

Article

“Because That’s What Scientists Do... They Like to Make Their Own Stuff”: Exploring Perceptions of Self as Science-Doers Using the Black Love Framework

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Abstract: This paper critiques traditional science assessments and advocates for reform-based learning that supports culturally diverse students, aligned with the Next Generation Science Standards (NGSS). While NGSS promotes collaborative, inquiry-driven practices, these are often difficult to assess through traditional high-stakes tests, which tend to reinforce systemic biases and marginalize students from non-dominant backgrounds. We examine the *Lotions and Potions: Science through Black Hair Care* curriculum, which uses a culturally sustaining approach, allowing students to respond flexibly in assessments. This approach enables students to participate fully in science practices without needing to conform to dominant cultural norms. Our findings highlight the benefits of culturally sustaining assessments that foster student voice, support diverse sense-making, and challenge exclusionary norms in science education. By positioning students as active knowledge builders who can draw on their cultural identities, such frameworks offer a more inclusive, empowering science learning experience. Future research will expand this model by refining pedagogical practices and curriculum design, particularly through culturally relevant applications of NGSS Science and Engineering Practices (SEPs) to further inclusivity in science and engineering education.



Academic Editor: Neil Gordon

Received: 1 November 2024

Revised: 11 January 2025

Accepted: 27 February 2025

Published: 13 March 2025

Citation: Likely, R., & Worsley, T. (2025). “Because That’s What Scientists Do... They Like to Make Their Own Stuff”: Exploring Perceptions of Self as Science-Doers Using the Black Love Framework. *Education Sciences*, 15(3), 359. <https://doi.org/10.3390/educsci15030359>

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Keywords: assessment; STEM; culturally sustaining; science curriculum; DIY hair care; Black Love

1. Introduction

Educational institutions and systems, through science assessments, stop short of supporting participation and inclusion of diverse groups through representation, expansive activities, and culturally sensitive evaluations. Hierarchies within science and engineering education are a result of the influence of Whiteness as a product of dominance, subordination, and privilege (Aschbacher et al., 2010; Calabrese Barton & Yang, 2000; Frankenberg, 1993; Sammel, 2009). Many minoritized students struggle to fully engage and prosper in traditional academic settings because they are viewed and treated as less competent in the dominant culture, while, simultaneously, their cultural wealth is undervalued (Yosso, 2005). For instance, various approaches to science education reform utilize a science-for-all perspective that inadequately attends to the gendered and racialized experiences of marginalized students. Examples from Tzou et al. (2021) support approaches to transformation within the curriculum, and assessment is systemic and linked to institutional forms of oppression. Middle-of-the-road approaches to expanding science education learning

experiences through the curriculum, instruction, and assessment are “dehistoricized and depoliticized” (Philip & Azevedo, 2017, p. 526). To expand, reform that stops short of complete restructuring of power within the classroom through curriculum and assessment is shallow, superficial, and insufficient. The work of transformation is not one that cuts corners or seeks to only add to curricula rather than transform it.

This repackaging of curricula and assessment have perpetuated oppressive pedagogical and evaluative practices that continue to marginalize students within science education. Therefore, “deliberate departure from so-called/assumed race-neutral guidelines and practices in the assessment design process—especially with respect to construct articulation—is necessary to disrupt these oppressive, white supremacist notions frequently replicated in/through most assessment systems” (Randall et al., 2023, p. 171). Overall, Whiteness is more than how people see themselves; as such, Whiteness is a product of dominance, subordination, and privilege (Sammel, 2009). Missing from these transitions in K-12 science curricula are the intentional inclusions of culture beyond the normalization of Whiteness within science education (Mensah & Jackson, 2018; Sammel, 2009). Whiteness here is defined as “the production and reproduction of dominance rather than subordination, normativity rather than marginality, and privilege rather than disadvantage” (Frankenberg, 1993, p. 236).

Educational reform has mirrored oppressive structures rather than provided a dismantled paradigm that leads to liberatory praxis for all students. As a result, efforts toward transformative science learning experiences utilize critical frameworks. For example, King and Pringle (2019) used the framework of critical race feminism and counterspaces to evaluate how Black girls access, engage in, and respond to a community-based STEM program. Their findings suggest that field trips and board games like Operation supported students’ interest in STEM. This research highlights a summer camp experience, I AM STEM, that focuses on the inclusion of field trips and outdoors activities within an informal curriculum designed for Black girls. Although this work mentions culturally relevant training for teachers, this research does not go into detail of any assessment instruments that supported the intersectional curriculum and STEM experience as other works have (Stephenson Reaves et al., 2022).

In agreement with Rosebery et al. (2016), it is these settled hierarchies that “can profoundly shape who and what is seen and heard as scientifically meaningful” (p. 1573) and, therefore, who is able to participate and persist in STEM spaces. Assessment instruments are purposed to provide evidence of knowledge in an observable fashion through various tasks. Traditional K-12 STEM curricula and assessments have prioritized less-than-effective learning techniques, such as memorization, and penalizes students who do not adhere to normalized majority culture norms for the expression of content understanding, such as exams (Philip & Azevedo, 2017; Randall et al., 2023; Rosebery et al., 2016; Tzou et al., 2021). However, not all assessments are written considering the complexities of students’ lives beyond the classroom. The evaluation tools within K-12 science learning spaces rely on settled hierarchies, or systemic oppression has impacted who is regarded as a scientist and what content qualifies as science (Mensah & Jackson, 2018; King & Pringle, 2019). These learning assessment techniques can feel further stigmatizing due to the ways they support, perpetuate, and uphold larger systems of oppression, biases due to endemic racism, and deficit-based approaches to learning assessments (Atwater, 2000; Crenshaw, 1991; Harris, 1993; Norman et al., 2001; B. Warren & Rosebery, 2011). A critique of culturally centered assessments around lack of rigor has further delayed expansive assessment practices through the “use of mechanisms that reproduce racial inequality and embedding them into the very fabric of educational assessment” (Randall et al., 2023, p. 171).

Reform-based science learning experiences are intended to provide students opportunities to think, behave, and believe like a scientist (Aikenhead & Elliott, 2010; Carlone et al., 2011; Tal et al., 2006). Although students have been encouraged to talk using scientific discourse (McNeill & Krajcik, 2008), in many ways, the evaluations of how students participate in conversation have not been recognized. Following Randall (2021), we agree that intentional resistance to current assessment development and implementation is necessary for expanding science learning instruction and assessment. We argue that many reform approaches for curriculum design and science practice assessments have perpetuated the marginalization, oppression, othering, and erasure of people who do not fit within such rigid and exclusionary spaces. Until the assessment community can answer such a question, we argue that traditional approaches to the validation of assessments maintain a white supremacist hegemony (Randall et al., 2023, p. 171). This research submits an example of ways a culturally sustaining curriculum can operationalize a framework rooted in humanizing Black girls within science learning curriculum and assessment. The guiding questions explore ways that a curriculum can expand assessment practices and impact their perceptions of science and themselves as science-doers.

2. Literature Review

Through this research, we trouble the ways that scientific argumentation as a practice has been presented in curricula and limited to assessment predominately through writing tasks within science and engineering education. Next Generation Science Standards (NGSS, 2013) were introduced for K-12 science learning through grade-appropriate science and engineering practices (SEPs), disciplinary core ideas, and crosscutting concepts. The NGSS framework focuses on practice-based learning in science and engineering by positioning students as active knowledge builders that are able to convey understanding through modeling explanations of difficult content, identifying solutions, and discussion and collaboration. These practices are fundamental to inquiry and knowledge development (Duschl & Osborne, 2002; McNeill & Krajcik, 2008; Sandoval & Reiser, 2004). The SEPs are “activities and processes that scientists, engineers, and mathematicians engage in to make sense of phenomena and solve problems” (NGSS, 2013, p. 5). These practices include asking questions, communicating information, developing and using models, planning an investigation, and arguing from evidence (NGSS, 2013). Activities that center on collaboration and discourse like the SEPs have been slow to be implemented because these activities do not lend themselves to assessment easily through high-stakes testing. The SEPs require adaptations in pedagogy and curriculum to include, support, and empower all student voices in classroom discourse (Duschl & Osborne, 2002; Osborne et al., 2001; Quinn et al., 2012; Sampson et al., 2011).

Although students’ engagement with SEPs is important for developing skills for acquiring deeper content knowledge (NGSS, 2013) the tools for assessment of SEPs can be exclusive to those whom are seen and labeled as participants in science and engineering practices (Patterson, 2019). Currently, the components of the standards are not assessed separately, such that the process of student knowledge-building with the SEPs is not evaluated apart from content recollection. Additionally, the expansion of evaluation beyond a right or wrong answer that focuses solely on core ideas or crosscutting concepts apart from the practices has been lagging. Additionally, the problem exists that standardized assessments do not consider the collaborative nature of the SEPs. Along those lines, SEPs have been marginalizing and exclusionary to peoples and communities who are not from Eurocentric, Westernized, and colonial perspectives (Aschbacher et al., 2010; Calabrese Barton & Yang, 2000; King & Pringle, 2019; Leonardo & Broderick, 2011; National Academies of Sciences, Engineering, and Medicine, 2024).

2.1. Scientific Argumentation

Scientific argumentation is the practice of presenting evidence-informed choices and decisions (Mathis et al., 2017). A scientific argument is composed of three parts: (a) claim—a statement that answers a question or problem; (b) evidence—measurement, observation, or relationship to support the claim; and (c) reason—explanations of how and why the evidence supports the claim using scientific principles or phenomena (CER) (Leite et al., 2011; McNeill et al., 2006; NGSS, 2013; Wallon et al., 2018; Wilson-Lopez et al., 2018).

