

Re-Envisioning the Culture of Undergraduate Biology Education to Foster Black Student Success: A Clarion Call

Terrell R. Morton,^{1*} Wesley Agee,² Kilan C. Ashad-Bishop,³ Lori D. Banks,¹ Zanethia Choice Barnett,¹ Imari D. Bramlett,⁴ Briana Brown,⁵ Walter Gassmann,⁶ Korie Grayson,⁷ Gail P. Hollowell,⁸ Ruth Kaggwa,⁹ Gaurav S. Kandlikar,¹⁰ Marshaun Love,¹¹ Whitney N. McCoy,¹² Mark A. Melton,¹³ Monica L. Miles,¹⁴ Catherine L. Quinlan,¹⁵ ReAnna S. Roby,¹⁶ Checo J. Rorie,¹⁷ Tatiane Russo-Tait,¹⁸ Ashlyn M. Wardin,¹⁹ Michele R. Williams,²⁰ and Ashley N. Woodson²¹

¹Department of Educational Psychology, University of Illinois Chicago, Chicago, IL 60607;

²Department of Molecular and Cell Biology, Washington University in St. Louis School of Medicine, St. Louis, MO 63110; ³Miller School of Medicine & Sylvester Comprehensive Cancer Center,

University of Miami, Miami, FL 33136; ⁴Department of Biology, Prairie View A&M University, Prairie

View, TX 77446; ⁵USDA Forest Service, Oxford, MS 38655; ⁶Division of Plant Sciences and

Technology, University of Missouri, Columbia, MO 65211; ⁷Re-Envisioning Culture Network,

Atlanta, GA 30331; ⁸Re-Envisioning Culture Network, Washington, DC 20059; ⁹Department of

Biological and Biomedical Sciences, North Carolina Central University, Durham, NC 27707;

¹⁰Donald Danforth Plant Science Center, St. Louis, MO 63132; ¹¹Center for Child and Family Policy,

Duke University, Durham, NC 27708; ¹²Department of Biological and Physical Sciences, Saint

Augustine's University, Raleigh, NC 27610; ¹³Department of Engineering Education, University

of Buffalo, Buffalo, NY 14260; ¹⁴Curriculum & Instruction, Howard University, Washington,

DC 20059; ¹⁵Margaret Cuninggim Women's Center, Vanderbilt University, Nashville, TN 37240;

¹⁶Department of Biology, North Carolina Agricultural and Technical State University, Greensboro,

NC 27411; ¹⁷Department of Cellular Biology, University of Georgia, Athens, GA 30602;

¹⁸Institutional Advancement, Albion College, Albion, MI 49224; ¹⁹Institute for Informatics,

Data Science & Biostatistics, Washington University in St. Louis School of Medicine, Saint Louis,

MO 63110

ABSTRACT

The purpose of this paper is to present an argument for why there is a need to re-envision the underlying culture of undergraduate biology education to ensure the success, retention, and matriculation of Black students. The basis of this argument is the continued noted challenges with retaining Black students in the biological sciences coupled with existing research that implicates science contexts (i.e., the cultural norms, values, and beliefs manifesting through policies and practices) as being the primary source of the challenges experienced by Black students that lead to their attrition. In presenting this argument, we introduce the Re-Envisioning Culture Network, a multigenerational, interdisciplinary network comprised of higher education administrators, faculty, staff, Black undergraduate students majoring in biology, Black cultural artists, community leaders, and STEM professionals to work together to curate and generate resources and tools that will facilitate change. In introducing the REC Network and disseminating its mission and ongoing endeavors, we generate a clarion call for educators, researchers, STEM professionals, students, and the broader community to join us in this endeavor in fostering transformative change.

INTRODUCTION

There exists a body of research that is dedicated to exploring and understanding factors that influence undergraduate students' retention and matriculation in Science Technology Engineering and Mathematics (STEM) disciplines (Chang *et al.*, 2014;

Mark Barsoum, *Monitoring Editor*

Submitted Sep 13, 2022; Revised Aug 7, 2023;

Accepted Sep 20, 2023

CBE Life Sci Educ December 1, 2023 22:es5

DOI:10.1187/cbe.22-09-0175

*Address correspondence to: Terrell R. Morton (mortont@uic.edu).

© 2023 T. R. Morton *et al.* CBE—Life Sciences Education © 2023 The American Society for Cell Biology. This article is distributed by The American Society for Cell Biology under license from the author(s). It is available to the public under an Attribution–Noncommercial–Share Alike 4.0 Unported Creative Commons License (<http://creativecommons.org/licenses/by-nc-sa/4.0>).

“ASCB®” and “The American Society for Cell Biology®” are registered trademarks of The American Society for Cell Biology.

Riegle-Crumb *et al.*, 2019). Scholars investigating these phenomena note that students from groups that have been historically and contemporarily excluded due to their social identities (i.e., Black Americans, Native Americans, and Latinx populations) are disproportionately underrepresented and underserved, thereby having lower retention and matriculation rates (NASEM, 2023). Studies on undergraduate student retention implicate various factors that could lead to attrition such as feeling isolated, tokenism, lack of mentorship, financial resources (Estrada *et al.*, 2016; Seymour *et al.*, 2019; Turner *et al.*, 2022). When considering the research specifically focused on Black student retention, particularly within undergraduate biology education (UBE), there are vexing trends that tell interesting stories.

Despite increases in Black student enrollment in four-year institutions, increases in Black students' expressed interest in majoring in Biological Sciences, and increases in overall Bachelor degrees awarded in Biological Sciences, the percentage of Bachelor's degrees in Biological Sciences awarded to Black students has remained consistently low around 8.5% from 2000 to 2019 (National Science Board, 2022). Here the biological sciences are defined as programs that attend to the study of biology and nonclinical biomedical programs. This definition is based on the National Center for Education Statistics, the source of the data referenced within the National Science Board report.

Scholars investigating this phenomenon implicate identity and the culture of the academic environment among the core concepts that account for the challenges ascertained. Identity can be defined as how a person names and understand themselves within various contexts and among various groups (Tatum, 1997; Kirk and Okazawa-Rey, 2018). As such, identity, within the context of this paper, reflects not only how Black students name themselves (e.g., race, gender, sexuality) but what those identities mean within society and science contexts (Morton and Parsons, 2018). This includes how they define and understand science, science exploration, and science innovation in relationship to how they position themselves.

For example, in exploring the experiences of students enrolled in an introductory undergraduate biology course at a Historically Black College and University (HBCU), Quinlan *et al.* (2021) delineated the components of self-efficacy and identity that impacted student persistence. They note that questions related to culture, expectancy, and whether students saw themselves as a scientist were important for student persistence. This example points to the role that institutional and classroom culture play on students' persistence. It also acknowledges the role students' perceptions of their self-efficacy inform their persistence. Self-efficacy is among the various concepts explored when investigating identity and STEM persistence (Robnett *et al.*, 2015).

Diving deeper into how science, institutional, and classroom cultures inform Black students' experiences, scholars report that science spaces are dominated by white and Asian men, present as competitive learning environments, and promote objectivity, individualism, and elitism as core cultural ideals (McGee and Martin, 2011; Seymour and Hewitt, 1997). These cultural norms, values, beliefs, and practices reflect a Western, Eurocentric ideology of science (Harding, 1992; Aikenhead, 2002), the dominating cultural ideology of science that exist. This dominating culture of science manifests through the academic environment, including the norms and practices transpiring within classroom, research, and common spaces.

The dominant cultural ideologies of science manifesting through academic and laboratory spaces directly impact how Black students perceive and understand their ability to explore and meaningfully engage in science (Martin-Hansen, 2018; Morton, 2021). When specifically examining the dominant cultural ideology of science manifesting within the biological sciences, scholars disclose that students may disengage from biology due to historical and contemporary ways in which biology has been motivated by and used to promote anti-Black ideas such as evolutionary biology and genetics as a justification for eugenics and race superiority (Brown and Mutgei, 2010; Graves, 2019).

Scholars note that within STEM spaces, Black students perceive their identity (e.g., race, race-gender, ethnicity, culture) to constitute strength and resilience given the culture of STEM (e.g., norms, practices, beliefs, and values) that situates them as deficient, inferior, and renders alienating and isolating learning environments for them (Morton and Parsons, 2018; Miles *et al.*, 2020). Black students' identity, their understandings of themselves as Black, shapes and informs their thoughts and behaviors about their participation and engagement within science courses and labs, where their perceptions of the science classroom culture inform their identity conceptualizations (Morton *et al.*, 2019). Given the existing statistical and ontological data about Black student experiences, and our collective desires to foster racially just science learning environments for Black students, in this paper we present an argument for analyzing and readdressing the dominant cultural ideology of science manifesting within UBE.

Critiquing the culture of the biological sciences and its implications for Black student experiences and outcomes, we argue, can lead to a re-envisioning of this culture and a deeper inclusion and improved retention of Black students. We propose that focusing on these cultural aspects necessitates a fundamental reorientation of efforts aimed at improving Black student experiences as existing programs focused on perceived deficiencies of students and operating with incremental and additive measures have shown limited efficacy. Additionally, accounting for scholarship that unpacks the racialized, politicized, and militarized approaches to science (e.g., Vossoughi and Vakil, 2018; Vakil and Ayers, 2019), we propose that focusing on re-envisioning the culture of science can lead toward science education, praxis, and innovation that advances a justice-oriented public good (e.g., McGee, 2020). As steps towards our goal, we first leverage anti-Blackness (Dumas and Ross, 2016) to articulate how the culture of the biological sciences is anti-Black. We then describe the establishment and purpose of the Re-Envisioning Culture network and how we see the work coming from this space helping to address anti-Blackness in biology by re-envisioning culture and praxis. We then end with a clarion call to our colleagues, presenting ideas for how they too can join us in this endeavor to re-envision the culture of science as a strategy for fostering Black students' success and holistic well-being.

