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The racial politics of STEM education in the USA: interrogations and explorations

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ABSTRACT

This special issue brings together a mix of early-career, mid, and senior scholars to critically examine current realities of, and boldly imagine future possibilities for, STEM education in the lives of racially minoritized children in the United States. Given the implicit and sometimes explicit aspirations of STEM education to be a counteracting force against racialized injustice, how do students and communities of color experience and make sense of STEM reforms/initiatives? By examining a broad range of STEM contexts including mathematics, computer science, science and environmental science education, and through a diversity of methodological approaches, this special issue aims to contribute to a scholarly conversation about how racialized power intersects with the larger themes and foci of STEM education. In our introduction, we both highlight broad themes of the issue, and offer possible directions for future research at the intersections of race, power, and STEM.

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Introduction

The recent blockbuster movie, *Black Panther*, was hailed as a breakthrough in advancing a compelling narrative of Black Power in the superhero genre. Unquestionably, audiences were entranced by a first for the Marvel comic series, a cinematically beautiful production which simultaneously forced them to grapple with themes of Black global liberation and freedom, and invited them to imagine the possibilities of a technologically advanced civilization untouched by the scourge of white imperialism and war. We begin with this film because it demonstrates how even within what is arguably a critical intervention on our contemporary discourse on race, the film still indulges an increasingly dominant narrative suggesting that STEM – science, technology, engineering, and mathematics – is key to combating racialized oppression. In the imaginary sub-Saharan African nation called Wakanda, it seems that science and technology advances have created the military power and wealth of the nation-state and advanced the well-being and happiness of the people.

Audiences are mesmerized by the uses of STEM in developing the superhero capabilities of Wakanda's ruler, King T'Challa (Chadwick Boseman). However, the

movie begins and ends in a poor Black neighborhood in Oakland, California, which establishes a diasporic connection between what the film depicts as the respected and respectable African nation, and poor and poorly educated Black people in the United States who continue to suffer the legacy of slavery and its afterlife (Hartman 1997; Sharpe 2016). In the final scene of *Black Panther*, through what is framed as a solution to centuries of oppression, the Wakandan King T'Challa makes his way back to Oakland and opens a STEM center for the city's underserved Black youth.

The need to explore the racial politics of STEM education

The idea of access to STEM education as a key mechanism to addressing racial injustice did not begin with *Black Panther* or with Hollywood for that matter. For instance, the notion that access to STEM is key in mitigating decades of structural inequality in Oakland, California, is in line with the Disney Corporation's plans to open 'STEM Centers' in Boys and Girls Clubs of Oakland and other major urban centers including Harlem and Chicago (Pereira 2018). This framing also reminds us that in 2015, on the heels of a hefty investment from the Intel corporation, civil rights leader Jesse Jackson visited Oakland public schools urging students to 'stop the violence' and instead, learn how to code and pursue careers in Silicon Valley (Nasir and Vakil 2017; Vakil 2018). In Oakland, not unlike other major urban metropolises in the US, STEM 'for all' has become all at once the rallying cry, a call to action and moralizing rhetorical device for an educational movement with seemingly endless funding and political support – a movement whose STEM education reforms and initiatives frequently target urban schools located in districts with high numbers of students of color.

This particular focus on students of color raises a number of important questions: In the first place, given the implicit and sometimes explicit aspirations of STEM education to be a counteracting force against racialized injustice, how do students and communities of color experience and make sense of STEM reforms/initiatives? In what ways are STEM reforms implicated in the advance of neoliberal multiculturalism, antiblackness, colonialism, white supremacy, and militarism in this unique historical moment? Moreover, what are the racial logics that inform how STEM is deployed as a 'justice' and/or 'civil rights' intervention? How do the racialized politics embedded in these reforms become embodied and contested in school cultures, curricular and epistemological priorities, and pedagogical practices? Across the articles in this issue, these and related questions are taken up through various critical examinations of race and power, and through diverse methodological approaches ranging from conceptual and theoretical interventions, to ethnographic and micro-ethnographic empirical studies of teaching and learning.

STEM (education) as socially constructed, contested, and indispensable

Some may misinterpret a special issue dedicated to critically examining the racial politics of STEM as 'anti-STEM.' While indulging such a misreading would distract from the important work put forth by authors in this collection, we nevertheless offer

a brief statement on our epistemological stance on STEM as a dynamically evolving body of knowledge and set of practices to create openings for broader engagement with the core ideas of this issue.