Many curricula provide assessment for only the written portions of an argument since the focus is on the use of evidence and backings to support the claim. Current assessment measures penalize students who may engage in argumentation in ways that are not acknowledged by traditional curriculum or assessment. Alternative assessment strategies such as oral assessments could reconnect students with oral practices that have been labeled as non-scientific when compared to colonial forms of assessment such as high-stakes testing (Abdi, 2012; Jencks & Phillips, 1998). These cultural misunderstandings can result in penalization for students' expression of science understanding based on cultural makers and signifiers (Rosebery et al., 2016). Therefore, multimodal assessments of argumentation presented students from minoritized communities with more sense-making opportunities through various evaluation tools (Ladson-Billings, 2006).

2.2. Black Educational Spaces (BESs)

Due to the participants of this study identifying predominately as Black and our emphasis on reimagining scientific argumentative assessment, we also draw from the theorization of Black Educational Spaces (BESs). When we look at traditional science learning environments, Black youth have mainly been exposed to these Westernized notions of science that are not representative of non-western cultures (Shaw et al., 2023; B. Warren & Rosebery, 2011). This is largely due to the majority of science educators being White, themselves having been schooled in White western science through their K-16, which leads to them reproducing teaching from a Eurocentric/Westernized viewpoint. Western science learning environments thus, arguably, are spaces of anti-Blackness, where Blackness is seen as a problem to be corrected rather than embracing the different perspectives that Blackness contributes to science (Dumas, 2016). Jenkins defines anti-Blackness as “the socially constructed notion that Black people are non-human, inherently problematic, and disposable”, and that it “structures the spatial arrangement and social imaginaries of every facet of American society” (Jenkins, 2021, p. 111).

Therefore, opportunities exist within science education spaces for Blackness to be centered, thrive, and be celebrated while learning. C. A. Warren and Coles (2020) describe BESs as spatial imaginaries where Black people's well-being is centered, often at the intersection between fugitivity and racial counterspaces. “Fugitivity is the imagined space that fosters possibility and resistance, while racial counterspaces are seen as physical locations that center healing and community-building” (C. A. Warren & Coles, 2020, p. 391). Three dimensions to provide solutions for Blackness to be centered, thrive, and be celebrated while learning were named: self-determination, self-actualization, and self-efficacy. Self-determination is contingent on providing opportunities for Black youth to have autonomy in their decision-making about who they are and who they are becoming. Self-actualization is evident through acknowledging and embracing the diversity amongst Blackness while not further essentializing and stigmatizing Blackness. Lastly, when Black youth are able to bring their whole authentic selves to the table and are not disassociated from any parts of their identities to achieve success, they have self-efficacy.

This type of liberatory, transformative change that decenters and unsettles Eurocentric, Westernized, and colonized ideologies is often slow in comparison to changes that support

systems already in power (Milner, 2008). Knowing the urgency of change, Ford et al. (1996) present a multicultural education frame in an effort to reduce educational inequities. These researchers propose a holistic perspective to addressing educational inadequacies that reinforce societal inequities within education through instruction, instructor diversity, curricula, and assessment. Multicultural education presents a paradigm to reform school and other educational institutions so that students from diverse racial, ethnic, and social-class groups will experience educational equality (Banks, 1993). Dixon-Román (2020) writes: “even with the sociocultural and postmodern turns in educational assessment and measurement, there remains a haunting logic in the epistemology of psychometrics that maintains colonialist formations” (p. 94).

2.3. Intersectionality in Education

Multicultural education through curriculum (multicultural curriculum) reflects perspectives of cultural inclusion of students through four main approaches: contributions, additive, transformational, and social action (Banks, 1993, 1997). These tenets of the multicultural curriculum are teaching values that support cultural diversity and individual uniqueness; encouraging the qualitative expansion of existing ethnic cultures and their incorporation into the mainstream of American socio-economic and political life; exploring alternative and emerging lifestyles; and encouraging a philosophy of multiculturalism and equity. However, contributions and additive approaches to the multicultural curriculum are insufficient to address intersectionality or be inclusive of student culture within the curriculum and assessment.

“No person has a single, easily stated, unitary identity” (Delgado & Stefancic, 2017, p. 9). In support, Bang (2015) brings to the forefront binaries or box models assigning identity categories based on culture, race, and ethnicity; therefore, intersectionality means the examination of how these boxes of race, sex, class, national origin, and sexual orientation, and their combinations respond to intersecting systems of oppression (Crenshaw, 1991; Delgado & Stefancic, 2017). The boxes and categorizations are not theoretical since larger systems reflect who has power and privilege and who does not (Delgado & Stefancic, 2017). “The intersection of racism and sexism factors into Black women’s lives in ways that cannot be captured wholly by looking at the race or gender dimensions of those experiences separately” (Crenshaw, 1991, p. 1244). Crenshaw (2010) unpacks the ways in which Black women experience systems of oppression and reform when Black, male experiences are centralized. Also, gender politics are associated with White women having the central narrative of feminism; as such, structures that generalize the experiences of either racial or gendered politics are reinforced. Black women are othered in both racial and gendered politics. Therefore, following systematically, STEM learning reform focused on racial agendas alone remain focused on a generalized experience racial experience of Black men and gendered experiences of white women as the diversity initiatives in STEM (Crenshaw, 1991).

Perspectives that seek not to recognize race and ways in which science education supports assimilation (Aikenhead & Elliott, 2010) as a pedagogical tool only reify inequalities and oppression while amplifying historical violence like colonization for students in non-dominant groups (Philip et al., 2018). It is inadequate for students who are required to assimilate into, and promoted for assimilating into, the norms of a science classroom (Mensah & Jackson, 2018). Therefore, the multicultural curriculum highlights equity through curricular change for diverse students at the transformational and social action levels which are purposed to prepare students to be critical thinkers and responsible citizens (Banks & Banks, 2004; Ford & Harris, 2000; Patterson, 2019).

Goals of the culturally inclusive curriculum and assessment are to integrate students' knowledge and culture in the classroom, develop racial identity, and provide a place in the curriculum for students to find commonness (Gay, 2000; Milner, 2014; Tatum, 1997). Building on Ladson-Billing's culturally relevant pedagogy as a foundation, Paris and Alim employ culturally sustaining pedagogy in an effort to combat the superficial use of culturally relevant pedagogy in which students express knowledge and participate in SEPs (Paris & Alim, 2014; Ladson-Billings, 1995). The three tenets of culturally relevant pedagogy are: (a) students must experience academic success; (b) students must develop and/or maintain cultural competence, and (c) students must develop a critical consciousness through which they challenge the status quo of the current social order. This pedagogical framework expands these tenets to perpetuate and continue youth culture through literacy and culture and to address assimilationist and monocultural processes of education and educational policy (Paris & Alim, 2014, p. 88). The literature has space for a curriculum and instruction and assessment that explore, honor, and extend students' various cultural expressions and ways of knowing (Lee et al., 2003). We follow standards that "reposition the linguistic, literate, and cultural practices of working-class communities as resources and assets to honor, explore, and extend" (Paris & Alim, 2014, p. 87).

Students may display an understanding of science content, but the presentation of the material is not in alignment with what the curriculum has identified as appropriate or correct, leading to penalization. To appease the curriculum's view of scientists, students are forced to operate not only at a cultural border between their everyday culture and the culture of school science, such that they are asked not only to learn a new subject with its own literacy, but also at cross-cultural borders in language, activity, and assessment as a means to demonstrate success in activities that are reflective of scientists (Aikenhead & Elliott, 2010). For example, cultural misunderstandings can result in students being improperly penalized for expressions of science understanding and participation that are based on normalized cultural makers and signifiers (B. Warren & Rosebery, 2011).

3. Conceptual Framework

A sociocultural learning framework such as a culturally sustaining framework toward curriculum and assessment suggests knowledge building to be explored, supported, and encouraged through culture and social experiences (Adjapong et al., 2016). In an effort to expand opportunities for cultural integration and expansion of the assessment of scientific argumentation, the after-school curriculum *Lotions and Potions: Science through Hair Care*, centered on skin and Black hair types as the focus content, a DIY product consisting of design activities. Additionally, a DIY video was embedded within the curriculum used as a summative assessment for scientific argumentation since students would need to provide scientific reasoning for their design choices of their product (Figure 1). Along those lines, attention to sociocultural aspects of learning have largely been missing from NGSS language and assessments (Likely, 2024). Considering students' culture and communal assets within science learning aids to deepen learning alongside relevant learning opportunities for students like the *Lotions and Potions* curriculum. Furthermore, we suggest further challenging settled hierarchies within STEM education by moving beyond content presentation toward expansive assessment instruments.

Academic Success	• Advancing knowledge about skin and hair.
Cultural Competency	• Engaging in cultural hair care practices creating DIY products
Critical Consciousness	• Celebrating and affirming Black hair through representation
Sustain Literacies	• Sustaining cultural literacies through curricular activities,
Address Assimilationist Policies	• Engaging multimodal assessments.

Figure 1. Alignment of the *Lotions and Potions* curriculum to a culturally sustaining framework.

