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Emancipating STEM Education through Abolitionist Teaching: A Research-practice Partnership to Support Virtual Microteaching Experiences

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ABSTRACT

In this paper, we share an approach to address systemic racism by highlighting a research-practice partnership [RPP] effort between a university and STEM program (I AM STEM) to understand the extent to which centering abolitionist teaching and emancipatory practices in a science methods course supported teacher candidates' virtual microteaching experiences. This study's conceptual framework put research-practice partnership in conversation with abolitionist teaching (Love, 2019) and community cultural wealth to explore access to STEM teaching and learning. We highlight the experiences of four secondary science teacher candidates through an embedded single case study. Data sources included observation field notes, microteaching reflections, semi-structured individual interviews, and lesson plans, which were analyzed using constructivist grounded theory approaches. Findings revealed that the teacher candidates embraced the concept of abolitionist teaching to inform their microteaching experiences by leveraging social justice standards and emancipatory pedagogies. The participants developed science lessons that honored students' cultural capital through critical readings, discussions, and reflections. Furthermore, the RPP between I AM STEM and the partnering university provided supports to contextualize and humanize science learning for Black and Brown children in online learning spaces. To expose and dismantle racism in science education, we must reimagine our science teacher preparation programs and courses. Thus, emancipating STEM education means engaging in the struggle toward humanity and collective healing. Abolitionist teaching within the context of science education does not require another reform effort. To disrupt systemic oppression, we must demand restorative justice and engage in direct transformative action.

KEYWORDS

Research-practice partnerships; pre-service science teacher education; microteaching; abolitionist teaching; community cultural wealth; COVID-19

> An abolitionist teacher is someone who does not take no for an answer. Doesn't take silence for an answer and navigates what negatively impacts the students. If it's not equitable, there's a problem. If there are distinct differences in how these students get treated versus how those students are getting treated, then there's a problem. Anything that destroys our students is a problem. While it's not my fault, it is my responsibility to fix it. It is my job as an abolitionist teacher to make sure that they don't experience inequities and that they have a fair opportunity. This includes fighting systemic barriers and systemic oppression.
>
> (Nate, Individual Interview, November 2020)

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In early 2020, the coronavirus (COVID-19) pandemic spread throughout the U.S. leading to the closing of 124,000 private and public schools that served 55.1 million school-aged students (Map: Coronavirus and School Closures, 2020). School building closures disrupted the traditional model of how children accessed education and exasperated existing inequities in low-income Black and Brown communities (Egede & Walker, 2020). As the school year ended, rhetoric around summer learning slide and learning loss increased because researchers emphasized aspects of schooling that were interrupted rather than what students were learning about themselves and others while simultaneously surviving multiple pandemics of COVID-19 and anti-Black racism. The New York Times described this phenomenon as a "pandemic within a pandemic" in which Black people are more likely to die at the hands of police officers and also are disproportionately at a greater risk of contracting the virus and experiencing poor health outcomes (Stolberg, 2021). The brutal killings of Black bodies at the hands of police with victims such as Breonna Taylor, George Floyd, and Rayshard Brooks left children with no room in traditional classrooms and curricula to grapple with vexations. *What larger structural and systemic issues have disenfranchised Black and Brown children—leaving them unprotected and vulnerable amid global pandemics? Were Americans still living the fallacy of a post-racial society and were schools equipped to interrogate White Supremacy and inherently racist policies and laws? How could we create spaces for children to engage in critical conversations and foster community?* These questions spurred us to consider the roles of science education and supports needed for preservice and in-service teachers during unprecedented times. We embarked on a journey to assist teachers in creating community and contend with what it meant to teach in classrooms that infiltrated children's homes and spanned across multiple modalities such as face-to-face, online, hybrid, and hyflex (combines the terms "hybrid" and "flexible" for the simultaneous integration of face-to-face instruction and online learning).

The year 2020 conjured more questions than answers, and normal routines shifted as people across the world grappled with trauma, grief, and loss, searching intently for hope, healing and restorative justice. The state of education coupled with civic unrest guided the development of a virtual iteration of the science, technology, engineering, and technology (STEM) camp—I AM STEM (a pseudonym) to provide emancipatory and transformative spaces for Black and Brown children to engage in difficult but necessary conversations and think critically about the country's current state. Emancipatory pedagogy centers the manifestation of humanization, critical conscientization, and a problem-posing educational system in creating a more just and democratic society (Nouri & Sajjadi, 2014). This approach invites educators and students to engage in sociopolitical awareness and negotiate curriculum collaboratively toward positive reform. Furthermore, emancipatory pedagogy centers students as critical agents and problem-posing pedagogy that is indigenously voiced (Swartz, 1996). In our efforts to emancipate STEM education, we drew on Love's (2019) notion of abolitionist teaching and mattering—the quest for humanity. She reminds us that reform alone is not justice and that freedom does not precede struggle. We must engage in this fight and work in solidarity to address issues that prevent our children and communities from thriving. In framing emancipatory pedagogy through the lens of developing abolitionist science teachers, we center agitation, activism, and advocacy as mechanisms for educators to work within educational structures while also seeking to dismantle oppressive systems. Agitation, as defined by Love and Muhammad (2020), is the act of disturbing, disquieting, and unhinging multiple forms of systemic oppressions. Natural ways that we