WHY RE-ENVISION THE CULTURE OF UNDERGRADUATE BIOLOGY FOR BLACK STUDENTS

Given the current and future socio-political context of learners, teachers, and overall society, it is worth noting how the continued perpetuation of dominant discourses within the context of undergraduate biological science is ultimately a disservice for

humanity at large. Continuing to privilege and position Western, Eurocentric, white-supremacist science knowledge does little to fully embrace or make room for diverse learning and ways of knowing (Mensah and Jackson, 2018). Privileging and positioning Eurocentric, white-supremacist science knowledge as the universal way of knowing and doing science has resulted in stagnation among STEM innovation and possibilities (McGee, 2020). As such, it is not nearly enough to continue to bridge students into STEM disciplines for the sake of participation, or to fulfill quotas of diversity (NASEM, 2023). These practices not only limit the possibilities of STEM, but they also can have negative impacts on Black students' success and overall well-being (Holly and Quigley, 2022; Morton *et al.*, 2019). These actions are particularly problematic given that Black students' ways of knowing and learning are currently not integral to the learning context in ways that disrupt normative science cultures or prompt new re-envisioned approaches to learning and the practice of science (Basile and Lopez, 2015; Quinlan, 2021; Roby *et al.*, 2022).

Culture of Science

Scholars exploring the experiences of Black students illuminate the exclusionary culture of science. Culture is defined as the norms, values, and beliefs of science disciplines as perpetuated by the structures of science contexts, and as interpreted by science participants (Parsons and Carlone, 2013). Science culture favors and privileges white male students thereby fostering alienating and isolating learning environments for Black students (Mutege, 2013). Science is perceived to be an ideal meritocratic system (Merton, 1957) that is, opportunities are distributed to all fairly, based on individual effort, talent, and achievement. Objective measures of performance and ability in science tout beliefs or being color- or identity-blind (Russo-Tait, 2022). However, this perspective does not consider systemic oppression and how it differentially operates on individuals given differences in their race, gender, and other social identities (Harding, 2008; Bonilla Silva, 2014).

Scholars argue that scientists undergo a process of socialization that supports the development of specific ontological and epistemological standpoints that facilitate the formation of these beliefs (Aikenhead, 1996; Carlone and Johnson, 2007). For example, the ontological position of objectivity, combined with the epistemological valuing of "the scientific method", allows for scientists to believe that, if they are objective in relation to their experimental studies, they are equally as objective in their treatment of people (Posselt, 2020). But, of course, scientists are people and are just as vulnerable to hegemonic messages about who is smart and who can succeed, especially in science. And research abounds on how anti-Blackness and racism occurs in STEM spaces (e.g., Bullock, 2017; Cedillo, 2018; Le and Matias, 2019).

Science is not color-blind, nor objective or apolitical (Harding, 1994; Atwater *et al.*, 2013). Further, imposing color-blind ideals work to erase diverse identities, cultures, and lived experiences, and positions white middle-class experiences as "universal" (Bonilla Silva, 2014; Dunac and Demir, 2017).

This approach creates the expectation that those from non-white backgrounds and cultures must assimilate to white, Eurocentric standards to successfully navigate science spaces (Morton and Nkrumah, 2021; Wright and Riley, 2021). In this

way, Black students are unable to bring their authentic selves into science spaces and must code-switch and manage stereotypes to persist (McGee, 2016). The science ethos of individualism and competition further excludes Black students, as research notes that Black students value collaboration and tend to explore postsecondary science given altruistic or equity-focused goals (Garibay, 2015; McGee and Bentley, 2017; Morton *et al.*, 2019). Black students who are passionate about science because they hope to use it as a tool to give back and support their communities are then discouraged from pursuing and remaining in science (Garibay, 2015; McGee and Bentley, 2017).

Black Student Experiences in Science

Black student experiences in UBE have both changed and remained the same over the years. The determining factor that has influenced the extent to which Black student experiences have shifted but yet remained the same is racism and the discriminatory practices that occur because of it. Historically, racism has operated in explicit and direct mechanisms to regulate Black student experiences in science (Brown and Mutege, 2010; Parsons, 2014). This includes perpetuating beliefs that Black people were inferior and incapable of engaging science learning and research and therefore discrediting their research (Graves, 2019; Prescod-Weinstein, 2020) as well as explicit forms of segregation that restricted Black people's access to high-quality educational resources that could be used to explore and understand the natural world. Such explicit forms of racism have led to Black students being prevented from studying science, not having access to the necessary resources that support full science engagement, and enduring hostile, toxic, and traumatizing experiences within science learning spaces (McGee and Bentley, 2017; Cedillo, 2018).

Contemporarily, we find the same outcomes for Black students in science; what differs is how racism manifests within science learning spaces. Racism in science manifests through both overt actions and covert or subtle actions often noted as racial microaggressions (McGee, 2016). These actions include belittling jokes, being ignored by peers, being falsely accused of cheating, or being laughed at by professors (Madden *et al.*, 2019; McGee, 2020). Racial microaggressions appear within science spaces through enacted policies and cultural practices that make it so that Black students must prove their intellectual abilities, and science capabilities to their peers and professors to demonstrate that they too are scientists (Grossman and Porche, 2013; Miles *et al.*, 2019). This experience prompts feelings of disconnection and a lack of belonging in science for Black students (Leath and Chavous, 2018; Jones, 2019).

Black students frequently express being disconnected and a lack of belonging from science for several reasons: being rendered invisible, having their voices silenced, and being alienated by their peers, professors, and other professionals (Solorzano *et al.*, 2000; Carlone and Johnson, 2007; Dortch and Patel, 2017). Black students feel invisible within science when the content presented in their science classes do not reflect their interests, realities, or communities (Leyva *et al.*, 2022). Invisibility also occurs through faculty members' pedagogical practice as Black students are often overlooked within scientific discussions (Malone and Barabino, 2009). Black students' interactions with non-Black peers also prompt feelings of alienation and isolation as many Black students disclose that non-Black students avoid

sitting next to them or do not choose them to be their partners on group work (Morton *et al.*, 2019; Miles *et al.*, 2020). In the instances when Black students do work with non-Black students in groups, Black students find their voices being silenced within groupwork, as peers often refuse to meaningfully engage them or consider their perspectives within shared assignments (Green *et al.*, 2019; Morton *et al.*, 2019). Black students also feel silenced when their ideas are not appropriately scaffolded by faculty within classroom discourse on science topics.

Overall, these experiences function as stressors for Black students, positioning science and science learning environments as racially hostile and traumatizing (Morton *et al.*, 2019; Watkins and McGown, 2022). As a result of these experiences, Black students' current success in STEM is predicated upon the various coping mechanisms they engage to navigate their STEM spaces (McGee and Martin, 2011; Brown *et al.*, 2016; Ferguson and Martin-Dunlap, 2021). These coping mechanisms require additional effort and energy on their part to endure the various challenges that they face.

Institutional Differences

In considering Black student experiences within undergraduate science learning environments, it is important to acknowledge the role of the institutional context. Research on or including Black students may draw from Historically Black Colleges and Universities (HBCU) or Predominantly White Institutions (PWI) settings. There is an emerging body of scholarship that explores Black student STEM experiences as Hispanic Serving Institutions (Choi *et al.*, 2023).

Scholars who specifically focus on HBCU contexts discuss the various forms of social and cultural capital that an HBCU learning environment offers Black STEM students (Toldson, 2018; Morton, 2021). As well, scholars investigate how these spaces influence Black students' persistence and decision-making (Quinlan *et al.*, 2021; Williams & Taylor, 2022). This includes but is not limited to racially affirming learning spaces, faculty, and support staff who employ ethics of care, and like-self peers who offer strong social networks (Perna *et al.*, 2010; Morton, 2021). While HBCUs are reported to offer these resources and more, scholars also note the various challenges Black students experience at HBCUs given limited resources, politics of respectability, and generalist presumptions about Black identity and Black student needs given beliefs about a universal, monolithic Black experience (Toldson, 2018, 2019). Despite the varied experiences, HBCUs are still responsible for almost half of Black STEM graduates, 24% of STEM bachelor's degrees, 25% of Black biology undergraduates, and approximately 30% of Black STEM doctoral degrees (Toldson, 2018; Wondwossen, 2020; Graham, 2021; NSF, 2023). HBCU's have effectively served a large portion of the United States' Black professionals, cultivating a lasting culture that has been shown to be extremely successful in producing some of the nation's most prominent minds. Furthermore, HBCUs are the only higher education institutions in the United States whose missions and plans were designed with the expressed goal of meeting the needs of Black people.

Researchers exploring Black student STEM experiences at PWIs outline the various challenges and traumas they face, associating these experiences with overt and covert forms of racism that manifest (McGee, 2016; McPherson, 2017; Rankin

and Thomas, 2020). Black students are reported to experience alienation, isolation, invisibility, and hypervisibility within their learning experiences (Hurtado *et al.*, 2007; Winkle-Wagner and McCoy, 2016). Such experiences prompt Black students to engage in various coping and resistance strategies to mitigate or combat the experienced hostility (McGee and Martin, 2011; Morton *et al.*, 2019). These strategies vary from creating or participating in counter-spaces, spaces designed with the specific intention of elevating and empowering Black students, to engaging various forms of help-seeking behaviors such as pursuing external mentorship or relying on family and peer networks (Ortiz *et al.*, 2019; Stanton *et al.*, 2022). Scholars invested in Black student success at PWIs note the various structural changes and programmatic supports necessary to facilitate and promote Black students' well-being (Lane, 2016).