3.1. Culturally Sustaining Approach to Assessment

The assessments within the curriculum center on the NGSS disciplinary core idea and crosscutting concept through the active engagement in the science and engineering practices. The transition to the NGSS, specifically the SEPs, has required new pedagogical practices and curricular activities (Duschl & Osborne, 2002; Leite et al., 2011; Osborne et al., 2001; Sampson et al., 2011). The SEPs require adaptations in pedagogy, curriculum, and assessment to include, support, and empower all student voices in discourse (Quinn et al., 2012). With this classroom practice of interaction, students have an opportunity to delve deep into academic discussion and are given space to practice play in learning (Nasir et al., 2006). Beyond proper resources for teachers to engage students in the SEPs, activities that center on collaboration and conversation through student culture have been slow to be implemented because these activities do not lend themselves to assessment easily through high-stakes testing. There has been a call for more culturally sensitive assessment instruments and options (Ford et al., 1996). Alternative assessment strategies such as oral assessments could reconnect students with oral practices that have been labeled as non-scientific when compared to colonial forms of assessment such as high-stakes testing (Abdi, 2012). Therefore, there exists opportunity for the development of a curriculum that intentionally engages students in the SEPs through collaboration and discourse.

Scholars Sampson et al. (2011) investigated the ways that students “produced better arguments” (p. 249) after an intervention that highlighted higher inclusion of disciplinary engagement and adherence to a CER model in writing. Along those lines, past experiences and cultural practices, when included within scientific arguments, have been considered inappropriate or incomplete (McNeill & Krajcik, 2008). This understanding lends itself to the position of students’ everyday speech and outside-of-the-classroom experiences as disconnected from and unsupportive of argument formation. Although scholars have been presenting various interventions for expanding the ways that scientific argumentation is evaluated in writing, much of this research moves toward assimilation by acknowledging arguments structured using a CER format, with the inclusion of specific disciplinary content, in order to be recognized as a high-quality scientific argument (McNeill & Krajcik, 2008; Osborne et al., 2016). Therefore, the criteria for evaluating the development of an argument were situated in mainstream science language and students’ ability to be stronger writers, rather than the affordances that highlight students’ strengths and affirm experiences beyond

the classroom. Rigid assessments of CER posit students as unable to identify “what counts” as relevant information rather than present expanded content or assessment tools such as the combination of written and combination of written and verbal arguments (Knight et al., 2013). Therefore, there exists an opportunity for the development of a curriculum that intentionally engages students in the SEPs through collaboration and discourse that situates students’ everyday ways of speaking as part of science discourse (McFadden & Roehrig, 2019; Siverling et al., 2019). Through this research, we have explored assessments that afforded students opportunities to participate in developing written and verbal arguments using culturally appropriate content and assessment strategies. Therefore, rather than continuing to limit the assessment of engaging in argumentation to writing (Osborne et al., 2004), we used a culturally sustaining curriculum to create a corridor for another presentation of a scientific argument to expand expression of evidence-informed decisions through writing and conversation.

3.2. The Black Love Framework

Black Love is used to validate students’ varied, non-traditional interests in STEM and to humanize students by creating critical community while working alongside them. Black Love (Figure 2) is comprised of two main tenets—STEM-related onto-epistemologies and critical relationality focused on integration of youth voice and interest. STEM-related onto-epistemologies (Tenet 1) has three subtenets that include high expectations of youth’s STEM expertise and ability to do rigorous STEM now; validating youth’s ideas so youth see themselves as doers of STEM; and active noticing. The subtenet of active noticing includes just-in-time teaching and culturally “STEMulating” pedagogical practices. Critical relationality focused on the integration of youth voice and interest (Tenet 2) has two subtenets that include collaboration in planning and critical community building through humanizing youth. Collaboration in planning means being flexible/adaptable and transparent/accountable. Critical community building through humanizing youth includes acknowledgement of feelings, learning and use of names, and space for critical conversations.

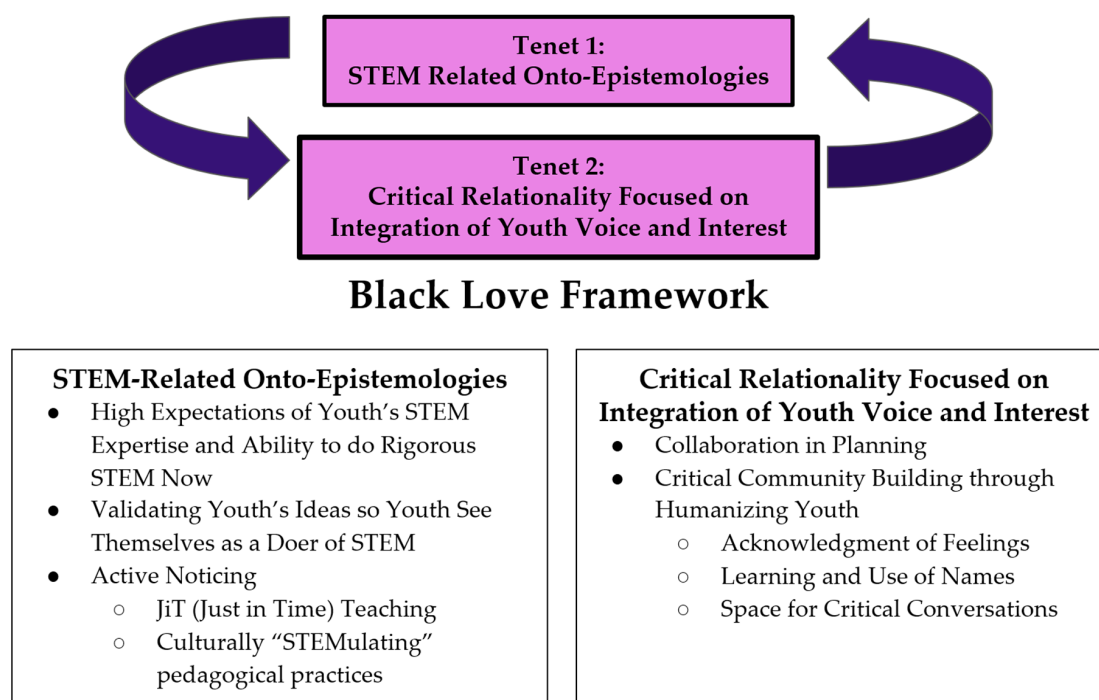


Figure 2. Black Love Framework highlighting the two tenets of STEM-related onto-epistemologies and critical relationality.

3.2.1. High Expectations of Youth's STEM Expertise and Ability to Do Rigorous STEM

Maintaining high expectations for youths' capacity to engage in rigorous science learning establishes a positive learning environment, reinforcing the belief that young people can succeed (McKinney [de Royston et al., 2020](#); [Ladson-Billings, 1995](#)). Such expectations create a norm where youth not only complete tasks but also demonstrate effort and take pride in their work. Within the Black Love Framework, educators are encouraged to value students and recognize their work as an extension of their identities. As youth share their knowledge with others, they begin to appreciate the significance of their contributions and their potential within STEM fields. While feelings of frustration may arise when faced with challenges, it is essential for youth to understand and work through these moments. Consistent high expectations help them learn from such experiences and persist in their efforts. Moreover, it is crucial that students know they are not alone in their educational journey; their educators are committed to providing the support needed for them to achieve success in rigorous STEM learning.

3.2.2. Validating Various Methods So Youth See Themselves as a Doer of STEM

The process of learning science has traditionally followed the steps of the scientific method, which includes observing, questioning, forming hypotheses, making predictions, testing theories, and refining those theories as needed. However, science is inherently dynamic, as is the process of actively learning science through SEPs such as argumentation. When youth engage in STEM, they often focus on achieving correctness or following a prescribed method, yet it is essential for them to understand that mistakes and iteration are integral parts of the learning journey ([Calabrese Barton et al., 2017](#); [Heredia & Tan, 2020](#)).

Youth bring diverse backgrounds and draw upon unique knowledge systems when interpreting STEM concepts and navigating problem-solving processes ([Gonzalez et al., 1995](#)). Engaging in STEM involves multiple pathways to solutions, which are informed by each learner's distinct onto-epistemologies. The learning environment should be designed to reflect and support this diversity, allowing youth to explore scientific concepts through various approaches. As they build their understanding of what it means to engage in science, students start to see themselves as active participants or "doers" of science—a perspective crucial for envisioning their future identities in STEM fields ([Calabrese Barton & Tan, 2010](#); [Roberts, 2010](#); [Wright, 2019](#)).

3.2.3. Active Noticing

The sustained engagement with the Lotions and Potions curriculum provided numerous opportunities to observe and understand how youth learn, work, and build connections within their learning environment ([Gay, 2000](#)). While much of this insight came from observation, educators emphasized active noticing, using these observations to actively support and enhance youth learning. Observing youth during science activities offers educators valuable insights into students' conceptual thinking, informing responsive pedagogical strategies. Understanding how youth approach STEM enables just-in-time (JiT) teaching and aids in identifying culturally relevant elements that effectively engage students in educational spaces ([Calabrese Barton & Tan, 2018](#)).

JiT Teaching. JiT teaching is a responsive approach that adapts to students' immediate needs, helping them progress to the next level of understanding ([Calabrese Barton & Tan, 2018](#)). This can involve teaching a specific STEM skill set, assisting youth as they navigate challenges—particularly when they feel discouraged or want to give up—or building on ideas they introduce into the program. JiT teaching demands a high level of observance from educators, who must closely track students' focus and thoughts. By understanding youths' perspectives and ideas, educators can tailor their support effectively.