First, we unequivocally state the importance, value, and heterogeneous intellectual, social, economic, and environmental benefits of science, and hence the indispensability of science (and STEM) education. The culturally-mediated and always socially constructed practice of science represents the remarkable achievement of organized, collective human activity for millennia, activity which is fundamentally rooted in the basic drive to explore the mysteries of the universe, to make sense of complex phenomena, to expand the boundaries of knowledge and to develop tools and technologies to advance the quality of life. Yet the fundamentally human nature of science is both blessing and curse, and raises complex questions about power and the social purposes and contexts of science. Whose science? When, what, and science towards which ends? What counts and who gets to decide? While engaging these questions fully would require a lengthy detour into debates around culture, epistemology, and ontology, most commonly taken up in the interdisciplinary field of Science and Technology Studies (STS), we briefly review implications for a situated view of science (Haraway 1988) for analyses of race and power with respect to education.

The omission of scientific histories, theories, contributions, and ways of being and knowing of historically non-dominant students of color in Western schooling contexts is a form of erasure and epistemic violence (Bang and Medin 2010; Spivak 1988). Scientific knowledge is commonly presented as settled truth, rather than a dynamically evolving, contested and culturally mediated body of knowledge and set of practices deeply enmeshed with the human experience. Although foregrounding the human forces that have shaped and continue to shape the character of science and technology may appear readily evident, the prevailing discourse in education suggests that knowledge in science and technology is autonomous and 'objective,' severely downplaying cultural and political aspects of knowledge production in these fields. For example, scholars scarcely and insufficiently reckon with the ways that science and technology play mediating roles and are embedded within complex sociopolitical ecologies that are linked with war and militarism (Leslie 1993; Vossoughi and Vakil 2018), or corporatism and consumerism (Noble 1979).

Science is surely not defined by these forces, but without rigorous assessment of the fundamentally political ways science can be deployed towards unjust and harmful ends, we are left with an incomplete, at best, or at worst a dishonest representation of what science is. And it is precisely this omission, this unwillingness to grapple with the larger political, ideological, and *racialized* context of STEM education that frames and gives purpose to this collection. In the remainder of this introduction, we provide a brief overview of two overarching themes the articles across this issue engage. In the first, we take a closer look at how discourses of multiculturalism and inclusion in STEM operate with respect to race, power, and racialization processes in schools. In the second, we invite a reimagining of learning in STEM anchored in race-specific visions of freedom and liberation.

Problematizing dominant narratives of STEM education

In a recent critical review of equity perspectives in STEM education research, Vossoughi and Vakil (2018) ask ‘STEM Towards what ends?’ a challenge for the field and proponents of STEM education to make explicit what are often invisible political and economic goals of STEM educational expansion efforts, particularly those targeting historically marginalized communities and schools. As Martin (this issue) argues, ‘the ideas of equity and inclusion in mathematics [and STEM] education have, for the most part, escaped critical analysis.’ (pg X) The critical analysis Martin calls for shines a light on what Sengupta-Irving and Vossoughi (this issue) refer to as ‘the inextricable link between STEM learning, national economic gain, and global ascendancy.’ (pg X) Education in the sciences, mathematics, and technology rides in as the emperor’s new clothes, regarded with awe but seldom subjected to analytical or political scrutiny. Often critical education scholars and educators fall into passivity in the face of a narrative that presupposes the value of STEM education as unassailable. Recognizing this gap, as a field we must ask: How do dominant narratives in STEM education position students of color as the taken-for-granted beneficiaries of educational policy, new curricula, or equity scholarship in STEM?