Summary

Taken together, the existing scholarship that investigates Black student experiences in STEM, science, or biology, more specifically attend to the challenges and sources of support present within their learning experiences. These challenges and sources of support and their impact on Black students' decisions, behaviors, and outcomes are connected to structural and systemic racism or gendered racism manifesting through the culture of science and the various institutional contexts. Given our position as the REC Network and our goals to re-envision the culture and context of UBE for Black students, we take a critical approach to examining the existing research on Black student experiences. Our critical approach is informed by anti-Blackness (Dumas and Ross, 2016) as a conceptual framework. Leveraging this perspective, we attend to how the culture and praxis of science in undergraduate biology foster realities that promote Black suffering and trauma. In framing Black student experiences in undergraduate biology through an anti-Black ideology, we present an opportunity for the biological science community to both see and target for change the existing perspectives and practices that promote a detrimental impact to Black students' learning, engagement, success, and overall well-being.

LEVERAGING ANTI-BLACKNESS TO CRITICALLY EXAMINE UNDERGRADUATE BIOLOGY EDUCATION

Existing research indicates that the culture of science privileges and favors white male students given that the culture of science is rooted in a culture of whiteness (Bullock, 2017; Le and Matias, 2019; Prescod-Weinstein, 2020). Whiteness, as a cultural phenomenon, attends to how the concepts of normality and the associating beliefs and practices that continually reference or uphold it are based in the fundamental belief that the white, cis-gendered, able-bodied, middle to high class man, their way of life, and their understanding of reality, is the presumed standard (Wright and Riley, 2021). In noting the specific implications of whiteness and oppression on the Black body and Black experiences, scholars generated anti-Blackness as a conceptual framework to focus on Black existence and the degree to which structural oppression intentionally targets Blackness (Hartman, 2007; Dumas and Ross, 2016).

Anti-Blackness is defined as the "embodied lived experience of social suffering and resistance... in which the Black [body] is a despised thing-in-itself (but not person for herself or him-

self) in opposition to all that is pure, human(e), and white” (Dumas and Ross, 2016). As a framework, anti-Blackness attends to how Blackness is regulated as not only other but anti-human, demonstrating how structural, social, and interpersonal processes and practices perpetuate the social, emotional, psychological, and physical suffering and death of those who inhabit Black bodies (Cedillo, 2018). As a framework, anti-Blackness has been used to examine K–12 STEM (Cedillo, 2018; Morton *et al.*, 2022), K–12 mathematics education (Martin, 2019), postsecondary engineering education (Holly, 2020), postsecondary STEM (King *et al.*, 2023) as well as science teacher education (Madkins and Morton, 2021). We extend this body of research by leveraging anti-Blackness to evaluate UBE.

Using anti-Blackness as a framework to analyze Black students’ experiences in UBE in relation to the culture and context of UBE, we note the anti-Black epistemology of science that has facilitated the physical suffering and death of Black people. For example, the belief that Black people are not human justified the experimentations done on the Anarcha, Betsy and Lucy for the sake of gynecology, the stealing of Henrietta Lacks’ cell, as well as the Tuskegee syphilis experiment (e.g., Washington, 2006). These practices, though conducted generations ago, still govern scientific practices, key procedures implemented, and understandings of Black pain tolerance, health crises, and needs that inform how the biological sciences are translated into practice.

Anti-Black science epistemology has also supported the psychological and social suffering and death of Black people as governing perspectives of what counts as science, what counts as scientific practices, and who are recognized as legitimate scientists continue to reject Afrocentric and Indigenous ways of knowing, doing, and being, thereby attempting to dictate how Black people must think, do, and be within and outside of the context of science (e.g., Walls, 2016; Menon, 2021; Morton *et al.*, 2022). These practices have direct implications on the content taught in undergraduate biology, the policies generated to control access to necessary resources (e.g., scholarships, undergraduate research experiences), and other concepts as they inform metrics of success that are generated including what performance indicators and behaviors communicate that a student is capable of engaging in the biological sciences.

These are but a few examples of anti-Black epistemologies embedded within the context and culture of UBE and how they inform the concepts of normality and standards that Black students have to contend within these spaces. Through anti-Blackness as a framework, we expose the insidious nature of UBE culture and praxis and its implications for Black student experiences and outcomes. This perspective reveals the severity of the trauma imposed on Black students; a perspective that would require scholars and practitioners to look beyond diversity and inclusion practices to engage Black students given the deeply entrenched disdain for Black bodies within UBE culture.

In noting these examples, and their explicit connection to anti-Blackness, efforts looking to ensure the success of Black students in UBE must directly address anti-Blackness in science culture. It is also important to unearth anti-Blackness in UBE so that through the re-envisioning process, we not only redress the traumatic culture, but we also ensure that we build towards a UBE culture that advances a justice-oriented, collective public

good. Building a culture with this in mind ensures that UBE learning spaces, outcomes, and scientific innovations do not recreate oppression and trauma. To engage this work, we both represent and propose a multigenerational, interdisciplinary network dedicated to re-envisioning the culture of UBE by specifying Blackness in its holistic, heterogenous form. Having established this space through the Re-Envisioning Culture Network, we work to advance our mission through disseminating our vision, putting out a clarion call to the field of biology education to join us in this endeavor. It is important to note that this is just the beginning of the re-envisioning process led by the REC Network. As we continue to delineate our positioning and conceptual framework in subsequent works and as the network grows, we strive to deepen and expand our ideas and impact.

WHO ARE WE?

Positionality is used as a term, or point of reference, to share how people view and interpret social worlds, and in turn, how said worlds impact people’s perspectives and decisions. Being cognizant of and upfront about one’s position, supports a deeper understanding of how systems of privilege and oppression influence research and work (Jacobson and Mustafa, 2019). Positionality is both self-determined and socially regulated, being influenced by multiple factors, including but not limited to race, gender, age, class, citizenship, etc., and ultimately affects how people interpret the society and are subsequently interpreted by society (Day, 2012; Ridgeway and Yerrick, 2018). As such, we take a moment to name the collective positionality of the Re-Envisioning Culture Network (REC Network) and its approach towards addressing the issues of Black student retention in UBE. To do so, we consider the vast individual positionalities represented within the REC Network, as it is a space comprised of individuals from varying backgrounds.

The REC Network was established through a National Science Foundation funded project (NSF #2018532). To build the network, members of the leadership team developed a multi-fold recruitment strategy that included leveraging existing individual connections, open recruitment through social media platforms, and snowball methods. Invitations sent through these various means indicated the purpose of the REC Network—seeking to explore strategies for redressing Black students’ retention in UBE by attending to science culture—and an open invitation to participate in the think tank and subsequent activities that followed. Those who elected to join the network expressed commitments to its mission and purpose. From this perspective, members of the network, though constituting diverse individual positionalities, coalesce in solidarity towards a shared, collectivist political goal (Miles *et al.*, 2019).

The REC Network is a group of diverse individuals across higher education institutions, STEM careers, K–12 education, Black cultural spaces, the arts, and the broader community. Collectively, we represent a group who strives to enhance Black undergraduate students’ STEM experiences and outcomes in and beyond the biological sciences. Banks (1998) notes that it is important to consider our lives and values as researchers and provides us with a framework that highlights individual values in relation to the culture we are studying. Banks’ (1998) work focuses on multiculturalism. Though the REC Network is not situated within a multicultural perspective, it is comprised of a

diverse group of individuals (e.g., race, ethnicity, gender, sexuality, religion, political ideology, etc.).

In recognizing the vast individual positionalities that have come together to advance a collective positionality that specifically attends to enhancing Black experiences and outcomes, we use this framework to unpack individual positionalities within the network and the collective positionality of the REC Network. Thus, Banks' (1998) work offers a framework that enables us as a network to consider how we identify in relation to examinations of Black identity and Blackness particularly within the UBE context. The intricacies of our individual relationship to Blackness informs our collective approach to naming and addressing anti-Blackness. More specifically, some people within the network maintain deep, collective perspectives of Blackness where they see themselves as political agents of the Black community striving for Black liberation. Others within the network do not identify as Black but see themselves as coconspirators for Black liberation. Some identify as Black but maintain an individualistic approach to Black success.

The REC Network is primarily comprised of individuals who self-identify as Black, as well as individuals who identify as Indigenous, Indian, Latinx, and white. All members of the REC Network are openly invested in the success of Black UBE students. Members of the REC Network come from a variety of professional backgrounds including undergraduate and graduate students, postdoctoral scholars, social science faculty, STEM faculty, STEM professionals, administrators, K–12 educators, Black cultural artists, and Black community leaders and activists. Sixty-nine percent of the REC Network is students, with 74% of them undergraduates. Among network members, approximately 33% are first-generation college students. The network includes members from 22 different U.S. states, with Mississippi, North Carolina, and Missouri most represented. Our membership includes members from across the socioeconomic spectrum, with 58% of members belonging to the middle class.

In recognizing the vast backgrounds of members of the REC Network, our collective positionality considers the multiple facets of Black heritage and culture shared among members of the REC Network, as well as perspectives completely external to the Black experience. As such, members of the REC network identify as indigenous-insiders, external-insiders, and external-outsiders to Blackness writ large (Banks, 1998) as well as to Blackness within the context of undergraduate biology. Members also identify as outsiders who stand in solidarity with Blackness.

Indigenous-insiders are people who “endorse the unique values, perspectives, behaviors, beliefs, and knowledge” associated with their determined community (p. 7). They are people that both perceived themselves to be members of the community, as well as being recognized by others both within and external to the community as a legitimate member (Banks, 1998). Indigenous-outsiders are people “socialized within the cultural community but has experienced high levels of desocialization and cultural assimilation into an outside or oppositional culture” (Banks, 1998). External-insiders are people who are socialized within a community, but given their own experiences and perspectives have decided to reject aspects of their cultural identity and practices. To demonstrate some of the perspectives, we present a few narratives as examples of the network membership.