This responsiveness may even require educators to quickly acquire new practices or skills to meet evolving needs.

Culturally “STEMulating” Skills. When engaging marginalized and minoritized youth through culturally sustaining learning experiences, it is essential to foster both academic success and culturally relevant learning. For instance, when youth are presented with a STEM-based project, they may identify themes that resonate with their cultural backgrounds. This might involve creating projects focused on community-specific topics or areas of personal interest, such as hair care. Learning becomes culturally STEMulating as youth engage in STEM practices, including SEPs, that are driven by their interests, fostering motivation and deeper connection to STEM concepts.

3.3. Connecting the Frameworks

We are recognizing the Black Love framework along with the culturally sustaining framework as the most appropriate framing for this study. The *Lotions and Potions* curriculum was developed to follow all six tenets presented by Paris and Alim (2014) (Figure 1). As such, a goal of this research is to highlight ways that current science curriculum, instruction, and assessment could be expanded. Whiteness within science learning was an explicit focus for the development and implementation of *Lotions and Potions*. The curriculum intentionally centers on, celebrates, and affirms Black girls through highlighting DIY haircare as a science activity. Additionally, pictures of young Black girls were on the cover of the lessons and throughout the learning materials. In an effort to follow Randall (2021) the curriculum sustained hair culture rather than whiteness as superior within learning materials including visuals. Also, the assessments were reflective of hair culture and student everyday speech through the CER framework.

4. Materials and Methods

Culturally sustaining teaching practices highlight the importance of relationships between teachers and students where teachers can use their professional capital to support the whole child. A culture of disruption is moving from the traditional practices steeped in dominant ideology through the reauthoring and extending of rights that lead to shifts in classroom hierarchies of power. Together these frameworks inform new possibilities of how to theorize educator–youth relationships specifically in informal STEM settings. The two guiding research questions for this qualitative study are:

1. *In what ways were the girls’ engagement within a culturally sustaining curriculum expanding assessment practices?*
2. *How did engaging in the curriculum using a Black Love framework impact Black female students’ perceptions of (a) science and (b) themselves as doers of science?*

Research participants of this study were ten Black middle-school girls from Philadelphia, PA, USA (Table 1). Participants included girls in grades five through seven (ages 10–13) that were recruited through a flyer distributed to several local after-school programs. The inclusion criteria for this project were enrollment in middle school and self-identification as a Black girl. Students were mainly from two local schools which have been given pseudonyms for this research. Five students were from CJ Walker School, four students were from Henrietta Lacks Charter School, and one student was from Catherine Johnson Charter School. Students’ participation in this study was voluntary, and their participation did not have any impact on students’ evaluations in their in-school science courses. The four students from Henrietta Lacks Charter School were accompanied to every session by one of the after-school staff and using school-designated transportation. The *Lotions and Potions: Science through Hair Care* class ran for six classes, twice a week for ninety minutes each class, thus totaling seventeen-plus hours of contact time.

Table 1. Participants for the after-school program.

Student Name	School	Grade	Age
Shauna	CJ Walker Charter School	6	12
Maci	CJ Walker Charter School	7	13
Melody	CJ Walker Charter School	5	10
Bianca	Henrietta Lacks Charter School	6	11
Karesha	Henrietta Lacks Charter School	6	11
Letrice	Henrietta Lacks Charter School	7	12
Lanna	Henrietta Lacks Charter School	7	12
Dream	Catherine Johnson Charter School	6	12
Princess	CJ Walker Charter School	6	11
Tia	CJ Walker Charter School	5	11

The design and facilitation of *Lotions and Potions: Science through Black Hair Care* foregrounded cultural elements of Black hair care product making as the object of inquiry and exploration and being able to be supported with scientific justifications through argumentation. We evaluated how students learned about Black hair care and how Black middle school girls are participating in SEPs.

Lotions and Potions: Science through Black Hair Care curriculum uses a three-pronged template inspired by NGSS's framework of DCIs, CCs, and SEPs (Figure 1). Each lesson in the *Lotions and Potions: Science through Black Hair Care* curriculum incorporates a different disciplinary core idea, a hands-on activity or DIY product, and SEP assessment activity in a lesson packet following examples from the engineering education curriculum to support activities that are hands-on, materials-intensive, and learner-driven (Cunningham & Carlsen, 2014). Additionally, each lesson packet had word search or crossword puzzle activities, content and explanations from *The Science of Black Hair* (Davis-Sivasothy, 2011) materials, DIY product instructions, and a journal section. Hair care content is relevant to life science since students explore the structure and function of cells making up larger systems (MS-LS1; NGSS, 2013), since skin and hair are a part of a larger system made of smaller cells. The multi-modal assessment opportunities for SEPs that were afforded through the culturally sustaining curriculum were developing a model, matching, and fill-in the blank activities, a pair-and-share activity, and the final DIY video. The standards were chosen to remain aligned with academic success of culturally sustaining pedagogy. The focus was on expanding the disciplinary core idea or main content of the standard beyond only cell parts as traditionally explored within middle-school science learning. The content for the curriculum was outlined by Next Generation Science Standards as noted in the literature review and Materials and Methods. The *Lotions and Potions* curriculum explores cells, organs, and systems using skin and hair. While expanding the use of this standard, the standard alignment provides an example of cultural alignment and inclusion within a science learning space. Applying the main content of science learning with culturally congruent science activities is the focus of equity within STEM education (National Academies of Sciences, Engineering, and Medicine, 2024; Patterson, 2019).

To identify the assessment opportunities that were available through the *Lotions and Potions: Science through Black Hair Care* curriculum, multimodal assessment instruments were best supported through a culturally sustaining framework. More specifically, students were given choice in the types of responses to give in the formative assessments. Also, students were not limited to written statements only for the curriculum. Since the *Lotions and Potions* curriculum centered on assessments that were designed following academic success and cultural competence, the intention of the assessment was to incorporate content and evaluation that sustained hair culture. "We know that students—especially marginalized students—do not experience the world including schooling in ways that are context-free,

so the question becomes why do we insist that they experience their assessments in this way?" (Randall, 2021, p. 82). As such, we recognize that marginalized and minoritized students would benefit from assessment that reflected true experiences in the world.

4.1. Worksheet Activities

The curricular artifacts that were used as a data source for communicating information through observation statements and developing and using a model were two activities from Lesson 2. Cultural words and expressions were vital to being incorporated within the formative assessments throughout the curriculum (Randall, 2021). Questions about the DIY products were centered on within each lesson. The curricular artifacts that were used to assess students' engagement with arguing from evidence come from a matching activity in Lesson 4 that gave students the opportunity to develop the main parts of a scientific argument. Particularly, the scientific argumentation activities were facilitated through a scaffold of Lesson 4 that would be assessed without a scaffold in Lessons 5 and 6. In Lesson 5, students engaged in a pair-share activity that allowed for the engagement of scientific argumentation in written and verbal form. We chose to highlight the written (Lesson 4–5) and verbal (Lesson 5–6) engagements of an argument since the elements of an argument are present beyond written pieces (Erduran et al., 2004; Toulmin, 2003).

4.2. Semi-Structured Interviews and Drawing Tasks

Each student participated in an interview before and after the class that asked them to draw themselves as a scientist and explain the picture. Specifically, the interview protocol was informed by research that incorporated students' pre and post drawings of their participation in science practices as a primary interview component (Tucker-Raymond et al., 2007). Each student then explained their various pictures. This pre- and post-interview approach allowed us to evaluate whether students' perceptions of what counts as science are impacted by their participation in the hair-care curriculum since the same protocol was used for both interviews. The pre-interviews lasted 6–13 min. The post-interviews lasted 8–32 min. Semi-structured pre-interviews were conducted with nine of the ten participants. Princess was the only student to not have completed a pre-interview since she joined the class at Lesson 3. We chose to forgo completing her pre-interview since it was beyond the time restraints of the class. All of the pre- and post-interviews were video recorded and transcribed for analysis. The student-generated drawings were given number in correspondence with their interviews and scanned digitally.

4.3. Data Analysis

We sought to identify characteristics needed for engaging in STEM learning using the principles of the Black Love framework (Worsley & Tan, 2024). This meant conceptualizing the restoring, fostering, and humanizing of Blackness. We identified the Black Love framework for this data analysis since (1) Black Love focuses on integration of youth voice and interest within curriculum; (2) the subtenets of high expectations of youth's STEM expertise and ability to do rigorous STEM now, validating youth's ideas so youth see themselves as doers of STEM, and active noticing guide instruction and promotes collaboration; (3) The subtenet of active noticing includes just-in-time teaching, and culturally "STEMulating" references curricular activities that are engaging. Therefore, analyzing the implementation of the *Lotions and Potions* curriculum had to extend beyond traditional pedagogical instruction and standardized science assessment (Jencks & Phillips, 1998). Rather, the focus of the curriculum centered on hair culture and engaging in practices such as DIY product-making as part of the assessment. Collaboration and student agency are as central to Black Love as they are to culturally sustaining approaches to curriculum and assessment, as with *Lotions and Potions*. For the purposes of this paper, we focus on Tenet 1, as it closely aligns with

our focus on assessment. STEM-related onto-epistemologies are the intersections of who someone is (ontology) and how they develop STEM-related knowledge (epistemology) (Barajas-López & Bang, 2018; Tan et al., 2019). The two are inextricably tied together and are constantly working with and against each other (B. Warren et al., 2020).