have connected Nouri and Sajjadi's (2014) definition of emancipatory pedagogy with Love's (2019) concept of abolitionist teaching are by prioritizing antiracist curricula over color-blindness and the lives of students over state-mandated standards.

We opened the paper with a statement from Nate, a student in the Master of Arts in Teaching (MAT) initial teacher preparation program, who enrolled in the methods course that was redeveloped to center abolitionist teaching and our quest toward leveraging emancipatory pedagogies in science. Teacher candidates were provided with spaces to reconceptualize their purpose(s) and roles within classrooms that served urban communities, particularly as they prepared to enter classrooms that vastly differed from the ones they experienced as learners and imagined leading as teachers. The study explores a research-practice partnership (RPP) between an institution of higher education and summer camp with access to teaching and learning serving as the problem of practice that united the two entities. Undergirding the partnership was a commitment to leveraging community cultural wealth (Yosso*, 2005) to inform the development and enactment of emancipatory pedagogies. Specifically, we focus on the microteaching experiences of teacher candidates in an introductory methods course and the intentional centering of critical readings and discussions that informed their participation in I AM STEM and pursuit of abolitionist teaching. The term *teacher candidates* is used because the MAT program is an initial teacher preparation program that prepares pre-service and provisional teachers for certification in 6–12 broad field science, biology, chemistry and physics. Therefore, some students are full-time instructors of record while others are recent graduates or career changers who have little to no classroom experience. The following research question guided the study: To what extent does centering abolitionist teaching and engagement in microteaching experiences through a research-practice partnership prepare teacher candidates to teach science to Black and Brown children?

Researcher positionalities

As we seek to emancipate STEM education and contextualize our study within issues of power, oppression, and justice, Maulucci and Mensah (2015) remind us that naming is a political act of ascribing identities to ourselves and others. In naming, we are cognizant of our own positionalities as researchers and acknowledge the intersectionality of our identity markers and roles in this work for increased transparency.

Author 1—Vanessa identifies as a Black woman, science teacher, descendent of immigrants, and as a researcher. She situates herself as a practicing scientist and currently serves as a high school science teacher of 6 years who is committed to strengthening out-of-school time (OST) STEM programs. Vanessa co-organized the virtual STEM program and was a graduate teaching assistant in the secondary science course for the master's degree program. She helped to facilitate readings and critical discussions on abolitionist teaching with this study's participants. She also reviewed reflections, engaged in informal conversations, and provided feedback on how to incorporate social justice standards and Culturally and Historically Responsive Education (Muhammad, 2020) in their development and implementation of the science lessons.

Author 2—Natalie serves as the founder and executive director of the summer STEM camp—I AM STEM, and faculty member at the partnering institution. She identifies as a Black woman activist scholar whose purpose in the academy is to serve Black and Brown

communities and provide a platform to elevate their voices. She has directed OST summer STEM programs for over a decade with experience establishing and sustaining RPPs that focus on increasing access and equity in STEM education. Natalie considers herself to be a cultural broker amongst I AM STEM, partnering institutions of higher education, community-based organizations, and youth and their families by serving as an intermediary to strategically bridge and negotiate relationships across entities.

Review of the literature

Abolitionist teaching and the educational survival complex

The abolitionist movement began with Black women teachers who fought to eradicate the slave trade (Hartman, 2007) and present Black people's humanity through education. Neal and Dunn (2020) wrote, "These women conjured revolutionary dreams of freedom—the life force that animated their motivations for teaching, pedagogies, and sociopolitical activism" (p. 59). Bettina Love (2019) studied this dedication to change and positioned abolitionist teaching as the catalyst for freedom, dreams, cultural expression, and visionary thinking. Black and Brown students' education has been a cultural assimilation process; if students fail to assimilate and fit the norm, they cannot be successful within the classroom. Abolitionist Angela Y. Davis (2011) suggested that "when children attend schools that place a greater value on discipline and security than on knowledge and intellectual development, they are attending prep schools for prison" (p. 39). The current state of education is constructed to filter Black and Brown students through the school-to-prison pipeline. The process of dismantling the pipeline illuminates James Baldwin's (1963) declaration that teaching Black students is a revolutionary act. This act works to challenge what Love (2019) described as the educational survival complex—a system built on Black and Brown student suffering in which they are educated with the intention of surviving rather than thriving. According to this complex, the focus of policies and teachers has been to *fix* students instead of engaging in a movement that centers radical systemic change. As Rodríguez (2010) stated, liberatory teaching that employs critical pedagogy practices becomes an abolitionist act. Therefore, any process used to locate the source of suffering and deconstruct Black and Brown students' structural oppression is seen as abolitionist teaching.