Blackness and Black identity hold different meanings to different people, even for those considered to be indigenous-insiders to Blackness and Black identity. Not all indigenous insiders identify as Black first. Some view Blackness as a forced identity and others as a source of power. For example, one researcher identified as a middle-class PhD-educated African American male who originated from a low socioeconomic background, a first-generation college student who was a product of a single teenage mother and raised by his grandparents in a rural conservative town in North Carolina. In this case, Black and African American are seen as related yet distinct regarding terminology applied. He used his experiences as motivation to succeed and to overcome low expectations, and this empowered him to mentor and advise those from his community to set goals that can also help them to overcome the burdens placed on people like him from society.

Other members who viewed themselves as indigenous-insiders within the Black community often feel as external-outsiders within the science community. While they are proud African Americans, they feel as if their identities place greater burdens on them within the science community. One scientist grew up in the southeastern (SE) United States (US) and is a minority on two fronts (race and sex) in both the field of biology and in the SE US. While conducting field work in the SE US, she is often privileged to work in some of the most pristine natural environments, but also faced with some of the most hostile social environments. These environments shaped where and when she conducted research, and how her research was perceived by others in the field. Another REC Network member identifies as an educated, working, middle class, African American female. She was raised in a single parent home and comes from a low socio-economic background. She obtained both her B.S. and M.Ed. from predominantly White institutions. During her time at these institutions, she experienced imposter syndrome and adapted by code-switching (e.g., changing our language and mannerism to be more Eurocentric). Both members' experiences connect them with marginalized biology students who share similar experiences.

The meaning and importance of Blackness also changes throughout our lives. One indigenous-insider views herself as a science education researcher with cross-cultural experiences that has caused her to reflect on, address, and redefine what Blackness means to her at different stages of her life. In hindsight, as an American of Afro-Caribbean descent her Blackness was fully centered. In that culture she never identified herself as Black because Black was perceived as a color and not a racial identity group. However, border crossing into an environment where whiteness rather than Blackness was valued lead to an identity crisis where her previous definition of herself was constrained and a new definition related to Blackness was forced upon her. She moved from an area where diversity among Black people was the norm, to a Western environment where all were relegated to one descriptor and diversity among Black people was less appreciated. Another external-insider identifies as a middle-class white immigrant. As an immigrant to the US without any formal schooling within the US, he considers educating himself about the discrepancies between the often-sanitized version of U.S. history and actual experiences of minoritized population, which he believes is one of the important parts of developing an identity and responsibility as a U.S.

TABLE 1. Recommendations for Re-Envisioning the Culture of UBE

Individual Consciousness Raising and Action	
	Believe that Black Undergraduate Students are Brilliant
	Diversify Blackness
	Appreciate Black Student Contributions
	Foster Racial Solidarity
Collectivist Strategies	
	Engage and Adopt a Shared Critical, Strengths-Based Framework
	Establish Reimagined Community Norms, Rules, and Regulations Based on the Critical, Strengths-Based Framework

citizen. Participating in the REC Network has given him the unique opportunity to connect, learn, and contribute to rectifying the burdens placed on marginalized biology students.

These examples provided demonstrate the vastness of positions existing within the REC Network, and how people with different perspectives of Blackness, including those who do not identify as Black, came together to explore and address issues related to Black student experiences in undergraduate biology. Through various activities and events, the REC Network strives to address the issue of retaining Black students in undergraduate biology by proposing and enacting strategies that transform the culture of undergraduate biology (i.e., the norms, values, beliefs, ideologies, and practices) rather than focusing on strategies to transform Black students. The REC network focuses on identifying the culture of UBE, examining the influence of UBE culture on Black students' engagement and persistence given their identity, and pinpointing elements of UBE culture to transform and enhance Black students' retention in UBE to graduation and beyond. This is influenced by our own perceptions, connectedness, and the value we assign to Blackness.

RE-ENVISIONING THE CULTURE: A CALL TO ACTION

The Black Lives Matter movement and disproportionate impacts of the COVID-19 pandemic has prompted a global awareness of issues pertaining to the Black community in the United States. The long-term impacts of systemic and societal racism are fully entrenched in every field, particularly STEM disciplines, prompting the need for individuals to reflect on their positionality, role, and responsibly to dismantle oppressive structures. Regardless of where an individual is currently located in their journey towards critical consciousness pertaining to Black engagement and existence within science, everyone should put forward effort to grow. Rationalizing the status quo through either antagonistic actions or by-stander mindsets normalizes and perpetuates oppression. As critical race theorists have reminded us, racism will evolve and reinvent itself to maintain and preserve white supremacy (Miles *et al.*, 2019; Holly and Masta, 2021; Morton, 2022). This presents the urgency for an equally robust response towards racism, which cannot be done alone, it must be a collective effort. Racial solidarity towards dismantling white supremacy is essential (Miles *et al.*, 2019).

Morton and colleagues (2022) proposed guiding principles for advancing Black liberation in K–12 science education that we will draw upon and adapt to share tangible next steps for re-envisioning the culture of UBE to foster Black students' success. These principles speak to the efforts an individual can put in place within various educational settings such as a classroom, laboratory, or journal club. We combine these principles with

the specific recommendations from Basile and Black (2019) to outline collective actions that can be implemented in group settings (i.e., departments, colleges, universities, professional associations) to advance the re-envisioning process. We specifically attend to the individual and the collective as we believe that systemic, cultural change requires a critical, systems thinking approach that focuses on individual consciousness raising and action coupled with collectivist, strategic action (Kezar, 2018). The recommendations we offer correspond with two overarching ideas—work that individuals should take on by themselves and work that people should do together as a collective. As such, Table 1 presents the outline of our recommendations as they correspond with the two overarching proposed ideas.

Individual Consciousness Raising and Action

Tasks specific to an individual's consciousness and action involve: 1) building from a perspective of Black undergraduate students' brilliance, 2) acknowledging the pervasiveness of anti-Black racism and its implications for Black students' experiences, 3) embracing the diversity of Blackness, 4) meaningfully integrating Black realities and ways of knowing within the learning space, and 5) fostering racial solidarity.

Black undergraduate students are brilliant. This statement is a fact, not to be proven or challenged, but believed and accepted. This statement and belief stems from a critical, strengths-based mindset about Black students (e.g., Harper, 2010) that focuses on what Black students bring to the learning environment rather than what they lack. Beginning with Black students as brilliant counters rhetoric and narratives of them being “underprepared,” “not engaged,” “at-risk,” and all of the other colorful ways that people reinforce deficit mindsets about Black people and their capabilities. This means Black students should be approached from a mindset that they are already innovative and come from a lineage of innovators and creators. Blackness is beautiful; it has and continues to influence the entire world and what we understand as human life.

Beginning with a perspective that Black students are brilliant requires faculty and instructors to maintain and employ a pedagogical style that embraces and refutes the reality of anti-Blackness in the U.S. and western, Eurocentric science—the main form of science taught in most undergraduate biology courses across the country. Faculty and instructors must contend with their current role and responsibility within the existing anti-Black system, and put forth consistent, intentional, conscious effort to combat anti-Blackness. Powell and colleagues (2021) provide a model in which student affairs practitioners can leverage critical race theory to enhance their

practices and interactions with marginalized students. This model suggests that practitioners embrace racial realism (i.e., that racism is real and permanent), explore their positionality, raise their critical consciousness, and engage in dialogic action to drive change.

We adapt a model that shares with and expects biology faculty and instructors to embrace the fact that anti-Blackness is real and exists both within U.S. society and the cultural practices of western, Eurocentric science. Faculty must explore their own belief systems and cultural values, recognizing how they have been socialized within a system of anti-Blackness and the role that they have played to-date in perpetuating its deleterious effects. In practice, this would reflect faculty engaging with materials that support deep exploration of their identities, power, privileges, and biases. One resource often used within educational research is Milner (2007)'s structured questions for determining what is seen, unseen, and unforeseen when it comes to engaging research with race. Similarly, Jacobson and Mustafa (2019) offer a social identity mapping tool for exploring one's positionality. As well, Morton (2023) points to a "sphere of influence" that individuals maintain that requires individuals to consider the power and privilege they maintain and how they can use said power and privilege to enact change. As the REC Network, we engage various reflexive activities that prompt individuals to think deeply about who they are, how they are showing up to this space, what power and privilege do they maintain when it comes to enhancing Black student experiences and how they can use that power to coincide with the mission of the network.

Harro (2018) outlines a "cycle of socialization" that discusses how one can come to understand reality and contribute to the same reality through their actions juxtaposed to the various external influences that shape one's experience. To break free of the cycle, one must be consistent, intentional, and conscious with their decisions and actions to continuously learn about the plight, experiences, and desires of Black people, utilizing their power to work in tandem with the community to effect change. Consistent, intentional, conscious effort within the classroom space includes, but is not limited to 1) designing course content around anchor phenomena that are specifically relevant to Black people, 2) incorporating contributions from Black scientists within course readings, problems, and solutions, 3) presenting the scientific concepts and ideas discussed in class as a form of cultural practice that is one way of knowing science versus the only way to know and do science, 4) coconstructing classroom norms, policies, and practices on things such as classroom participation, classroom attendance or presence, classroom accountability measures, and 5) creating assignments that allows students to bring in their funds of knowledge, cultural backgrounds, and language to augment classroom discussions and understandings (Collins, 2021; Quinlan, 2021; Morton *et al.*, 2022).