4.4. Curricular Activities and Worksheets

The combined frameworks of CSP and Black Love were applied in the analysis of the curricular activity assessments in Lessons 2, 4–5, and 6. In order to assess student participation with science practices, activities from Lesson 2, Lessons 4–5, and student-generated DIY videos from Lesson 6 were used. The activities within the curriculum aligned with the life science standard as the academic success. In Lesson 2, students developed observation statements of hair patterns and a model of their hair pattern based on the figure presented in Lesson 2, the physical skin model in the room, and the synthetic hair models provided to the student. The relevance of hair typing with the observations followed the cultural competence component of CSP. Additionally, Lesson 4 presented deconstructed pieces of a scientific argument, claim and evidence, through a matching activity. This supported the verbal and written practices of engaging in scientific argumentation that was part of Lessons 5 and 6. In Lesson 5, two out of the three pair-and-share prompts led to the development of a scientific argument. The written and verbal responses of the scientific argument were coded for a claim, evidence, and reason statement. Lastly, the DIY video in Lesson 6 served as an oral presentation of students' knowledge of making a DIY product and engaging in argumentation. Treagust et al. (2001) suggest that "oral presentations are an effective way to assess students' knowledge if they are accompanied by means of interpreting responses similar to a scoring rubric" (p. 139). DIY presentations were presented as if they were oral presentations that were recorded (Wolf et al., 1991). All of the DIY videos were transcribed and coded for a scientific argument.

Following students' plurality in ways of speaking and expressing understanding, the responses in these lessons were not focused on scientific vocabulary alone, but rather, how the students engaged in observations and developed a scientific argument while participating in culturally relevant activities such as hair care. Black Love also highlights the inclusion of youth voices and interests through activities. Lastly, the focus of the assessments was to expand opportunities for science practices such as written arguments to be inclusive of verbal argument development as well. These culturally "STEMulating" curricular activities and assessments were analyzed in the sections below.

4.5. Semi-Structured Interviews

Semi-structured interviews were transcribed as they occurred. We did not analyze any of the pre-interviews until the post-interviews were completed. Each pre- and post-interview went through the first round of open, inductive coding to create a list of codes that described what was occurring within the data (Strauss & Corbin, 1990). Separating the data based on related codes was useful for organizing and retrieving meaningful pieces of the data (Coffey & Atkinson, 1996). All codes and categories developed from the pre-interview data were applied to the post-interview data; that is, deductive coding was used in conjunction with inductive coding, to generate new codes from the post-interview data (Creswell, 2013; Glaser & Strauss, 1967). Following Tucker-Raymond et al. (2007), we developed a coding scheme for the pre- and post-interviews that included (a) what was the student doing: *making/mixing* and *sharing*; (b) what the student was using: *materials* (c) the who of each activity—who was or was not part of the activity in the drawing: *collaboration*; (d) the when of each activity—when wearing or not wearing certain things: *clothing*, and how often an activity occurred: *repetition*

(see Findings for full coding scheme). The next section explores the various perceptions the students had of science activities and themselves as science-doers.

The new codes captured commonalities across the post-interviews that did not appear in the pre-interviews. Categories and themes reflecting students' perceptions of "what counts as science" were identified in order to provide an initial interpretation of potential commonalities and differences across students. Students' science drawings were coded alongside the interview transcript, since it was incorporated into interpreting how students were perceiving themselves as science-doers (Glaser & Strauss, 1967).

4.6. Positionality Statement

As science educators and researchers, we sought to explore students' perceptions of science content and themselves as science-doers before and after informal science interventions. Following Groenke et al. (2015), we wanted Black girls to be able to see themselves in science materials and texts. Intersectionality rooted in Black feminist practices and theories identifies and names matrices of oppression and how they should be addressed through equitable interventions (Carastathis, 2014; Collins, 2000). Weaving the Black Love framework into the *Lotions and Potions: Science through Hair Care* curriculum serves as one response to equitable interventions for Black girls within science/STEM spaces. We, as Black girl researchers and STEM educators, align with Butler (2018) in recognizing the ways that "Black girls—and the researchers who work with them—are attentive to the ways race, class, gender, and additional interlocking identities tied to place funnel into urban classrooms" (p. 29). Leveraging our identities and in agreement with Dotson, we argue that the ways that Black women and girls are oppressed and in which spaces should be named (Dotson, 2011). For example, this research is an example of naming STEM spaces as being oppressive and marginalizing due to Whiteness as a property within STEM education (Harris, 1993; Mensah & Jackson, 2018). Our response is to highlight standard aligned-science activities that center on Black hair and affirm hair culture.

Following King and Pringle (2019), we are positioned through this work as researchers, curriculum developers, and class facilitators. With experience in teaching undergraduate laboratory classes, designing and implementing experiential science curricula for middle students, and experience as hair and body product makers, we leveraged these experiences into one after-school program. Coupled with our identities and following, we understand this research as part of a larger movement to be inclusive of experiences and societal issues of Black girls within STEM spaces (Butler, 2018). Although we identify as Black women like the participants of our study, we are careful to attend to reflexivity and recall as a part of the research practice (Richardson, 2000). Probst and Berenson (2014) explain reflexivity as an "awareness of the influence the researcher has on what is being studied and, simultaneously, of how the researcher process affects the researcher. It is both a set of mind and a set of actions" (p. 814).

We have sought to develop a science experience for Black girls by a Black girl. Following Irizarry, this learning experience is "For Us, By Us" (FUBU), with the "Us" being a collective descriptor of Black women who have been othered, marginalized, and oppressed in STEM spaces (Irizarry, 2017). These identities are pivotal pieces of collection, understanding, and presentations of the data (Ravitch & Carl, 2019). Our identities as researchers, scientists, tinkerers, curriculum developers, teachers, and Black women are directly impacting research interests, analysis, and conclusions.

5. Results

In order to answer the first research question *In what ways were the girls' engagement within a culturally sustaining curriculum expanding assessment practices?*, we used the Black

Love Framework, to outline formative assessment results from the *Lotions and Potions* curriculum. Specifically, in the below section, we analyze findings from curricular artifacts that highlight the SEP argumentation from evidence. The curricular artifacts that were used to assess students' engagement with arguing from evidence through written (Lesson 4–5) and verbal (Lesson 5–6) formative assessments.

There were moments in the class where the author, as the teacher, noticed the girls developing a scientific argument beyond the worksheet through conversation around the assessment. Therefore, the combination of both the written and verbal responses from a student or partner group is what led to the development of a complete argument which is summarized at the end of this section. This aligns with the notion of high expectations of youth's expertise and ability to do rigorous science learning. Although some students had their voices more present in the video, all students contributed to the conversation in their videos. Driver et al. (2000) expressed that "if science is to be taught as socially constructed knowledge then this entails giving a much higher priority than is currently the case to discursive practices in general and to argument in particular" (p. 297). Although the arguments were very simple in that they did not include much elaboration, the structure of the argument was present in the discourse or writing for each group. Conversation was promoted in an effort to support students' knowledge development and engagement in SEPs. The open-ended worksheet prompts and DIY video sustained student voice and choice. More specifically, Shaun and Karesha collectively developed an argument through conversation around the prompt. Additionally, Lanna and Maci presented separate scientific arguments, but both students were afforded the opportunity through the DIY video to share their responses as to why lotion is important. This opportunity for diverse and pluralistic knowledge expression of the scientific argument was supported by the design of the assessment tool, as well as the opportunity to participate being equal for each student. The CERs for the arguments the students made were relevant and connected. None of the arguments, although not all correct, were disconnected from the subject area of the curriculum. We will discuss the importance of these findings within science and engineering education and present suggestions for future research.

5.1. Lesson 5: Pair-and-Share Activities

In Lesson 5, the girls were to choose one of three pair-and-share activities, two of which scaffolded argumentation. One prompt was for the girls to explain how to make lotion by identifying what the ingredients were for and why lotion was useful. Karesha and Shauna answered the prompt by listing the ingredients and materials used in making lotion like a recipe. Since their response did not answer the prompt fully, the author engaged the class in a conversation leading with the question "Why is lotion important?". In Excerpt 1, the girls verbally engaged in argumentation.

Excerpt 1. Conversation about why lotion is important.

1. Maci—So you won't be ashy.
2. Author—Why else is lotion important?
3. Shauna—It makes your skin moisturized.
4. Author—Why do you need your skin to be moisturized?
5. Shauna—If it's dry, it could fall off.
6. Maci—How your skin fall off?
7. Karesha—Dirt could get in it, and you will get sick.
8. Author—What happens if your skin is too dry?
9. Maci—If my skin is dry, it will crack.

From the exchange in Excerpt 1, we highlight active noticing and JiT teaching to outline several claims that were presented. Maci's claim (line 1) centered around the idea that a lack of lotion would result in "ashy" skin, while Shauna's claim (line 3) centers on lotion's presence in moisturizing one's skin, which is the content focus and claim to answer a question. The evidence used to support Maci and Shauna's claims can be found in lines 5 and 9 of the exchange. Shauna's claim for the importance of using lotion is supported by her evidence (see line 5) that without the moisture that lotion provides, one's dry skin would fall off or crack. This is an example of scientific reasoning presenting from the content in Lesson 5 from *The Science of Black Hair* regarding the lack of moisture leading to brittle and dry hair and skin. It is interesting to see how Shauna's peers also connected with this response (see lines 7 and 10) and provided additional detail to Shauna's "evidence" for the need of using lotion. In this scenario, we contend that the girls were engaged in a practice that we are calling "*collective argumentation*", where various students contributed to the development of a scientific argument using evidence. This is reliant on the JiT teaching and active noticing of the Black Love framework. Addressing the question "*why lotion is important*", this collective argument was constructed by combining three students' responses: It makes your skin moisturized (Shauna's claim, line 3); If my skin is dry, it will crack (Maci's evidence, line 9); Dirt could get in it, and you will get sick. (Karesha's reasoning line 7).