Current state of science education for Black and Brown students

In science education specifically, Bryan Brown (2019) noted the existence of a generational educational dilemma that involves stereotypes used to determine who can and cannot participate in science. This dilemma in science education has created a narrative that Black and Brown students are not active science participants or do not adequately reflect scientific talent. Stubborn statistics reported by the National Science Foundation (2017) reveal that many science and engineering degrees awarded to Black students remain flat, while those awarded to their White and Asian counterparts have increased. Scholars have explored factors that influence the low STEM degree completion rates (especially in certain degrees) and reported cultural or academic isolation, faculty low-performance expectations, unsupportive peer groups, and discrimination as some of the mitigating factors impeding retention (Gandara & Maxwell-Jolly, 1999; Steele & Aronson, 1995). The urgency to study

the experiences of students of color in the science disciplines has erected a body of research centered around recognizing the cultural sensitivity of science teaching and learning across K-20 contexts (Gilbert & Yerrick, 2001). Science classrooms routinely promote assimilation and linguistic conflict (Fradd & Lee, 1999), and gender, and ethnic identity dissonance through inappropriate curricula and toxic learning environments (Brickhouse, 1994).

In school-based learning spaces, many U.S. states have adopted the Next Generation Science Standards (NGSS) that was birthed out of the *Framework for K-12 Science Education* (National Research Council, 2012). NGSS employs a three-dimensional model that blends science and engineering practices, disciplinary core ideas, and crosscutting concepts. The framework used to inform the standards states, "a major goal for science education should be to provide all students with the background to systematically investigate issues related to their personal and community priorities" (National Research Council, 2012, p. 278). While a 41-member Diversity and Equity Team met at the inception of NGSS and were tasked to ensure that student identity and community were illustrated within the standards, the diversity component is currently situated in Appendix D of the standards far away from the primary scientific components. Therefore, the council's ideological commitments in the standards have hindered their usefulness within schools serving predominantly Black and Brown students (Morales-Doyle et al., 2019). An equity agenda is required that centers the needs and community cultural wealth of Black and Brown youth so that they no longer exist in the margins of science education reform documents, schools, and society writ large. In our research, we drew upon emancipatory pedagogies to decolonize curriculum and center the histories, identities, and lived experiences of Black and Brown learners whose contributions are not readily recognized or leveraged in traditional White heteronormative classrooms. While we prepare pre-service teachers to design standards-aligned lessons, the content standards and practices are secondary when one is committed to social justice and connecting with students' interests and cultures.

Community cultural wealth in STEM learning spaces

Yosso*'s (2005) Community Cultural Wealth (CCW) model examines the under-utilized assets that Black and Brown students bring into the classroom and illuminates the potential to transform current school climates. Traditional education models use a deficit lens to portray Black and Brown communities as spaces of "cultural poverty disadvantages." At the same time, CCW "focuses on and leans from the array of cultural knowledge, skills, abilities, and contacts possessed by socially marginalized groups that often go unrecognized and unacknowledged" (Yosso*, 2005, p. 69). In conjunction with critical race theory (CRT), CCW acknowledges aspirational, familial, social, linguistic, resistant, and navigational as the six forms of capital that work together to support Black and Brown students as they navigate the current monovocal school climate. As Valenzuela (1999) illustrated, schools often work to support students that are "disadvantaged" in the areas of race, class, and culture in which their cultural capital does not match the recognized norm.

Research in STEM education have acknowledged and reported the importance of leveraging CCW. Ortiz et al. (2019) explored the community cultural wealth of Black students and how they cultivate STEM identities. Their findings have implications for how the various forms of capital can inform the preparation, recruitment, retainment, and graduation of the Black students pursuing STEM majors and careers. Kelly et al. (2019) utilized the

CCW model to examine a hands-on bilingual STEA^{2}M camp that offered Mexican American students the opportunity to engage with agriculture during summer break. The study documented interests in agriculture and a new drive to continue the development of their Spanish language mastery. Samuelson and Litzler (2016) utilized the CCW model to examine the capital Black and Brown students use to navigate college engineering programs. The study found that students use navigational and aspirational capital heavily and that Black women and men activate their capital differently (Samuelson & Litzler, 2016). As Yosso* (2005) stated, "These experiences expose the racism underlying cultural deficit theorizing and reveal the need to restructure U.S. social institutions around those knowledge, skills, abilities, and networks—the community cultural wealth—possessed and utilized by People of Color" (p. 76).