The diversity of Blackness. Contextualize Blackness in ways that acknowledge, value, and embrace the vast histories and experiences of Black people across the African Diaspora. As we demonstrated within our positionality statement, Blackness, describing how people embrace and engage their racial identity, encompasses individuals with varying perspectives about what is considered Black and how one understands their self as

Black. This includes Black people of different ethnic backgrounds, cultural identities, as well as sociopolitical perspectives. Generalist assumptions that "all Black people look alike" or that "all Black people are the same" perpetuate anti-Black racist ideologies and outcomes. Maintaining a heterogeneous perspective of Blackness coincides with the CRT tenet of anti-essentialism (Patton, 2015), an underlying framework for the Powell and colleagues (2021) model.

Embracing Black as rich and heterogeneous within biology teaching and learning ensures that Black perspectives of and contributions to science from ancient and modern Africa are included (Van Sertima, 1983) as well as historical and modern-day Black scientists from different backgrounds (Quinlan, 2020). A diversity of Blackness also supports funds of knowledge, as local and community Black scientists who are often not regarded as such, nor recognized and appreciated for their innovations and approaches to understanding and engaging the natural world.

Appreciate Black student contributions. Critically examine department and classroom practices that stifle the voices and innovation of Black students. DeCuir-Gunby and colleagues (2022) usage of critical race mixed methods to examine the Black college students' experiences with racial microaggressions and belonging, calls for understanding how race impacts collegiate classroom practices. This can be done by conducting climate investigations that use surveys, interviews, and focus groups to understand the complexity of Black students' experiences. And most important, the findings should be used to develop strategies for change if they are not favorable, as well as remove and rewrite policies (explicit and implicit) that compare and contrast Black students to each other and other groups. Eliminate competition and the drive for individual engagement and achievement because they lead to exclusion and only unfavorable outcomes for Black students.

Arday and colleagues (2021) shares that although there is opposition to decolonizing pedagogical practices in university spaces, we must not allow these "gatekeepers to maintain a monopoly on the types of knowledge to be proffered" (p. 310). Successful environments for Black students in higher education center aspects of their culture and address biases they may face while making Black contributions in classrooms and provide mentorship (Williams *et al.*, 2021). Same-race peer groups in these environments can aid in positive racial identity and increase belonging and visibility (Thelamour *et al.*, 2019). Therefore, fostering a space that decolonizes educational practices that are rooted in power, privilege, and whiteness allows us to embrace communal and collective learning, development, and assessment. This can be initiated by including students in the process of curriculum transformation. Students must learn how to work together in racial solidarity, regardless of their race, gender, and citizenship status. This is an area that typically goes unaddressed by most undergraduate programs.

Foster racial solidarity. Racial solidarity focuses on building relationships with others who are not of the same racial identity, to support actions that focus on dismantling systemic oppression and white supremacist ideologies and practices as it effects one specific raced-group (Miles *et al.*, 2019). Racial solidarity thus means leveraging one's privilege, power, and

platform to enhance the outcomes of another raced group. Fostering racial solidarity can occur through various forms of advocacy and support. What matters most in racial solidarity, particularly for supporting Black people given the ideals espoused by the REC Network, is that one must be cognizant of their identities and associated power and privileges, and use that power and privilege to advance the goals and missions outlined by the collective Black community.

Racial solidarity in this context does not mean that non-Black individuals can make uniform or unilateral decisions about how to support Black students. As well, racial solidarity does not mean that non-Black individuals must be silent and cannot share opinions. Instead, it means that non-Black individuals recognize the power and privilege afforded to them by white supremacy and use that power and privilege to advance Black liberation, as defined by the collective Black community. The goal is for racial solidarity to promote structural, systemic change that facilitates growth, strength, sufficient resources, and independence among Black people in ways that ensure Black people can maintain their distinctive identities, cultures, and values. It is through collective efforts that racial solidarity erodes the presence and power of white supremacy in undergraduate biology learning environments.

Collectivist Strategies

Collectivist strategies focus on changes to policies, practices, and “unspoken” norms that govern how someone must show up and behave to be valued and be a part of the undergraduate biology community. Promoting collectivist action involves: 1) grounding the work in a critical, strengths-based conceptual framework that centers and supports a heterogeneity of Blackness, 2) designing and implementing rules, regulations, and norms for the community to embrace and promote the success and holistic well-being of Black people.

Critical, strengths-based frameworks. There has been a recent uptake in asset-based and strengths-based mindsets and approaches to science teaching and learning. These frameworks focus on what people have and bring to the table, building from their strengths versus focusing on what people do not have or need and attempting to fix or save the person (Wofford and Gutzwa, 2022). Making a strengths-based or asset-based perspective critical requires acknowledging and intentionally combatting the systemic and structural oppression that attempts to marginalize and incapacitate people. Examples of critical strengths-based frameworks that have been used in STEM education research and praxis include Community Cultural Wealth (e.g., Ortiz *et al.*, 2019; Denton *et al.*, 2020), Funds of Knowledge (e.g., Denton and Borrego, 2021), and culturally relevant, responsive, and sustaining pedagogies (Mensah and Larson, 2017).

Critical strengths-based frameworks serve as the conceptual and pragmatic boundaries for all policies, practices, and norms implemented within individual classrooms (e.g., thinking about classroom management style, classroom community, classroom participation and engagement, course assignments) as well as within departments, colleges, universities, and professional associations. As the REC Network, we currently approach our collectivist work using Afrofuturism as a conceptual framework. Afrofuturism as a framework promotes three core ideas:

1) understanding the multiple truths of the past to ensure a promising, Afrocentric future, 2) an unapologetic centering of and focus on Black culture, Black creativity, Black capabilities, and Black possibilities, and 3) engaging science/speculative fiction, creativity, STEM innovation, and futuristic possibilities within a context that is Black centric (Womack, 2013). STEM scholars have discussed the possibilities of leveraging Afrofuturism within STEM teaching and learning, pointing out the innovative possibilities that can come from people envisioning a future for Black people that reflects an understanding and potential deliverance from past and current systemic oppression (Alexander, 2019; Holbert *et al.*, 2020; McGee and White, 2021).

Community norms, rules, and regulations. Policies, practices, and the unwritten norms govern communities and societies. These concepts socialize people into how to operate within the specific community (Harro, 2018), leading to community-specific identities and onto-epistemologies. To redefine the cultural and community norms, practices, and policies of undergraduate biology, people must work as a collective—through racial solidarity efforts—to change the existing departmental, college, university, and professional associations perspectives and practices. One of the key concepts that must change is how these spaces define success as it pertains to understanding and practicing the forms of knowledge associated with the biological sciences. Redefining what constitutes success brings with it changes to how success is measured, what forms of knowledge are necessary to demonstrate that someone is successful, thereby impacting “who” is recognized and hallmarked as a successful person within the community.

At the departmental level, Weatherston and Schussler (2021) note that shifting the definitions of success require critical questions of the frameworks and underlying assumptions that drive departmental actions and outcomes. From our point of view, this would entail the department undergoing a series of reflexive activities that require faculty and staff to examine the extent to which their current policies and practices have resulted in the holistic well-being of Black students. Holistic well-being accounts for Black students’ personal, social, emotional, academic/professional, cultural, and financial comfort and success. This examination includes individual introspection, each individual person’s role and responsibility, as well as the collective’s approach and outcomes. Beyond identifying the current departmental state, this process would also then require faculty and staff to connect these outcomes to the specific policies and practices implemented, and work to redefine said policies and practices from a critical, strengths-based framework that embraces and emboldens Blackness.

To pinpoint some specific areas to target for redefining through this framework, we draw from Basile and Black (2019). These authors recommend that STEM departments: move STEM courses away from rote testing and normal curve grading toward more authentic models of STEM learning...hire and retain more Black STEM faculty and staff...create, support, and continually fund campus-recognized student groups and other support-based community endeavors for Black STEM students (Malcolm & Feder, 2016)... rebuild STEM advising models such that advisors are highly trained in fostering access for marginalized students, cultural competency, and in acting as an advocate for students (p. 385-386).

We extend these recommendations by leveraging the perspectives of Dupree and Boykin (2021). These scholars emphasize the need to engage cluster hires and targeted recruitment strategies for Black faculty and staff, and implementing retention strategies by providing funding, resources, and mentorship specific to their academic and social needs, as well as incentivizing research, teaching, and service that focus on uplifting Black people.

As more departments within specific colleges implement these practices, the broader culture of higher education will shift, thereby driving changes to the overall culture of the biological sciences writ large. Investments from the professional societies that support biology-based research and practice is also key to bringing about the cultural shift as professional societies often set the tone for what kind of scholarship and praxis is deemed valuable within the overall community. Change agents in the classroom and department can also be advocates for collective change efforts within professional societies.

CONCLUSION

In 1964, Malcolm X delivered an address at the founding rally of the “Organization of Afro-American Unity.” In this speech, Malcolm outlined the foundational principles and beliefs that governed this organization, addressing many topics including education. In this speech, Malcolm states, Education is an important element in the struggle for human rights. It is the means to help our children and our people rediscover their identity and thereby increase their self-respect. Education is our passport to the future, for tomorrow belongs only to the people who prepare for it today (Blackpast, 2007).

It was his premise that in taking charge of Black education and being intentional about teaching Black learners their histories and culture beyond enslavement, the Black community would be able to ensure a healthy, sustained future. In drawing from these ideas, we remind the readers that the current state of UBE is a space that does not situate Blackness, Black people, or Black possibilities. And while there are efforts put forth to support equity and inclusion within this space, these strategies will forever be limited in their ability to advance Black liberation and success because they often try and work within the existing social, cultural, political boundaries of the discipline and environment. In efforts to ensure a liberated, Black future, we must prepare for it today through approaches like re-envisioning the culture of UBE. As such, we hope that others will join us in this endeavor to drive this change within and across local and national science contexts.