The other prompt asked the girls "*How can I make the lotion smell good?*" by presenting a scenario of a missing ingredient (Figure 3). To illustrate the girls' approaches for developing scientific argument, we analyzed and presented responses from two of the groups: Bianca/Melody and Letrice/Princess. Bianca and Melody responded to the prompt with the response of, "Put some s[c]lent in your lotion. Like peppermint, vanilla, grape, lemon, orange" (Figure 4). The components of a scientific argument that this group presented for making the lotion smell good included: *Put some s[c]lent in your lotion* (claim) *peppermint, vanilla, grape, lemon, orange* (reason). Although they did not create a complete argument, they did answer the question without stating any evidence. Their scientific reasoning of essential oils having varied scents is supported since essential oils do add sensory benefits to hair products (Davis-Sivasothy, 2011). Letrice and Princess responded by writing, "*You use essential oil to make it smell good. You can use peppermint, orange, vanilla, and more*" (Figure 5). The components of a scientific argument that this group presented were a claim, evidence, and reason. Their argument for making the lotion smell good was constructed around the following: *use essential oil* (claim) *to make it smell good* (evidence) and *you can use peppermint, orange, vanilla, and more* (reason). Letrice and Princess responded in writing using a complete scientific argument. Between both groups, the girls responded to the prompt in a complete argument.

C. Jalissa has her own YouTube channel where she makes DIY shampoos, lotions, and oils from the "Lotions and Potions" Class. How should she respond to the comment below? Prepare to share with the class.



Figure 3. Prompt C from Lesson 5 about scent.

Leave notes here: Put some sent in your lotion.
like Pepermint, Vanilla grape,
lemon, orange,

Figure 4. Bianca and Melody's response to Prompt C from Lesson 5.

Leave notes here:
You use essential oil to make it smell
good. You can use Peppermint, oranges
Vanilla, and more.

Figure 5. Letrice and Princess' response to Prompt C from Lesson 5.

5.2. Lesson 6: DIY Video Argumentation

During the last lesson of the curriculum, Lesson 6, the girls made DIY videos with their partners. DIY videos were conceptualized as a summative opportunity for assessing the girls' development of scientific arguments, specifically focusing on the inclusion of articulating a claim, the evidence for the claim, and associated reasoning within the curriculum. The students expressed evidence-based choices as they explained their choices for the design of their final product. The instructions were for students to identify how the ingredients were used in the final product of their choosing and why the product was important; however, most of the student groups only answered, "Why is your product important?" rather than focusing on individual ingredients that were part of the final product. Scientific arguments were still formed regardless of whether the groups answered both question prompts that supported the development of an argument in an effort to present structure to a process, rather than highlighting one conclusion or right answer (Cunningham & Carlsen, 2014; Mathis et al., 2017). We should also note that we were not analyzing their responses for correctness rather for completeness by identifying the claim, evidence, and reasoning within their scientific argument. An analysis of the evidence-informed choices the students made via arguments is provided in the following section (Table 2).

Table 2. Summary of the girls' full scientific arguments made in the DIY videos.

Group	Claim	Evidence	Reason
Bianca and Melody	you need oils for your hair	so it won't dry	if it dries up your hair begins to break off
Dream and Tia	you will need the lotion	if you don't have body lotion then your skin could get really dry	maybe it could crack
Lanna and Maci	make sure your hair is moisturized	if you don't your hair can fall out	[because] your scalp can be dry
	it's a good thing to keep your body moisturized with lotion	it won't be dry	so your skin won't crack . . . it won't fall and get wrinkly

5.3. Bianca and Melody

Bianca and Melody recorded a DIY video on their development of hair oil with Bianca being the leading voice in the video. Melody introduced herself and held up the ingredients and materials as Bianca talked about them. Bianca presented the argument for the group by stating, "First we're going to say you need oils for your hair so it won't dry it. And if it dries up your hair begins to break off". This group answered the question "why is hair oil important?" with the scientific argument of *you need oils for your hair* (claim) *so it won't*

dry (evidence) *if it dries up your hair begins to break off* (reason). Although Bianca led the conversation, both girls expressed support in the argument that was presented.

5.4. Dream and Tia

Dream and Tia designed a lotion for their DIY video. The girls alternated who was speaking and presented the materials and ingredients as they spoke. They answered the question of “Why is your product, hair oil, important?” with a full scientific argument. Dream said, “Hair and body lotion is important because if you don’t have body lotion then your skin could get really dry”. Tia followed her with saying “And maybe it could crack. And in the winter your skin will crack easily because it’s cold and it will make your legs or your hands get frostbite and you will need the lotion”. The claim they were making through conversation was *you will need the lotion*. Therefore, their full scientific argument as one statement is *you will need the lotion* (claim) *if you don’t have body lotion then your skin could get really dry* (evidence) *maybe it could crack* (reason). The evidence of the necessity of lotion was presented in the negative since the girls gave evidence of what would have if one did not have lotion. Also, this is another example of students participating in collective argumentation where the students worked collaboratively to present one full argument.

5.5. Lanna and Maci

Lanna and Maci also chose making lotion as the topic of their DIY video. Lanna predominantly picked up the materials and showed them to the camera until they were mixing the lotion and they took turns mixing as they did in the “Lotions and Potions” class while they were making the lotion. Their argument was presented through their conversation. Lanna said,

You want to make sure your hair is moisturized because if you don’t, your hair could crack up. Ok, no, your scalp can be dry. And your hair can fall out. Like get really hard and fall out. That’s why you need to make sure you keep your hair moisturized every single day.

Although not in order, Lanna presented a full scientific argument. To answer the prompt about why her product was important, she made the claim to *make sure your hair is moisturized*. Her evidence was in the negative of what happens when your hair is not moisturized. The evidence for the argument was *if you don’t . . . your hair can fall out*. The scientific reason Lanna gave for one’s hair falling out was *your scalp can be dry*. Therefore, her scientific argument, as one statement that answers the question “Why is lotion important?” is that lotion is important to *make sure your hair is moisturized* (claim) *if you don’t your hair can fall out* (evidence) [because] *your scalp can be dry* (reason).

Maci also presented an argument with a claim, evidence, or reason. Maci said, “It’s a good thing to keep your body moisturized with lotion so your skin won’t crack, and it won’t be dry, and it won’t fall and get wrinkly”. Her claim is *it’s a good thing to keep your body moisturized with lotion*. The evidence for her claim is also in the negative of what happens if you do not use the lotion. The evidence was *so your skin won’t crack. . . it won’t fall and get wrinkly*. The reason for this claim that you want to keep your body moisturized with lotion is *it won’t be dry*. Therefore, her scientific argument as one statement is *it’s a good thing to keep your body moisturized with lotion* (claim) *so your skin won’t crack . . . it won’t fall and get wrinkly* (evidence) [because] *it won’t be dry* (reason). Ultimately, this group made two scientific arguments separately to answer the question of why lotion is important.

In summary, three out of the five groups verbally expressed a verbal scientific argument in a DIY video (see Table 2). The two groups, Letrice/Princess and Karesha/Shaina, did not provide the importance of their products and actually presented their process as a recipe for their designed product rather than expanding on the use of each material,

ingredient, or the product as a whole. What is also important to note is that as students participate in practices of argumentation, reasoning where misconceptions arise is vital to the sense-making process, such that through collaboration, testing, and conversation, correctness can come to the forefront. Therefore, we did not evaluate the correctness of the argument, but the presence of the CER. We were leveraging the Black Love framework here, knowing the goal of the JiT teaching and broad student sense-making. Teachers should be able to support students in building new knowledge in a way that supports scaffolding and correcting answers. We are not promoting the incorrect answer. We are providing a pedagogical strategy in which, although the answer is wrong, the structure for a scientific argument is right (Table 3). It is the teachers' responsibility to notice the sensemaking efforts toward a complete and accurate CER statement. The interpretive power of teachers contributes to broader learning spaces in science (Rosebery et al., 2016).

Table 3. Summary of girls engaging in scientific argumentation.

Group	Lesson 5 Prompts			DIY Video		
	Claim	Evidence	Reason	Claim	Evidence	Reason
Bianca and Melody		written	written	verbal	verbal	verbal
Dream and Tia		N/A		verbal	verbal	verbal
Karesha and Shauna	verbal	verbal	verbal		none	
Lanna and Maci		N/A		verbal	verbal	verbal
Letrice and Princess	written	written	written		none	

In order to answer the second research question, “How did engaging in the curriculum using a Black Love framework impact Black female students’ perceptions of (a) science and (b) themselves as doers of science?”, we analyzed the pre- and post-interviews with a drawing task. The comparison of pre- and post-interviews showed that the students perceived a shift in where science practices can happen: in-school versus out-of-school (Table 3). These findings align with the Black Love Framework through validating various methods, so youth see themselves as doers of STEM. Each of the students then explained their drawings, indicating whether or not the activity happened at school or out of school. Regarding the pre-interviews, all of the students indicated that their experiences of being scientists was part of their in-school science experience. Bianca did not indicate where her experience happened in her interview. Maci, Melody, Shauna, and Tia, who all went to the same school, mentioned the in-school science program. For the post-interview drawings, all of the students indicated that their experience of being a scientist was part of their in-school or out-of-school science experience (Table 4). Only Maci mentioned an in-school experience. Maci and Shauna were the only two students who did not draw themselves as scientists in the hair care class, but they did discuss their activities during the hair care class as part of their interview.