Conceptual framework and research context

To explore the centering of abolitionist teaching in science and the engagement of teacher candidates in microteaching experiences within a methods course, the conceptual framework put research-practice partnership (Penuel & Gallagher, 2017) in conversation with abolitionist teaching (Love, 2019) and community cultural wealth (Yosso*, 2005). See Figure 1 for a visual depiction of this model.

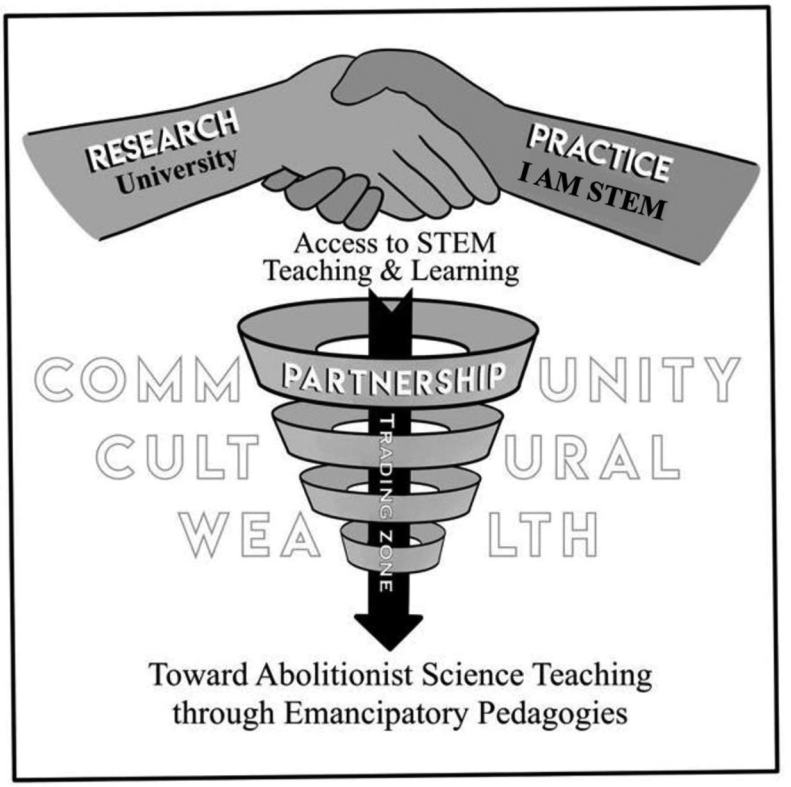

Figure 1. Conceptual framework.

The RPP between an institution of higher education and the I AM STEM summer camp (context of this study) was initiated and sustained to increase access to STEM teaching for prospective educators and learning for Black and Brown children and their families. Penuel and Gallagher (2017) define RPPs as "long-term collaborations between practitioners and researchers that are organized to investigate problems of practice and solutions for improving educational systems" (xi). Four key characteristics that guide RPPs are the focus on problems of practice, long-term commitment of partners, mutualistic relationship through the employment of intentional strategies, and a generation of original analyses instead of merely repackaging existing data (Penuel & Gallagher, 2017). To extend this definition and characteristics, Resnick and Kazemi (2019) state, "Research-practice partnerships offer the potential for collaborative, context-specific approaches to supporting practitioner learning" (p. 1). RPPs can be established to engage in justice-oriented efforts to moderate inequities, but partners must engage in local sense-making (Bevan et al., 2018).