Nxumalo and ross (this issue) explore this question in their examination of the ways antiblackness functions in environmental education for young children. They explore how Black children are altogether excluded from nature spaces, or included through ‘discursive constructions of nature as a source of “fixing” certain children’ (pg X). They add, ‘The construction of Black childhoods as out-of-place in or out-of-touch with natural spaces, without attention to structural inequality, helps enable nature education to be positioned as a form of rescue, such as in improving the developmental trajectories for so-called “at-risk” Black children’ (pg X). Beyond exposing an ideology of rescuer and rescued, their work also interrogates the refusal of Black childhood through racial innocence narratives – narratives that they argue hold innocence as the exclusive possession of white childhoods. In this way, Black children *become* the deficit and dysfunction that already exists in the racialized spaces they inhabit; urban school gardens and other environmental educational programs then, become ‘ways to offer certain children respite from “rough” neighborhoods, to help them to develop “normal” relations with nature, and to learn about healthy foods, for children always already viewed as lacking’ (pg X) This gestures towards what Sengupta-Irving and Vossoughi name as the politics of respectability in STEM, in which persons devalued in society will be valued when they reflect what the market values (e.g., STEM skills), as a way to end racialized poverty by gaining power within capitalism. Coupled with the politics of representation, where the diversification of who wields power displaces the questioning of power structures themselves, participation in STEM is framed as what students of color *should* do if they have an interest in their individual or collective advancement (Sengupta-Irving and Vossoughi this issue).

Also in this issue, Morales-Doyle and Gutstein examine how educational leaders and city officials have imposed dominant framings of STEM in recent high-profile school closures in the Chicago Public School (CPS) system, which have overwhelmingly displaced African-American and Latinx students. Within the ‘portfolio

district model,' reflecting the national trend towards market-based solutions to public education, students stripped of their neighborhood schools are presented with the 'opportunity' to enroll in STEM-based schools. In this way, 'STEM education in CPS is implicated in school closings and the forced removal of huge swaths of communities of color, as part of remaking Chicago as a so-called global city..' (pg X) However, this 'option' also disguises that the offering is of less high profile or prestigious STEM careers, those primarily requiring low-skill and existing on the lower rungs of a racially stratified labor force – careers such as laboratory assistants, digital line-workers, and technicians. This particular outcome of STEM educational reforms represents an often glossed over manifestation of racial capitalism (Robinson 2000), where individuals are promised access to economic and social mobility, but in reality set up for highly tenuous career paths with minimal opportunity for positions of leadership or power. In addition, low-level pathways to STEM careers rarely empower students from racially nondominant communities with the agency to raise critical questions, challenge, or otherwise intervene on ethical and moral abuses of power.

Another dominant STEM narrative is that of the 'pipeline.' While discussion of the 'STEM pipeline' is somewhat commonplace, and often invoked unproblematically, we take a more expansive view of the STEM 'pipeline' to examine ways that STEM education serves as a conduit for participation in a range of industries, agencies, and STEM careers, in addition to dominant ways of being, thinking, and learning STEM. For instance, as referenced earlier, normative forms of science education erase through omission nondominant epistemologies, and privilege Eurocentric epistemologies. Nxumalo and ross (this issue) take this up in the context of how school gardens have figured prominently within early childhood environmental education: '...instrumentalization of school gardens leaves little room for unsettling hierarchical perspectives between humans and nature since nature is valued primarily for what it can do for certain children.' (p. XX) They go further, questioning the often implicit assumption that children of color in urban environments lack substantive or meaningful interactions with nature:

There is also a risk of limiting what counts as nature in urban environments, reinscribing colonial nature/culture divides, and ignoring the multitudes of life forms that are always present in urban environments outside of the boundaries of the school garden. (p. XX)

The STEM as pipeline frame is commonly employed (in national reports, scholarly articles, news media articles) as a way to illuminate the pathways from early childhood education to advanced STEM careers, such as engineer, research scientist, or university professor. Particularly in discussions of equity and diversity in STEM, the metaphor is extended to address 'leaks' in the pipeline, what are thought of as dysfunctions in the educational system that contribute to students dropping out of the STEM pipeline. The corrective action, then, is to patch up the leaks so that all deserving students can find their place in the STEM ecosystem.

Running with the metaphor, in this issue we also ask: *Is the destination of the pipeline always a desirable destination, particularly for children and communities of color?* Or as Martin questions, 'First, into what have we been asking Black learners to integrate; what is the fundamental character of mathematics education that has contributed to Black learners being less than full participants and experiencing dehumanizing treatment

when they do participate?’ (pg X) We must also pose another kind of question with respect to the pipeline: What of the students who decide to leave to pursue other interests? Are they failures? We issue a challenge to the ways that the metaphor ‘implicitly assumes that racially minoritized students and girls should pursue a STEM career, which hints of paternalism in negating the possibility that not choosing STEM careers reflects sound reasoning.’ (Sengtupa-Irving and Vossoughi this issue pg X) While the STEM pipeline metaphor may be helpful in ongoing efforts to remedy the unequal distribution of learning opportunities within social or institutional contexts, it simultaneously advances a particular framing of race, children, and STEM that we refute in this collection.