ACKNOWLEDGMENTS

We would like to thank the many members of the REC-Network who serve as coconspirators with us in our efforts to combat anti-Blackness in UBE. These members include undergraduate students, graduate students, postdocs, faculty, administrators, community leaders, activists, and more. We are also grateful for the wisdom offered from Dr. Eileen C. Parsons and Dr. Stephanie Toliver. Your thoughts and perspectives help guide our work. This essay was funded by the National Science Foundation, grant number 2018532. Any opinions, findings, and conclusions or recommendations expressed in this paper are those of the hosts and do not necessarily reflect the views of the National Science Foundation.

REFERENCES

- Aikenhead, G. S. (1996). Science education: Border crossing into the subculture of science. *Studies in Science Education*, 27(1), 1–52.
- Aikenhead, G. (2002). Whose scientific knowledge? The colonizer and the colonized. *Counterpoints*, 210, 151–166.
- Alexander, N. N. (2019). Daija's awakening: Critical race theory and Afrofuturism in mathematics education. In Davis, J., & Jett, C. C. (Eds.), *Critical race theory in mathematics education* (pp. 56–74). New York, NY: Routledge.
- Arday, J., Zoe Belluigi, D., & Thomas, D. (2021). Attempting to break the chain: Reimagining inclusive pedagogy and decolonising the curriculum within the academy. *Educational Philosophy and Theory*, 53(3), 298–313.
- Atwater, M. M., Lance, J., Woodard, U., & Johnson, N. H. (2013). Race and ethnicity: Powerful cultural forecasters of science learning and performance. *Theory into Practice*, 52(1), 6–13.
- Banks, J. A. (1998). The lives and values of researchers: Implications for educating citizens in a multicultural society. *Educational Researcher*, 27(7), 4–17. <https://doi.org/10.3102/0013189X027007004>
- Basile, V., & Black, R. (2019). They hated me till I was one of the “good ones”: Toward understanding and disrupting the differential racialization of undergraduate African American STEM majors. *Journal of Negro Education*, 88(3), 379–390.
- Basile, V., & Lopez, E. (2015). And still I see no changes: Enduing views of students of color in science and mathematics education policy reports. *Science Education*, 99(3), 519–548. <https://doi.org/10.1002/sce.21156>
- Blackpast (2007, October 15) (1964). Malcolm X's speech at the founding rally of the organization of Afro-American unity. *Blackpast*, Retrieved June 18, 2022, from <https://www.blackpast.org/african-american-history/speeches-african-american-history/1964-malcolm-x-s-speech-founding-rally-organization-afro-american-unity/>
- Bonilla-Silva, E. (2014). *Racism without racists: Color-blind racism and the persistence of racial inequality in America* (4th ed.). Lanham, MD: Rowman & Littlefield.
- Brown, B. A., & Mutegi, J. W. (2010). A Paradigm of Contradictions: Racism and Science Education. In Peterson, P., Baker, E., & McGaw, B. (Eds.), *International Encyclopedia of Education* (Vol. 1, pp. 554–564). Oxford, UK: Elsevier.
- Brown, B. A., Henderson, J. B., Gray, S., Donovan, B., Sullivan, S., Patterson, A., & Wagstaff, W. (2016). From description to explanation: An empirical exploration of the African-American pipeline problem in STEM. *Journal of Research in Science Teaching*, 53(1), 146–177. <https://doi.org/10.1002/tea.21249>
- Bullock, E. C. (2017). Only STEM can save us? Examining race, place, and STEM education as property. *Educational Studies*, 53, 628–641.
- Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching*, 44(8), 1187–1218. <https://doi.org/10.1002/tea.20237>
- Cedillo, S. (2018). Beyond inquiry: Towards the specificity of anti-blackness studies in STEM education. *Canadian Journal of Science, Mathematics and Technology Education*, 18(3), 242–256.
- Chang, M. J., Sharkness, J., Hurtado, S., & Newman, C. B. (2014). What matters in college for retaining aspiring scientists and engineers from under-represented racial groups. *Journal of Research in Science Teaching*, 51(5), 555–580. <https://doi.org/10.1002/tea.21146>
- Choi, Y. H., Tacloban-Moore, M. J., Eddy, S. L., Potvin, G., Benabentos, R., & Kramer, L. (2023). “Eventually, it became my source of motivation”: Black STEM transfer students' agentic responses to negative campus ethos at an HSI. *Journal of College Student Retention: Research, Theory & Practice*, *Advanced Online Publication*. <https://doi.org/10.1177/15210251231157650>
- Collins, S. N. (2021). The importance of storytelling in chemical education. *Nature Chemistry*, 13, 1–3. <https://doi.org/10.1038/s41557-020-00617-7>
- Day, S. (2012). A reflexive lens: Exploring dilemmas of qualitative methodology through the concept of reflexivity. *Qualitative Sociology Review*, 8, 60–85.
- DeCuir-Gunby, J. T., McCoy, W. N., & Gibson, S. M. (2022). The utility of critical race mixed methodology: An explanatory sequential example. In Pasque, P. A., & Alexander E. (Eds.), *Advancing Culturally Responsive Research and Researchers* (pp. 201–216). New York, NY: Routledge.