This study's RPP occurred within the contexts of a secondary science methods course in an urban research university and a summer program. The course was the first of a 3-semester sequence that centered pedagogical content knowledge, curriculum planning, teaching strategies and methods, content, and technology necessary for secondary science education. The first reading in the secondary science methods course focused on abolitionist teaching and disrupting the educational survival complex (Love, 2019). As teacher candidates grappled with what it means for Black children to thrive in a system that was designed to oppress and exclude them, we introduced lesson planning and more asset-based and affirming approaches to curriculum development. We highlighted frameworks such as Ladson-Billings (1995) Culturally Relevant Pedagogy, Asante's (1991) Afrocentric Pedagogy and Muhammad's (2020)'s Culturally and Historically Responsive Education. These pedagogies center students' cultures, identities, sociopolitical awareness, and criticality. We operationalized this justice-oriented focus by using the social justice standards as a framework for anti-bias education (Southern Poverty Law Center, 2016). The social justice standards are comprised of anchor standards and age-appropriate learning outcomes that are divided into four domains—identity, diversity, justice, and action. The partnership's research component occurred within the science methods course that featured discussions, a book study, and microteaching experiences. Teacher candidates implemented lessons and engaged with students within the context of the virtual STEM camp—I AM STEM (the practice component of the study). This partnership prepared MAT students for their future classrooms that would be everchanging during a global pandemic. I AM STEM has been linked to various positive academic and pedagogical impacts, such as increased participation in advanced science courses (King & Pringle, 2019); broadening of novel teaching practices in multicultural contexts (King, 2017); improved access to participation in STEM (King et al., 2021), and development of strong STEM identities (King et al., 2020). Since its inception in 2012, the program has served over 1,600 K-12 children and their families by providing STEM enrichment, mentoring, tutoring, and social-emotional development for participants' overall well-being. Curricula includes topics such as Black & Latino History, computer science, health and wellness (emphasis on COVID-19), (Un)Hidden figures in STEM, digital storytelling, mathematics in graffiti, and ethnomathematics. I AM STEM offers Black and Brown students access to STEM, as illustrated in Figure 1, and provides a safe space for teacher candidates to engage with culturally diverse students for their microteaching experiences. The racial demographics of children served in the 2020 iteration

of the program was 264 who identified as Black/African American, 10 as Biracial, 13 Latino/a, and 13 as White. Camp participants spanned 21 U.S. states, the District of Columbia, Jamaica, and Trinidad and Tobago.

In direct response to COVID-19 and social distancing mandates, this was the first year offering the STEM camp and science methods course online. In the RPP, teacher candidates engaged in weekly synchronous meetings and taught three 45-minute STEM lessons at I AM STEM. The first one was a science lesson that they cotaught with a peer, the second was a science lesson that they facilitated individually, and the last lesson was co-planned and cotaught with a MAT student in mathematics education. Teacher candidates developed a lesson plan and scholar resource card that included materials that youth participants needed, delivered the lesson, and wrote a reflection. While teacher candidates were enrolled in the secondary science or mathematics education programs, their microteaching experiences crossed multiple grade bands. This provided opportunities to engage with children in elementary, middle, and high school while also being exposed to learning progressions within science.

Yosso*'s (2005) community cultural wealth (CCW) model was prevalent throughout the conceptual framework and informed how partners examined the problem of practice and approached access to equitable science teaching and learning. Each component of this research was constructed to engage Black and Brown students in a curriculum that illuminated their communities and affirmed their identities. Yosso*'s (2005) CCW model provide a lens for us to explore how teacher candidates create spaces for students to utilize their specific backgrounds and humanize science instruction. In concert with emancipatory pedagogies, CCW supports the development and enactment of curricula that allows students to see themselves within science and build a positive connection between teachers and students. Love (2019) stated that our current structures and reform efforts are simply tweaking the system rather than attacking the root cause of Black and Brown student suffering. Therefore, establishing a RPP with a community partner and leveraging CCW to promote access and equity in STEM education (and science education specifically), was an approach that we adopted within our methods courses toward abolitionist teaching and humanizing science education.

Research participants

This study focuses on the experiences of four science teacher candidates and unveils their understandings of abolitionist science teaching and the roles of the RPP in supporting their enactment of emancipatory pedagogies with Black and Brown children. All participants are Teaching Fellows in a federally funded program that provides scholarships, stipends, and programmatic support to recruit and prepare STEM majors and professionals to become K-12 teachers. Pseudonyms for the four participants selected for this study are Nate, Isabella, Jamal, and Melanie. A brief description of each participant is provided below with demographic information included in Table 1.

Nate is a 24-year-old Black male from the south. He lived on the same block for 12 of the first 18 years of his life with his mother in one and two-bedroom apartments. After high school, Nate earned his bachelor's degree in biology from a four-year institution and is in pursuit of his MAT degree. He self-identifies with many of his students' culture, but now shares differences as it relates to socioeconomics.

Table 1. Participant demographic information.

Participant Pseudonym	Gender	Pronouns	Race/Ethnicity	Highest Science Degree
Nate	Male	He/him/his	Black/African American	Bachelor's in Biology
Isabella	Female	she/her/hers	Hispanic/Latina	Ph.D. in Chemistry
Melanie	Female	she/her/hers	Caribbean/West Indian	Bachelor's in Biology
Jamal	Male	he/him/his	Black and Filipino	Bachelor's in Biology

Isabella identifies as a 30-year-old Mexican American female. She grew up with two immigrant parents who depended on her to assist them in maneuvering unknown territory. She has a keen awareness of injustice due to her family's linguistic and cultural differences from the accepted norm. She received her bachelor's degree in Chemistry, followed by a fellowship to complete a Ph.D. at the same institution of higher education. She is in pursuit of the MAT degree to learn pedagogical tools that she can embed in her science classroom.