Reimagining the place of politics and identity in STEM

How do we hold the above truths regarding the cultural and racial politics of current dominant forms of STEM education without losing hope and excitement for the transformative learning possibilities in STEM? How do we eschew cynicism about the place of STEM education in our children’s lives? How do we resist reducing a progressive agenda in STEM education to the savior politics of diversity and representation? We advocate instead for a two-fold approach that entails what Dumas and Ross (2016) call a politics of refusal, coupled tightly with an ambitious reimagining of what learning in STEM could and should be. A politics of refusal in STEM means recognizing the historical contributions and profound significance of science, while also refusing to ignore the myriad ways in which scientific knowledge and forms of racialized power have co-constructed one another historically and in the present (Baraka 1971; Haraway 2013; Star 1999).

Importantly, refusal and reimagining do not operate as distinct processes. As Martin (this issue) explains: ‘Envisioning and actualizing this refusal requires one to invoke Black radical imagination (Kelley 2002) and engage in Black liberatory fantasy (Dumas and Ross 2016) about the form and structure of such refusal and how it facilitates Black people flourishing in their humanity.’ (p. XX) The work of reimagining what is possible within and in relation to STEM learning rests on, indeed relies on, critical understandings of how current foundations of STEM education invoke, reinforce, reflect, and refract anti-Black, settler-colonial, and neoliberal sociopolitical structures and ideologies in society.

The kind of refusal and reimagining we envision begins with a reconfiguring of available subject positions for STEM learners (Davies and Harre 1990) in which contradictions between students’ political selves and identities, and their academic/disciplinary identities are explicitly contested and transformed. Research on academic identities in STEM tends to focus on their perceived relevance to the psychological and social dimensions of learning (e.g., Wenger 1999). Sociocultural learning scientists have expanded the scope to include a focus on students’ cultural and racial identities, theorized as relevant to academic identity and therefore academic achievement (Martin 2000; McGee and Martin 2011; Nasir and Hand 2006; Tatum 1992). Political identity, though, has largely been viewed as outside the scope of research on learning in STEM. Yet, it is precisely this focus that we invite readers to consider in this collection. Imagine the possibilities that open when being a ‘STEM person’ (as a programmer,

student, teacher, scientist, engineer, technician, or professor) invites a world view and set of cultural, ecological, and societal storylines that are synergistic with the kinds of values, morals, and ethics associated with participation in historical resistance and freedom struggles. One can be a scientist or engineer and a community activist without irony or pause. Or a *political* engineer, for instance, whose curiosity and pursuit of technical knowledge and understanding is always guided by a motivation to imagine and design new technologies that resists oppression and empowers marginalized groups in society. Notably, while STEM professionals with sociopolitical identities have always existed, and continue to exist (e.g., recent employee-led protests at Google, Microsoft, and other high-profile tech-companies), the relationship between one's political stance and skillful mastery of a technical domain remains tenuous, the notable exception, or co-existing but marginally related to one another. This stands in contrast to other knowledge domains, literacy for instance, where historical figures such as Malcolm X, and more broadly the Black educational tradition (Walker 2000), teach us that processes of learning and liberation can and must be deeply intertwined.

To construct these newly imagined worlds of STEM where liberatory politics and deep disciplinary learning co-exist and co-develop will require new kinds of inter- and transdisciplinary methodological design and inquiry. Drawing on speculative fiction and recent theorizations of Black space in education (Ross [forthcoming](#)), Nxumalo and ross (this issue) engage in what they call 'speculative reconfigurings' that burst open the realm of possibilities in environmental education:

In these imagined Black fugitive futures, racial innocence is disrupted. Play, embodied encounters with the outdoors, humor, activism, environmental science, environmental racism, history, Black and Indigenous geographies, and more, are all necessary parts of Black space in environmental education for young children. (p XX)