- Denton, M., & Borrego, M. (2021). Funds of knowledge in STEM education: A scoping review. *Studies in Engineering Education*, 1(2), 71–92. <http://doi.org/10.21061/see.19>
- Denton, M., Borrego, M., & Boklage, A. (2020). Community cultural wealth in science, technology, engineering, and mathematics education: A systemic review. *Journal of Engineering Education*, 109(3), 556–580.
- Dortch, D., & Patel, C. (2017). Black undergraduate women and their sense of belonging in STEM at predominantly white institutions. *NASPA Journal About Women in Higher Education*, 10(2), 202–215.
- Dumas, M. J., & Ross, K. M. (2016). “Be real Black for me”: Imagining BlackCrit in education. *Urban Education*, 51(4), 415–442.
- Dunac, P. S., & Demir, K. (2017). Negotiating white science in a racially and ethnically diverse United States. *Educational Review*, 69(1), 25–50.
- Dupree, C. H., & Boykin, C. M. (2021). Racial inequality in academia: Systemic origins, modern challenges, and policy recommendation. *Policy Insights from the Behavioral and Brain Sciences*, 8(1), 11–18.
- Estrada, M., Burnett, M., Campbell, A. G., Campbell, P. B., Denetclaw, W. F., Gutiérrez, C. G., ... & Zavala, M. (2016). Improving underrepresented minority student persistence in STEM. *CBE—Life Sciences Education*, 15(3), 1–10. <https://doi.org/10.1187/cbe.16-01-0038>
- Ferguson, D., & Martin-Dunlop, C. (2021). Uncovering stories of resilience among successful African American women in STEM. *Cultural Studies of Science Education*, 16(3), 461–484. <https://doi.org/10.1007/s11422-020-10006-8>
- Garibay, J. C. (2015). STEM students’ social agency and views on working for social change: Are STEM disciplines developing socially and civically responsible students? *Journal of Research in Science Teaching*, 52(5), 610–632.
- Graham, M. (2021, September 10). HBUCs are producing Black STEM professionals – But PWIs aren’t matching that energy. *Afrotech*, Retrieved May 30, 2023, from <https://afrotech.com/hbcus-black-stem-professionals>
- Graves, J. L. (2019). African Americans in evolutionary science: Where we have been, and what’s next. *Evolution: Education Outreach*, 12(18), 1–10. <https://doi.org/10.1186/s12052-019-0110-5>
- Green, A. M., Brand, B. R., & Glasson, G. E. (2019). Applying actor-network theory to identify factors contributing to nonpersistence of African American students in STEM majors. *Science Education*, 103(2), 241–263.
- Grossman, J. M., & Porche, M. V. (2013). Perceived gender and racial/ethnic barriers to STEM success. *Urban Education* 49 (6), 698–727.
- Harding, S. (1992). After eurocentrism: Challenges for the philosophy of science. *PSA: Proceedings of the biennial meeting of the philosophy of science association*, 2, 311–319.
- Harding, S. G. (1994). Is science multicultural?: Challenges, resources, opportunities, uncertainties. *Configurations*, 2(2), 301–330.
- Harding, S. G. (2008). *Sciences from below: Feminisms, postcolonialities, and modernities*. Durham, NC: Duke University Press.
- Harper, S. R. (2010). An anti-deficit achievement framework for research on students of color in STEM. In Harper, S. R., & Newman, C. B. (Eds.), *Students of color in STEM: Engineering a new research agenda*. *New Directions for Institutional Research* (pp. 63–74). San Francisco, CA: Jossey-Bass.
- Harro, B. (2018). The cycle of socialization. In Adams, M., Blumenfeld, W. J., Hackman, H. W., Zuniga, X., & Peters, M. L. (Eds.), *Readings for diversity and social justice* (4th ed, pp. 27–33). New York, NY: Routledge.
- Hartman, S. (2007). *Lose your mother: A journey along the Atlantic slave route*. New York: Farrar, Straus, and Giroux.
- Holbert, N., Dando, M., & Correa, I. (2020). Afrofuturism as critical constructionist design: Building futures from the past and present. *Learning, Media and Technology*, 45(4), 328–344.
- Holly, J. Jr. (2020). Disentangling engineering education research’s anti-Blackness. *Journal of Engineering Education*, 109(4), 629–635. <https://doi.org/10.1002/jee.20364>
- Holly, J. Jr., & Quigley, L. T. (2022). Reckoning with the harm of anti-Blackness in engineering education: A reparatory justice research approach. *Journal of Women and Minorities in Science and Engineering*, 28(2), 95–110. <https://doi.org/10.1615/JWomenMinorScienEng.2022036667>
- Holly, J. Jr., & Masta, S. (2021). Making whiteness visible: The promise of critical race theory in engineering education. *Journal of Engineering Education*, 110(4), 798–802.
- Hurtado, S., Han, J. C., Sáenz, V. B., Espinosa, L. L., Cabrera, N. L., & Cerna, O. S. (2007). Predicting transition and adjustment to college: Biomedical and behavioral science aspirants’ and minority students’ first year of college. *Research in Higher Education*, 48(7), 841–887.
- Jacobson, D., & Mustafa, N. (2019). Social identity map: A reflexivity tool for practicing explicit positionality in critical qualitative research. *International Journal of Qualitative Methods*, 18, 1–12. <https://doi.org/10.1177/1609406919870075>
- Jones, T. C. (2019). Creating a world for me: Students of color navigating STEM identity. *Journal of Negro Education*, 88(3), 358–378.
- Kezar, A. (2018). *How colleges change: Understanding, leading, and enacting change*. New York, NY: Routledge.
- King, G. P., Russo-Tait, T., & Andrews, T. C. (2023). Evading race: STEM faculty struggle to acknowledge racialized classroom events. *CBE—Life Sciences Education*, 22(14), 1–16. <http://doi.org/10.1187/cbe.22-06-0104>
- Kirk, G., & Okazawa-Rey, M. (2018). Identities and social locations: Who am I? Who are my people? In Adams, M., Blumenfeld, W. J., Hackman, H. W., Zuniga, X., & Peters, M. L. (Eds.), *Readings for diversity and social justice* (4th ed) (pp. 10–15). New York, NY: Routledge.
- Lane, T. B. (2016). Beyond academic and social integration: Understanding the impact of a STEM enrichment program on the retention and degree attainment of underrepresented students. *CBE—Life Sciences Education*, 15(3), 1–13.
- Le, P. T., & Matias, C. E. (2019). Towards a truer multicultural science education: How Whiteness impacts science education. *Cultural Studies of Science Education*, 14(4), 15–31. <http://doi.org/10.1007/s11422-017-9854-9>
- Leath, S., & Chavous, T. (2018). Black women’s experiences of campus racial climate and stigma at predominantly white institutions: Insights from a comparative and within-group approach for STEM and non-STEM majors. *Journal of Negro Education*, 78(2), 125–139.
- Leyva, L. A., McNeil, R. T., Balmer, B. R., Marshall, B. L., King, V. E., & Alley, Z. D. (2022). Black queer students’ counter-stories of invisibility in undergraduate STEM as a white, cisheteropatriarchal space. *American Educational Research Journal*, 59(5), 863–904. <http://doi.org/10.3102/00028312221096455>
- Madden, K., Pereira, P., Rezvi, S., Trinder, V. F., & Martin, D.B. (2019). 4 Cartographies of race, gender, and class in the white (male settler) spaces of science and mathematics: Navigations by Black, Afro-Brazilian, and Pakistani/American Womxn. In McGee, E. O., & Robinson, W. H. (Eds.), *Diversifying STEM* (pp. 69–106). New Brunswick, NJ: Rutgers University Press. <https://doi.org/10.36019/9781978805712-005>
- Madkins, T. C., & Morton, K. (2021). Disrupting anti-Blackness with young learners in STEM: Strategies for elementary science and math teacher education. *Canadian Journal of Science, Mathematics, and Technology Education*, 21(2), 239–256. <https://doi.org/10.1007/s42330-021-00159-1>
- Malcolm, S., & Feder, M. (Eds.) (2016). *Barriers and opportunities for 2-year and 4-year STEM degrees: Systemic change to support students’ diverse pathways*. Retrieved August 15, 2023, from <https://www.nap.edu/catalog/21739/barriers-and-opportunities-for-2-year-and-4-year-stem-degrees>
- Malone, K. R., & Barabino, G. (2009). Narrations of race in STEM research settings: Identity formation and its discontents. *Science Education*, 93(3), 485–510. <http://dx.doi.org/10.1002/sce.20307>
- Martin, D. B. (2019). Equity, inclusion, and antiblackness in mathematics education. *Race Ethnicity and Education*, 22(4), 459–478.
- Martin-Hansen, L. (2018). Examining ways to meaningfully support students in STEM. *International Journal of STEM Education*, 5(1), 53. <https://doi.org/10.1186/s40594-018-0150-3>
- McGee, E. O. (2016). Devalued Black and Latino racial identities: A by-product of stem college culture? *American Educational Research Journal*, 53, 1626–1662.
- McGee, E. O. (2020). *Black, brown, bruised: How racialized STEM education stifles innovation*. Cambridge, MA: Harvard Education Press.
- McGee, E., & Bentley, L. (2017). The equity ethic: Black and Latinx college students reengineering their STEM careers towards justice. *American Journal of Education*, 124(1), 1–36.
- McGee, E. O., & Martin, D. B. (2011). “You would not believe what I have to go through to prove my intellectual value!” Stereotype management among successful Black mathematical and engineering students. *American Educational Research Journal*, 48, 1347–1389.

- McGee, E. O., & White, D. T. (2021). Afrofuturism: Reimagining STEM for Black urban learners. In Milner, H. R., & Lomotey, K. (Eds.), *Handbook of Urban Education*, 2nd ed. (pp. 384–396). New York, NY: Routledge.
- McPherson, E. (2017). Oh you are smart: Young, gifted African American women in STEM majors. *Journal of Women and Minorities in Science and Engineering*, 23(1), 1–14. <https://doi.org/10.1615/jwomenminor-scieng.2016013400>
- Menon, B. R. (2021). The missing colours of chemistry. *Nature Chemistry*, 13, 101–106.
- Mensah, F. M., & Larson, K. (2017). *A summary of inclusive pedagogies for science education [Background paper for the Board on Science Education of the National Academy of Sciences, Engineering, and Medicine]*. Department of Mathematics, Science & Technology, Teachers College, Columbia University. Retrieved June 20, 2021, from https://sites.nationalacademies.org/cs/groups/dbassite/documents/webpage/dbasse_189501.pdf
- Mensah, F. M., & Jackson, I. (2018). Whiteness as property in science teacher education. *Teachers College Record*, 120(1), 1–38. <https://doi.org/10.1177/016146811812000108>
- Merton, R. K. (1957). Priorities in scientific discovery: A chapter in the sociology of science. *American Sociological Review*, 22(6), 635–659. <https://doi.org/10.2307/2089193>
- Miles, M. L., Buenrostro, P. M., Marshall, S. A., Adams, M., & McGee, E. O. (2019). Cultivating racial solidarity among mathematics education scholars of color to resist white supremacy. *The International Journal of Critical Pedagogy*, 10(2), 97–126.
- Miles, M. L., Brockman, A. J., & Naphan-Kingery, D. E. (2020). Invalidated identities: The disconfirming effects of racial microaggressions on Black doctoral students in STEM. *Journal of Research in Science Teaching*, 57(10), 1608–1631. <https://doi.org/10.1002/tea.21646>
- Milner, H. R., IV. (2007). Race, culture, and researcher positionality: Working through dangers seen, un- seen, and unforeseen. *Educational Researcher*, 36(7), 388–400. <https://doi.org/10.3102/0013189X070309471>
- Morton, T. R. (2021). A phenomenological and ecological perspective on the influence of undergraduate research experiences on Black women's persistence in STEM at an HBCU. *Journal of Diversity in Higher Education*, 14(4), 530–543. <https://doi.org/10.1037/dhe0000183>
- Morton, T. R. (2022). Critical race theory and STEM education. In Price, P. G. (Ed.), *Oxford Encyclopedia of Race and Education*. New York, NY: Oxford University Press. <https://doi.org/10.1093/acrefore/9780190264093.013.1614>
- Morton, T. R. (2023). Critical race theory and its relevance for chemistry. *Nature Chemistry*, 15, 1043–1046. <https://doi.org/10.1038/s41557-023-01271-5>
- Morton, T. R., Gee, D. S., & Woodson, A. N. (2019). Being vs. becoming: Transcending STEM identity development through afropessimism, moving towards a Black X consciousness in STEM. *The Journal of Negro Education*, 88(3), 327–342. doi: 10.7709/jnegroeducation.88.3.0327
- Morton, T. R., Miles, M. L., Roby, R. S., & Ortiz, N. A. (2022). "All we wanna do is be free": Advocating for Black liberation in and through K-12 science education. *Journal of Science Teacher Education*, 33(2), 131–153.
- Morton, T. R., & Nkrumah, T. (2021). A day of reckoning for the white academy: Reframing success for African American women in STEM. *Cultural Studies of Science Education*, 16(2), 485–494. <https://doi.org/10.1007/s11422-020-10004-w>
- Morton, T. R., & Parsons, E. C. (2018). #BlackGirlMagic: The identity conceptualization of Black women in undergraduate STEM education. *Science Education*, 102(6), 1363–1393. <https://doi.org/10.1002/sce.21477>
- Mutegi, J. W. (2013). "Life's first need is for us to be realistic" and other reasons for examining the sociocultural construction of race in the science performance of African American students. *Journal of Research in Science Teaching*, 50(1), 82–103.
- National Academies of Sciences, Engineering, and Medicine (NASEM) (2023). *Advancing antiracism, diversity, equity, and inclusion in STEM organizations: Beyond broadening participation*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/26803>
- National Science Board (2022). *Science & engineering indicators 2022: Higher education in science & engineering*. Alexandria, VA: National Science Foundation (NSB-2022-3).
- National Science Foundation. (2023). *Diversity in STEM: Women, minorities, and persons with disabilities in science and engineering*. Alexandria, VA: National Science Foundation (NSF 23-315).
- Ortiz, N. A., Morton, T. R., Miles, M. L., & Roby, R. S. (2019). What about us?: Exploring the challenges and sources of support influencing Black students' STEM identity development in postsecondary education. *The Journal of Negro Education*, 88(3), 311–326. <https://doi.org/10.7709/jnegroeducation.88.3.0311>
- Parsons, E. C. (2014). Unpacking and critically synthesizing the literature on race and ethnicity in science education. In Lederman, N. G., & Abell, S. (Eds.), *The handbook on research in science education* (2nd ed., pp. 167–186). Philadelphia: Taylor & Francis.
- Parsons, E. C., & Carlone, H. B. (2013). Culture and science education in the 21st century: Extending and making the cultural box more inclusive. *Journal of Research in Science Teaching*, 50(1), 1–11.
- Patton, L. D. (2015). Disrupting postsecondary prose toward a critical race theory of higher education. *Urban Education*, 51(3), 315–342. <https://doi.org/10.1177/0042085915602542>
- Perna, L. W., Gasman, M., Gary, S., Lundy-Wagner, V., & Drezner, N. D. (2010). Identifying strategies for increasing degree attainment in STEM: Lessons from minority-serving institutions. *New Directions for Institutional Research*, 2010(148), 41–51.
- Posselt, J. R. (2020). *Equity in science: Representation, culture, and the dynamics of change in graduate education*. Redwood City, CA: Stanford University Press.
- Prescod-Weinstein, C. (2020). Making Black women scientist under white empiricism: The racialization of epistemology in physics. *Signs: Journal of Women in Culture and Society*, 45(2), 421–447.
- Powell, C., Demetriou, C., Morton, T. R., & Ellis, J. M. (2021). A CRT-informed model to enhance experiences and outcomes of racially minoritized students. *Journal of Student Affairs Research and Practice*, 58(3), 241–253. <https://doi.org/10.1080/19496591.2020.1724546>
- Quinlan, C. L. (2020). Expanding the science capital in K-12 science textbooks: A notable doctor's insights into biology and other accomplishments of African American scientists. *American Biology Teacher*, 82(60), 381–388. <https://doi.org/10.1525/abt.2020.82.6.381>
- Quinlan, C. L. (2021). Emergent themes and pragmatic research methods for meaningful cultural representation of Blacks in multimedia products for the science classroom. *International Journal of Science Education*, 43(14), 2316–2332. <https://doi.org/10.1080/09500693.2021.1959959>
- Quinlan, C. L., Picho, K., & Burke, J. (2021). Creating an instrument to measure social and cultural self-efficacy indicators for persistence of HBCU undergraduates in STEM. *Research in Science Education*, 52, 1583–1601. <https://doi.org/10.1007/s11165-021-09992-8>
- Rankin, Y. A., & Thomas, J. O. (2020). The intersectional experiences of Black women in computing. *SIGCSE'20: Proceedings of the 51st ACM Technical Symposium on Computer Science Education*, 199–205. <https://doi.org/10.1145/3328778.3366873>
- Ridgeway, M. L., & Yerrick, R. K. (2018). Whose banner are we waving? Exploring STEM partnerships for marginalized urban youth. *Cultural Studies of Science Education*, 13(1), 59–84. <https://doi.org/10.1007/s11422-016-9773-1>
- Rieggle-Crumb, C., King, B., & Irizarry, Y. (2019). Does STEM stand out? Examining racial/ethnic gaps in persistence across postsecondary fields. *Educational Researcher*, 48(3), 133–144.
- Robnett, R. D., Chemers, M. M., & Zurbruggen, E. L. (2015). Longitudinal associations among undergraduates' research experience, self-efficacy, and identity. *Journal of Research in Science Teaching*, 52(6), 847–867. <https://doi.org/10.1002/tea.21221>
- Roby, R. S., Udoh, E., Williams, M. R., Hunter, A. E., Warden, A. M., Miles, M. L., & Morton, T. R. (2022). #SayHerName: Anchoring Black feminist epistemologies at the crux of postsecondary STEM culture. *Journal of Women and Minorities in Science and Engineering*, 28(3), 83–99. <https://doi.org/10.1615/JWomenMinorScienEng.2022036607>
- Russo-Tait, T. (2022). Color-blind or racially conscious? How college science faculty make sense of racial/ethnic underrepresentation in STEM. *Journal of Research on Science Teaching*, 59(10), 1822–1852. <https://doi.org/10.1002/tea.21775>
- Seymour, E., & Hewitt, N. (1997). *Talking about leaving: Why undergraduates leave the sciences*. Boulder, CO: Westview Press.
- Seymour, E., Hunter, A. B., & Weston, T. J. (2019). Why we are still talking about leaving. In Seymour, E., & Hunter, A. B. (Eds.), *Talking about leaving revisited* (pp. 1–53). Cham, Switzerland: Springer.