Jamal identifies as Black and Filipino. He is a 27-year-old male with a bachelor's degree in biology. Jamal is passionate about teaching science to students with special needs so that they are able to connect with the content. Jamal is driven to become a certified high school science teacher to promote the inclusion of students with disabilities.

Melanie is 25 years old and identifies as West Indian and Caribbean. She has a bachelor's degree in biology and is seeking teaching certification. Melanie is passionate about finding ways to engage students in science and strengthening student-teacher relationships. She hopes to pique students' interests so that they can connect with the content and apply it to their everyday lives.

Research methods and design

Data sources and data collection

An embedded single case study was conducted to collect data and analyze components of the RPP between the university and STEM camp (Yin, 2003). The overall case study is contained within the larger study examining the science teaching and learning during a global pandemic. Data within an embedded single case study is collected within clusters to crystallize themes at each level of investigation. We employed Ellingson's (2009) principles of crystallization with deep descriptions of the data and attention to interpretation through multiple forms of inquiry. Clustered data sources that informed this study were observation field notes, microteaching reflections, semi-structured individual interviews, and lesson plans. In presenting excerpts from teacher candidates' interviews and reflections, multiple truths presented themselves through the integrated crystallization process. Observation field notes served as an initial form of analysis to synthesize the participants' experiences in the methods course and as they engaged in microteaching in the STEM Camp. The teacher candidates' microteaching reflections were utilized to document their development of lessons that sought to humanize the science curriculum. All participants engaged in three microteaching experiences either in student pairs or individually (Science Microteaching Co-Taught Experience, Individual Microteaching Experience, and Science and Mathematics Microteaching Experience). They designed age-appropriate lessons for elementary and middle school camp participants. As part of the methods course, they were

asked to write reflective essays after each experience focusing on how they developed positive classroom cultures and designed lessons that embraced students' histories and identities. In the fall semester, researchers conducted individual interviews where we asked participants about their cultural backgrounds and connections with students in the classrooms. They reflected on their microteaching experiences in I AM STEM by sharing aspects that informed their current practices. We also asked them to articulate what abolitionist science teaching meant to them within the context of their own classrooms, schools and communities.

Data analysis

Constructivist grounded theory was the analytical approach employed in this study due to its iterative process and recognition that theories interpret the participants' realities (Charmaz, 2017). A line-by-line coding process was used to analyze the interview transcripts and reflections closely. New ideas that did not previously exist emerged as each line was read and interpreted. This line-by-line coding process allowed for nuances to be captured and an accurate depiction of each participant's reality in that moment in time. Once the initial coding process was completed, researchers highlighted the most frequent codes within the data. This process included making decisions about the initial codes' components that were the most important or answered the research question (Charmaz, 2006). After the focused coding process, researchers used the clustering memo process to organize themes that emerged. The center of the cluster included a conceptual idea that was seen throughout the research. Focused codes were mapped out to symbolize connections to other codes that were then used to construct theories. Grounded theory yielded the inductively derived typology from which the representative themes were drawn by interweaving reflections and interviews to present the findings. Crystallization was beneficial because our study emphasized relationships due to the complex dynamics of the RPP as it relates to the methods course and implementation of the virtual microteaching experiences in collaboration with a community-based organization. This framework provided an in-depth understanding of centering abolitionist teaching and emancipatory pedagogies within the microteaching and broader introductory science methods course. Three major themes emerged from this critical inquiry and are described on the findings section below.

Findings

Major findings of this study revealed that (a) participants embraced the concept of abolitionist teaching to inform their microteaching lessons by leveraging social justice standards and emancipatory pedagogies; (b) the RPP between I AM STEM and the partnering university provided supports to contextualize and humanize science learning for Black and Brown children in online learning spaces; and (c) teacher candidates developed science lessons that honored students' cultural capital through critical readings, discussions, and reflections.