Nxumalo and ross's approach of advancing speculative fiction as a creative and generative mode of imagining liberatory educational spaces resonates with and extends Freirian-inspired social justice traditions in mathematics and science education (Barton 2003; Gutstein 2006; Morales-Doyle 2017), where educators work with students and communities to identify local place-based problems to explore and address using STEM knowledge and tools. Across these approaches, an ethic of participatory design (Bang and Vossoughi 2016; Fine 2009; Gutiérrez and Vossoughi 2010) is vital to ensuring new visions for learning are co-developed in solidarity with marginalized communities. Morales & Doyle (this issue) present the case of Walter H. Dyett High School in Chicago as a prime example, a public school that would be closed if not for the historic 2015 hunger-strike that was part of a multi-year community resistance (Ewing 2018). As described in the article, the newly opened school was built on 'community wisdom' which prioritized design goals organized around environmental, economic, and racial justice.

Lifting up the wisdom, knowledge, identities, values, and cultural and political ways of knowing and being within historically racialized and nondominant communities is not a romantic disposition or a political gesture empty of substance, but rather one that recognizes how 'racially minoritized women [and communities] have continuously innovated and created against the tight constraints of racial, class, and gender oppression; they are innovators and creators bone-deep.' (Sengupta-Irving and Vossoughi, pg

X). New visions for STEM learning as part of a practice of freedom and justice demands deep attention to these bone-deep historically and culturally mediated forms of ingenuity (Gutiérrez et al. 2017). In the same vein, the work of reimagining must center ‘minoritized students’ subjective experiences as we learn what it takes to create places of refuge and joy that refuse a loss of self.’ (Sengupta-Irving and Vossoughi, pg X)

Centering students’ subject experiences, including their racialized and politicized identities, issues a challenge to STEM educational designers and educators to think beyond revised learning objectives or the inclusion of culturally relevant content in new curricula. This is too often a matter of using culturally relevant moments as a ‘hook’ to interest students without deeply reframing the underlying values, practices and purposes of STEM disciplines. The experience of learning, we must remember, is ‘enmeshed with ethical relations’ (Sengtupa-Irving and Vossoughi, pg X) and fundamentally rooted in the nature of human relationships that come to define any particular learning environment.

For instance, in a recent study of 6th-graders using technology to design an app to address the issue of police violence in their community, Vakil and de Royston (2018) show how one upper-middle class boy was able to dominate and suppress the perspectives of the other boys who resided in a severely socioeconomically marginalized neighborhood in their city. The quality, and trajectory of, social relations determined the final project the students ‘collaboratively’ designed (a mobile app that assisted police officers), and an educational experience that was designed to empower ultimately missed the mark.

In this issue, Vakil and McKinney de Royston look at another example of how relationships between students can have profound implications for learning in ways that derail what may have been learning goals organized around justice and empowerment. In this case, students in a racially diverse high school computer science class were engaged in a project to address racial inequalities in their school. However, due to mounting tensions between students of color and white students in the class, centering sociopolitical content in class discussions elevated existing rifts in the class and the school at large. Reimagining what STEM learning might be, therefore, must also entail a deep attention to the quality of student relationships, and in particular, how race and power mediate these relationships in classrooms where socioeconomic and race-based divisions are an undeniable component of the social life of schools.

A necessary conversation

We hope that this special issue will stimulate and amplify a critical conversation about STEM education and race in this particular historical moment. On the one hand, within European nations and the United States, we are witnessing the deeply troubling ascendancy of white nationalist, xenophobic, anti-Black, anti-Semitic, and anti-Muslim elements in popular society as well as in the halls of power. Yet, simultaneously, we are in a political moment defined by impressive shows of solidarity, resistance, and opposition to reactionary forces, especially among young people, people of color, and other marginalized groups across the globe.

Within these contradictions and possibilities, however, the role, purpose, and positionality of STEM and STEM education is stunningly absent from the broader intellectual and

political discourse. This is true despite the overwhelmingly powerful role science and technology play in global and local conflicts (e.g., technologies that enable the continued Israeli occupation of Palestine, surveillance technologies that monitor the #BlackLivesMatter movement, drone technologies and political assassinations during the Trump and Obama presidencies, allegations of Russian hacking of the U.S. election). This special issue intervenes precisely to illuminate and amplify the process of filling this critical gap in scholarship. While keeping the power, tension, danger, and democratic potential of the current moment in the forefront, the articles in this issue attend directly with how racialized power intersects with the larger themes and foci of STEM education, collectively contributing to an incisive critical race analysis of STEM education.

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