- Solorzano, D., Ceja, M., & Yosso, T. (2000). Critical Race Theory, Racial Microaggressions, and Campus Racial Climate: The Experiences of African American College Students. *The Journal of Negro Education*, 69(1/2), 60–73. Retrieved January 1, 2018, from <http://www.jstor.org/stable/2696265>
- Stanton, J. D., Means, D. R., Babatola, O., Osondu, C., Oni, O., & Mekonnen, B. (2022). Drawing on internal strengths and creating spaces for growth: How Black science majors navigate the racial climate at a predominantly white institution to succeed. *CBE—Life Sciences Education*, 21(1), 1–20.
- Tatum, B. D. (1997). *Why are all the Black kids sitting together in the cafeteria? And other conversations about race*. New York, NY: Basic.
- Thelamour, B., George Mwangi, C., & Ezeofor, I. (2019). “We need to stick together for survival”: Black college students’ racial identity, same-ethnic friendships, and campus connectedness. *Journal of Diversity in Higher Education*, 12(3), 266–279. <https://doi.org/10.1037/dhe0000104>
- Toldson, I. A. (2018). Why historically Black colleges and universities are successful with graduating Black baccalaureate students who subsequently earn doctorates in STEM (editor’s commentary). *The Journal of Negro Education*, 87(2), 95–98.
- Toldson, I. A. (2019). Cultivating STEM talent at minority serving institutions: Challenges and opportunities to broaden participation in STE at historically Black colleges and universities. In Winfield, L. L., Thomas, G., Watkins, L. M., & Wilson-Kennedy, Z. S. (Eds.), *Growing diverse STEM communities: Methodology, impact, and evidence* (pp. 1–8). Washington, DC: ACS Publications. <https://doi.org/10.1021/bk-2019-1328.ch001>
- Turner, S. L., McWhirter, E. H., Lee, H., Mason-Chagil, G., Smith, S., Jacobs, S. C., & Jackson, A. P. (2022). Barriers to STEM Efficacy and Outcome Expectations Among Native American College Students. *The Counseling Psychologist*, 50(7), 981–1008.
- Vakil, S., & Ayers, R. (2019). The racial politics of STEM education in the USA: Interrogations and explorations. *Race Ethnicity and Education*, 22(4), 449–458.
- Van Sertima, I. (1983). *Blacks in science: Ancient and modern*. Piscataway, NJ: Transaction Publishers.
- Vossoughi, S., & Vakil, S. (2018). Toward what ends? A critical analysis of militarism, equity, and STEM education. *Education at war: The fight for students of color in America’s public schools*, 117–140.
- Walls, L. (2016). Awakening a dialogue: A critical race theory analysis of US nature of science research from 1967 to 2013. *Journal of Research in Science Teaching*, 53(10), 1546–1570.
- Washington, H. A. (2006). *Medical apartheid: The dark history of medical examination on Black Americans from colonial times to the present*. New York, NY: First Anchor Books.
- Watkins, S. E., & McGown, B. L. (2022). Black men doctoral scientists and engineering persisting: Peer support and racism in science and engineering. *Journal of Research in Science Teaching*, 59(10), 1853–1875. <https://doi.org/10.1002/tea.21777>
- Weatherton, M., & Schussler, E. E. (2021). Success for all? A call to re-examine how student success is defined in higher education. *CBE—Life Sciences*, 20(3), 1–13. <https://doi.org/10.1187/cbe.20-09-0223>
- Williams, K. L., Russell, A., & Summerville, K. (2021). Centering blackness: An examination of culturally-affirming pedagogy and practices enacted by HBCU administrators and faculty members. *Innovative Higher Education*, 46, 733–757.
- Williams, K. L., & Taylor, L. D. (2022). The Black cultural student STEM success model: A framework for Black students’ STEM success informed by HBCU environments and Black educational logics. *Journal of Women and Minorities in Science and Engineering*, 28(6), 81–108.
- Winkle-Wagner, R., & McCoy, D. L. (2016). Feeling in an “alien” or “family”? Comparing students and faculty experiences of diversity in STEM disciplines at a PWI and HBCU. *Race Ethnicity and Education*, 21(5), 593–606.
- Wofford, A. M., & Gutzwa, J. A. (2022). Funds of science identity: Toward an asset-based framework for undergraduate STEM research and praxis. *Journal of Women and Minorities in Science and Engineering*, 28(3), 59–81.
- Womack, Y. (2013). *Afrofuturism: The world of black sci-fi and fantasy culture*. Chicago, IL: Chicago Review Press.
- Wondwossen, W. (2020, September). The science behind HBCU success: How NSF and HBCUs are supporting research that explores HBCU success rates across all STEM fields a model for broadening participation across higher education. *National Science Foundation*, Retrieved August 25, 2023, from <https://new.nsf.gov/science-matters/science-behind-hbcu-success>
- Wright, C., & Riley, A. (2021). Mitigating the need for resiliency for Black girls: Reimagining the cultural brokering through a lens of science as white property. *Cultural Studies of Science Education*, 16(1), 495–500. <http://dx.doi.org/10.1007/s11422-020-10005-9>