The ways that the girls perceived science activities was also impacted based on the students’ responses before and after the “Lotions and Potions” class. In the pre-interviews, students largely referred to sharing, materials, and collaboration as their perceptions of science and themselves as science-doers. In the post-interviews, mixing and making were highlighted as a science practice the most by the girls. Nine of the ten girls highlighted the materials and collaboration as their perceived perception of doing science. Of note, only two students highlighted formally sharing information as a science practice by the end of the curriculum. Making/mixing and materials were the most consistently mentioned for the students before and after the curriculum intervention. The students expressed an expansion in their perceptions of what scientists do and what materials scientists use from before to after the completion of the *Lotions and Potions* class.

Table 4. Location of where students drew themselves participating in science during pre- and post-interviews.

Participant	Pre-Interview		Post-Interview	
	In-School	Out-of-School	In-School	Out-of-School
Bianca		not applicable		X
Dream	X			X
Karesha	X			X
Lanna	X			X
Letrice	X			X
Maci	X		X	
Melody	X			X
Princess		not applicable		X
Shauna	X			X
Tia	X			X

Regarding mixing and making practices (referred to as *making* in Table 5), before the class, three students, Bianca, Letrice, and Shauna, perceived making as part of their science experience and highlighted mixing and making as science practices. By the end of the class, all ten of the girls indicated that making and mixing are practices that scientists participate in. Before the class, five students, Dream, Karesha, Melody, Shauna, and Tia, indicated that sharing information was a practice that science-doers participate in. After the class, only two students, Melody and Shauna, perceived sharing information as a science practice. Before the class, five students, Lanna, Letrice, Maci, Melody, and Tia, recounted a time when they worked with a partner and collaboration was part of their science experience, although the students participated in conversation across the table and with their partners. After the class, nine students, all of the girls except Bianca, indicated that collaboration was a part of their science experience. Before the class, five students, Bianca, Dream, Lanna, Letrice, and Shauna, mentioned the materials as being part of their experience as science-doers. After the class, nine students, all except Melody, focused on the materials as a part of their perceptions of what scientists do and use. Before the class, one student, Shauna, referenced the clothing worn as they were engaging in science-doing. After the class, six students, Dream, Karesha, Lanna, Maci, Shauna, and Tia, highlighted clothing as part of science-doing and themselves as scientists. Lastly, before the class, two students, Shauna and Tia, indicated that repeating a project or process was part of their science experience. After the class, four students, Lanna, Maci, Princess, and Shauna, highlighted that repeating a process was part of their self-perceptions as scientists.

In summary, students were expanding their perceptions of themselves as scientists, and science practices, after their experience with the hair care curriculum. Although no students indicated sharing, clothing, or collaboration as a part of their science experience during the class, all of the students expanded their initial perceptions of themselves as science-doers, including themselves as part of their perception of science. The next section highlights the students' shift in science perceptions and themselves as science-doers through their pre- and post-images and interviews. Through these interviews, the active noticing and JiT teaching is mentioned. Additionally, the ways a majority of the students highlighted the *Lotions and Potions class* indicates how DIY haircare is a culturally STEMulating skill. Examples of two student responses are below.

Table 5. Description of codes from pre- and post-interviews.

Code	Code Description	Example
Making/Mixing	Making and mixing things to create a product are science practices including references to DIY activities.	“Yes because they mix up chemical to make hair care supplies.”
Sharing	Telling someone information about science is a science practice.	“Telling people what the weather is going to be and how it’s going to be like.”
Materials	Using various materials such as chemicals is a science practice.	“Yes because you can experiment (experiment) with different materials.”
Collaboration	Working with a partner(s) to complete the science activity.	“Me and my partner and other people and their partners were making stuff.”
Clothing	Lab coats and/or goggles as part of the identity of a scientist.	“Because scientists wear the lab coats with the science thing and glasses and stuff.”
Repetition	Doing something multiple times is a science practice.	“Scientist is people who make their own do it your self and people who do things over and over again.”

5.6. Individual Perceptions of Science

Dream. In the pre-interview, Dream conceptualized herself as a scientist when she had to do a school project as a weather reporter (see Figure 6). Her perception of herself as a scientist included her sharing, identifying materials, and repetition. Her ability to share about the weather was what she considered a scientist to do. She shared science by “Telling people what the weather is going to be and how it’s going to be like”. She said that telling others the weather was important “So people can know how to dress. So they wouldn’t dress in summer clothes when it’s cold and wouldn’t dress in winter clothes when it’s hot”. The materials she highlighted as “scientific tools” included a “weather balloon” and “thermometer”. However, from her interview, she did not use those tools. She watched people release weather balloons and use “a whole bunch of computers and monitors” to share weather conditions. Dream did not have the experience of using the described “scientific tools” to report the weather. However, sharing the weather report regardless of using the tools was still a scientific practice. She also mentioned that she had done this particular activity “a few times”, making it a repeated activity. Dream’s pre-interview drawing gave the insight that sharing the weather report using various materials over multiple times is what a scientist does. In the post-interview, Dream presented herself as a scientist when she made lotion in the Lotions and Potions Class (see Figure 7). She identified making/mixing, materials, clothing, and collaboration as part of her science experience.

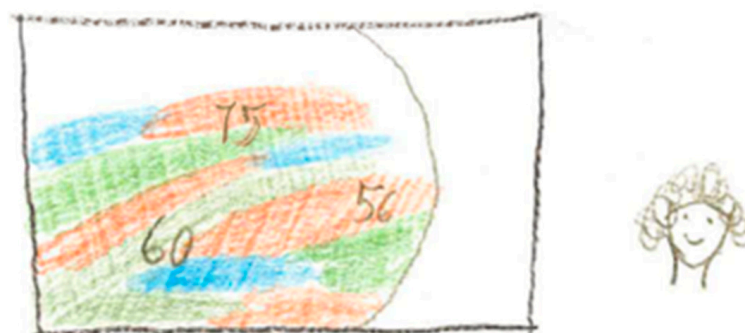
**Figure 6.** Dream’s pre-interview drawing of herself reporting the weather.



Figure 7. Dream's post-interview drawing of herself making lotion.

In Excerpt 2 from the interview transcript, Dream shares how making/mixing using different materials, collaboration, and clothing are part of her science experience. In line 1, Dream moved between identifying various materials and mixing those materials to make her lotion product. In lines 3–8, she listed the various materials she used while she was being a scientist while making lotion. In lines 9 and 11, Dream was explicit that doing the mixing and making yourself makes you a scientist. What was particularly important for Dream was the ability to be a scientist by engaging in the investigation personally. Dream responded to how she was being a scientist with “So how I was being a scientist is if you’re working on something and basically put effort into it and try to make it yourself, I think that’s considered being a scientist”. She believed her involvement with the process made her a scientist. This contrasts with her pre-interview drawing, where she did not use the materials to be a science-doer.

Excerpt 2. Dream on how making/mixing and materials are used in science.

1. Dream—What I did was show how we made our lotion. First we got the shea butter and put it in a bowl and mashed it up a little bit. Then we blended it with the hand mixer. Then we added castor oil first. Then we blended it again. Then we added the olive oil and we blended it again. Then we added the coconut oil. And you know, we blended it again. Then we mixed it up and made sure all of the chunks was out. Then we put it into 2 containers because I was working with another person. And we wrote our names on it so we wouldn’t get it mixed up. Then we added our scents. And my scent was orange and peppermint. But you can’t really smell orange. Only peppermint.
2. Likely—What are these things in the picture?
3. Dream—These are the cups. Kind of how much to put inside each of them.
4. Likely—So it’s the cups of oil with the labels on it? And this is your lotion
5. Dream—Yes
6. Likely—And?
7. Dream—The hand mixer and me in the corner
8. Likely—Tell me about how you were being a scientist in this drawing?
9. Dream—Because I was doing my own little DIY and was making it myself
10. Likely—And that’s how you were being a scientist? Say some more.
11. Dream—So how I was being a scientist is if you’re working on something and basically put effort into it and try to make it yourself, I think that’s considered being a scientist. Because you have to make sure you have the right amount and if you do put too

much, you have to balance it out. Scientists they observe things. What I observed in my lotion was the smell and the texture. You could put it on your hand and it would be a cream, but if you left it on too long, it would turn into a liquidy thing.

Regarding clothing, Dream identified the “lab jackets” as scientific. She said “A lot of people use lab jackets. The lab jackets—you use them to protect yourself from hot things or if something happens, you don’t want to get it on yourself”. The way Dream used the lab coat as protection validated the lab coats’ functionality as scientific. Although she wore the safety glasses, she did not mention them as part of her science experience.

Dream included collaboration also as her perception of science. Although she did not draw her partner, she did use “we” and “our” to explain how she made the lotion with her partner. Also, Dream discussed value of working with someone else. She said “Because if you only work by yourself, you wouldn’t see it from another person’s eyes.... If you work with them it would make not everything easier but the person will make you end up seeing it how they see it”. Dream perceived science in collaboration with other as a way to expand one’s perspectives.