The teacher candidates embraced the concept of abolitionist teaching to inform their microteaching lessons by leveraging social justice standards and emancipatory pedagogies. The microteaching experiences provided a low-stakes environment for teacher candidates to promote the inclusion of all students. This process required them to unpack the

domains of diversity, justice, identity, and action in the social justice standards (Southern Poverty Law Center, 2016), and to think critically about their practices and lessons. We opened the paper with Nate defining what abolitionist teaching meant to him in the context of larger systemic and structural forms of oppression. He highlights the importance of speaking up, naming injustice, and acting upon inequities to provide students with an excellent education. In Nate's lesson that he taught in collaboration with a mathematics preservice teacher, they used the high school standard HS-LS1-1, which required students to synthesize an explanation based on evidence for how the structure of DNA determines the structure of proteins (NGSS Lead States, 2013). They also selected social justice standard SJS:13 where students analyzed the harmful impact of bias and injustice on the world, historically and today (Southern Poverty Law Center, 2016). After the Science and Mathematics Microteaching Experience, Nate stated,

> The incorporation of the social justice standards in this lesson was anchored in challenging students to think and articulate how the Golden Rice phenomenon affects individuals and communities . . . Furthermore, the activity was designed to push students to think analytically about the multiplicity of factors involved in two people making a decision for large populations of dark and brown bodies.
>
> (Nate, Science and Mathematics Microteaching Reflection, July, 2020)

Nate described how he constructed a lesson that provided spaces for camp participants to challenge policies that negatively affected Black and Brown communities. Students engaged in argumentation as they explored how those in positions of power get to make decisions that impact the general population. Golden Rice is a genetically modified organism that has been grown in laboratories, greenhouses, and fields. While it has many benefits as a potentially lifesaving food, there are possible risks to human health and the environment (and politics) that have restrained its dissemination. The social justice standards helped students to apply the science to society and analyze how people of color have been treated unfairly throughout history. Students also discussed issues of power and privilege and how policies have sought to oppress certain populations. Love (2019) discussed the difficulty of fighting for educational justice and the reality that dark people are often tasked with dismantling centuries-old oppressions. While the fight for freedom takes on many forms, one must be willing to welcome struggle. As science educators, we cannot afford for curriculum to be whitewashed and decontextualized where children never have opportunities to learn about issues of interest or concern to them.

Similarly, Melanie developed a collaborative lesson with a preservice mathematics education teacher candidate using the seventh grade NGSS standard, S7L3b. This lesson required students to develop and use a model to describe how asexual reproduction can result in offspring with identical genetic information while sexual reproduction results in genetic variation. They also included the social justice standard, DI.3–5.6 where students expressed comfort with people who were similar to and different from them and engaged respectfully with all people. Melanie reflected on the middle school STEM lesson in an excerpt that is shared below:

> Our closing discussion focused on the recessiveness of sickle cell anemia. Scholars (participating students) enjoyed talking about this because some of them or their family members either have or carry the trait. Similarly, some scholars in this microteaching experience knew about the disease, and one scholar briefly talked about her mom having the disease. Out of my three

> microteaching experiences this summer, I believe social justice standards were executed the strongest in the genetics lesson. Relating dominant/recessive traits ties heavily to abolitionist teaching that Dr. Bettina Love (2019) describes as demolishing the ideas that "dark" children just need grit and survival, and instead, focuses on strengthening their identity and empowerment.
>
> (Melanie, STEM Microteaching Reflection, July 2020)

An explicit connection to abolitionist teaching and emphasis on emancipatory practices yielded positive outcomes in the microteaching experiences because camp participants saw their identities reflected in the curriculum. Student participants openly discussed their histories and own personal experiences to connect with the scientific concepts. Making connections to health issues that plague Black communities and focusing on identity and empowerment rather than grit and survival was a mechanism that Melanie used to humanize her science curriculum.

Another example is Isabella's STEM coteaching experience with a mathematics education co-teacher. This lesson focused on a third-grade standard, S3L2, that required students to explore, research, and communicate solutions, such as conservation of resources and recycling of materials to protect plants and animals (NGSS Lead States, 2013). They chose to incorporate the social justice standard, AC.K-2.17, in which students recognized their responsibility to stand up to exclusion, prejudice, and injustice (Southern Poverty Law Center, 2016). Isabella and her co-instructor taught a STEM lesson on pollution to rising second and third grade scholars. She reflected on the experience by stating,

> Unfortunately, Black and Brown communities are consistently and disproportionately burdened by pollution. Hence, my goal was to engage the students by illustrating the prevalence of pollution in our communities and how to stand up against it by bringing awareness to it or coming up with ideas on how to combat the issue. This was my favorite part of the lesson because we had the opportunity to teach them about their history and the contributions made. We had the opportunity to teach them about injustices prevalent in our communities, and we introduced different ways to protest against injustices if ever experienced.
>
> (Isabella, STEM Microteaching Reflection, July 2020)

Isabella encouraged students to examine their own communities and educated them on how to become advocates to enact change. As teacher candidates deconstructed Love's (2019) educational survival complex, they were equipped with tools and resources to make their science lessons reflect this awakening. An abolitionist pursuit is built on creativity, ingenuity, and a rebellious spirit that demands schools and curricula center antiracism, healing, and joy. Isabella created spaces where youth could learn about and take action against injustices within their communities. This approach humanizes the educational spaces in which we are teaching and learning by prioritizing youth and communities above the standards.

