when left unexplored, perpetuate myths of meritocracy, colorblindness, and objectivity in science education. We hope the findings from this study provide a potential entry point for teacher educators and professional development and learning leaders to support culturally relevant knowledge and ideological change.

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