Karesha. When asked to draw a time that she was a scientist, Karesha drew herself in her 5th grade science classroom (see Figure 8). Her perception of herself as a scientist was to share with other students safety instructions about handling dry ice. When asked how she knew the information about the dry ice to share with other students, she shared that she repeated what the science teacher told her to say (Excerpt 3). She did not research any of the information about dry ice to share with her classmates or inform how she handled the chemical. She was acting as a helper to the teacher rather than researching and synthesizing any information about the dry ice. Although Karesha saw her efforts as important to the safety of those in classroom, she did admit to being told what to say from the teacher. Although sharing safety tips about dry ice was very important to the classroom, this experience was not indicative of her understanding of dry ice. Rather, her ability to repeat instructions from her teacher to her classmates resonated with her as a science-doer. In an effort to further understand Karesha’s experience in her science classroom, I asked if she worked with the dry ice with one of the groups she told me about. She responded with “I was just walking around and seeing stuff. Passing out the ice”. Karesha further solidified her recollection of a science-doer as a helper in a science classroom by sharing information directly from the teacher to her class. Ultimately, she felt that she was actively engaged in doing a science practice.

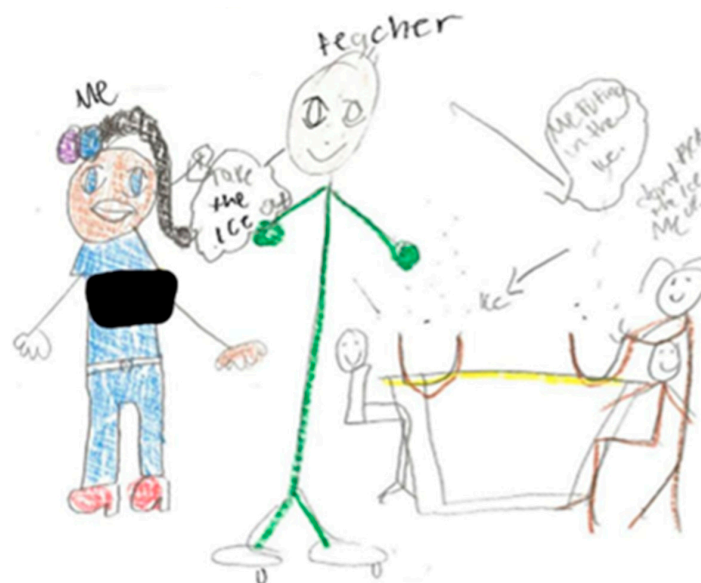


Figure 8. Karesha’s pre-interview drawing of herself in the science classroom.

5.7. Excerpt 3: Karesha Talking About the Dry Ice

1. Author—can you tell me about your picture please?
2. Karesha—So here's my teacher telling me to take the ice out. Here's me. Here's the group and table I was at. And I told the kids "don't pick up the ice". This was me and the ice and the cup. This was his and it was already going up and bubbling and stuff.
3. Author—Tell me about how you were being a scientist in this picture?
4. Karesha—I was pulling out the equipment and telling them about the dry ice and where it came from.
5. Author—And that's what scientists do? They take out the equipment?
6. Karesha—Yes
7. Author—Did you already know about the dry ice?
8. Karesha—He told me about it. He told me what to say.

After the Lotions and Potions Class, Karesha drew herself making soap (see Figure 9). When asked about her picture and how she was being a scientist, Karesha gave an account of mixing/making, the use of different materials, clothing, and collaboration.

This is me, it's like soap. That's me scraping it off. That's me pouring the soap into here. That's me pouring the oil into here. And there is the hot water we poured into here...I was holding the bowl and pouring the stuff.

When asked why scientists do the things she drew, Karesha's response was "Because that's what scientists do. They like to make their own stuff. They like to experience a lot". Karesha's conceptualization of a science-doer included the activity of making. The materials Karesha mentioned using were the bowl, African black soap, spatula, and oil. She also highlighted certain clothing in her picture "because scientists wear the lab coats with the science thing and glasses and stuff". Lastly, her perception of science included her partner, although she did not draw her. She used the conversations with her partner and people in the class to help her "because some things I don't know and somethings people do know and it would be fun for them to tell me". Karesha saw her collaboration as a way to know more than what she knew herself. On working with others beyond her partner, she said "we just worked together. . . The people in the class were nice. They weren't mean or judgmental. It was cool".



Figure 9. Karesha's post-interview drawing of herself making lotion.

6. Discussion and Conclusions

Youth are more engaged with STEM-based projects when they feel connected and it is something they want to do (Calabrese Barton & Tan, 2018; Mensah, 2011). Diversity in representation through the curriculum is important to students' feelings of inclusion and in direct opposition to students being pushed out (Ford & Harris, 2000; Morris, 2016).

Through disruption of settled hierarchies within science learning through the curriculum, assessments, and instruction, we have presented a STEM learning space that shifts what language and activities are seen and recognized as meaningful within science. Using an asset-based approach to assessment and evaluation promoted students' engagement in understanding a process instead of effective memorization (Erduran & Jiménez-Aleixandre, 2007; Evagorou et al., 2015). Following Randall and colleagues, we are presenting an approach to assessment that considers and incorporates student culture as part of the curriculum and assessment in an effort to impact self-perception (Randall et al., 2023).

Our goals for science assessments are in line with Randall "I argue that the foundational assessment design's commitment to neutrality—operationalized by our fierce eradication of anything that could be considered "construct-irrelevant variance"—is, in effect, sustaining the inherent Whiteness-as-superior bias of our assessment design practices. We need to first reimagine how we define constructs so that Whiteness is decentered, and then we need to design assessments accordingly" (Randall, 2021, p. 84). The *Lotions and Potions* curriculum centers on a culturally diverse approach to science learning that also required expanded assessments. This inclusion is meant to see student populations from "differentiated backgrounds, abilities and understandings regarding science" through an asset-based approach rather than "well aligned with monolingual mainstream testing" (Cardozo-Gaibisso et al., 2020, p. 860). Within the culturally sustaining framework, students' knowledge was honored as important and valuable to the science experience beyond the binary of right and wrong. Likewise, multimodal opportunities can raise sensitivity for the diversity of students. Rather than continue with ready-made templates for SEPs that are foundationally placed in rigid structures of binaries of right and wrong, like argumentation, we have presented an example of expanding the expression and evaluation of SEPs. Additionally, through a culturally sustaining approach, we have presented more ways that students' ideas shift about collaboration within science, where science occurs, and what science-doing can look like, including DIY hair products. As noted in the literature review, the collaborative nature of the SEPs is often not assessed, or the focus of learning further marginalizing minoritized students. (Aschbacher et al., 2010; Calabrese Barton & Yang, 2000; Mathis et al., 2017; National Academies of Sciences, Engineering, and Medicine, 2024). By integrating their interests into their STEM practices, they make their projects their own. In formal settings, science tends to be taught traditionally, which can lead youth of color to not be interested or identify with STEM (Calabrese Barton & Tan, 2018; Gutiérrez, 2008; Mensah, 2011). This curriculum created an opportunity for students to reauthor rights by developing agency within a STEM learning space (Calabrese Barton & Tan, 2020).

Although not generalizable, larger implications of this research are for cultural processes such as verbal expression of knowledge to be treated and acknowledged as assets for evaluation of learning (Bang & Medin, 2010). We recognize the necessity in reimagining measurement in learning to be "open to the transformations of the uncompressible infinities of blackness" (Dixon-Román, 2020, p. 96). We have presented an experience that supports cultural processes as assets, promotes conversation for science sense-making, and does not require assimilation or the removal of cultural signifiers while participating in SEPs (Bang & Medin, 2010; Brown & Campione, 1994; Engle & Conant, 2002; Hand et al., 2012; Higgins, 2016). We have provided an example of a learning experience where Blackness could thrive and be celebrated as a racial counterspace within science learning (C. A. Warren & Coles, 2020). Future studies point toward expanding not only pedagogical practices but also curricular adjustments, particularly with a focus on expanding culturally relevant activities around SEPs, including evaluating how SEPs are applied differently in science and engineering curricula, respectively (Bang et al., 2012; Cunningham & Carlsen, 2014; Rosebery et al., 2016; Stephenson Reaves et al., 2022).

Rather than continuing to limit the assessment of engaging in SEPs to writing, we used multimodal assessments presented to students from minoritized communities with more sense-making opportunities through various evaluation tools (Kohn, 2000; Ladson-Billings, 2006). Lastly, alternative assessment strategies such as oral assessment would also repair a large breach in reconnecting oral practices (Abdi, 2012) with societies whose traditions have been labeled as ineffective and insubstantial compared to colonized forms of assessment, such as high-stakes testing. We have made visible the ways in which students can engage in SEPs using a culturally sustaining approach to assessment. We consider it pivotal to incorporate relevant activities for marginalized and minoritized students through which science and engineering practices can be evaluated using a culturally sustaining framework.

Author Contributions: Conceptualization, R.L.; methodology, R.L. and T.W.; software, R.L.; validation, R.L.; formal analysis, R.L.; investigation, R.L.; resources, R.L.; data curation, R.L.; writing—original draft preparation, R.L. and T.W.; writing—review and editing, R.L. and T.W.; visualization, R.L.; supervision, R.L.; project administration, R.L.; funding acquisition, R.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of Drexel University (protocol code #1710005695 and 4 November 2019).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

Conflicts of Interest: The authors declare no conflict of interest.

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