The RPP between I AM STEM and the partnering institution of higher education provided supports to contextualize and humanize science learning for Black and Brown children in online learning spaces. The virtual STEM camp offered teacher candidates an opportunity to engage with Black and Brown students and facilitate context-specific practices. Regardless of the practices that teachers employ, they must experience a joy in teaching from a place of resistance, agitation, purpose, love, and mattering (Love, 2019). Educators cannot teach students they do not know and cannot claim to love them while

simultaneously subscribing to harmful rhetoric about their families and communities. Through this process, teacher candidates began the process of building positive relationships and a good rapport with their students. Isabella's individual science microteaching experience included the NGSS middle school standard, PS2.B, where students described how Earth's gravitational force acts upon an object near Earth's surface to pull that object (NGSS Lead States, 2013). She also incorporated the social justice standard, JU.K-2.11, in which students examined how their friends have many identities, but they are always still just themselves (Southern Poverty Law Center, 2016). In an interview following the summer microteaching experience, Isabella stated,

> I definitely think that the STEM camp gave me a big boost. And it definitely prepared me to teach my students. I became more empathetic towards my students using the readings that we did in class. I definitely thought that I could just go in there because of my personal experience with them, but I was like, there's more to that. The students and I are still very different, and I feel like that summer experience got me there.
>
> (Isabella, Individual Interview, July 2020)

Isabella, who identifies as Mexican, believed that she would be more equipped to connect with her students because she also experiences cultural incongruencies with the school curriculum. Isabella actively sought to build relationships with camp participants and connected with them around music that they like to listen to and other interests. The summer microteaching experience illuminated practices that are needed to communicate effectively with her students, and differences that may exist between her lived experiences and theirs. Through the methods course, Dr. Love's (2019) work on mattering resonated with Isabella and she sought to construct lessons that centered Black joy. This RPP effort afforded her with opportunities to reflect on her students' humanity and positions in society. In her independent microteaching reflection on the same lesson, Isabella stated,

> Our students' thriving cannot happen unless we as teachers stand up for our students and break down barriers that are consistently keeping them in survival mode. Thus, I planned this lesson with a lot of Love and taught them my highest expectations in hopes of bringing them lots of joy, resistance, knowledge, and skills.
>
> (Isabella, Individual Microteaching Reflection, 2020)

Traditionally, teacher preparation programs focus on lesson planning, classroom management, subject matter, pedagogy, and clinical experiences. While all of this is important, centering the children, their lives and community was pivotal and made possible because of the community partnership. This approach helped pre-service teachers to see past the science content and seek to address other barriers that often prevents students' success in science. Isabella stated that she became aware of numerous constraints that situated students within survival mode. This process began to illuminate the need for emancipatory pedagogies in her quest toward abolitionist science teaching. The microteaching experience challenged the teacher candidates' content knowledge and pushed them to prioritize getting to know themselves and their students.

During Nate's individual microteaching experience, he utilized the NGSS standard PS2-3, where students developed questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other (NGSS Lead States, 2013). He also used the social justice standard, ID.3, in which students recognized

that people's multiple identities interact and create unique and complex individuals (Southern Poverty Law Center, 2016). After completing the lesson with fourth and fifth grade scholars, Nate wrote the following reflection,

> The short segment with the students made me reflect on the importance of the concept Dr. Love calls "mattering." It is a common misconception that "dark children [are] deemed lazy," but I often question whose standards because my experiences with these students were not the case. They were enthusiastic about learning. So, what happens to our dark children?
>
> (Nate, Individual Microteaching Reflection, July 2020)

Nate's experience with Black and Brown students within the virtual STEM camp provided a context to deconstruct ideologies and challenge generalizations about students and their capabilities. He problematized structures and systems that often preclude students' engagement in science instruction. The methods course readings, coupled with direct engagement with Black and Brown students, unearthed questions about student learning and their positions within the educational survival complex. The RPP provided a space for teacher candidates to create lessons that centered their students' lived experiences.

After Melanie's previously discussed middle school genetics STEM lesson, she wrote,

> Melding genetics with scholars' anecdotes dissolve the widely portrayed notion that the study of genetics is unrelatable, or even unattainable, for minority students. Throughout this microteaching, scholars became part-time geneticists, theorizing about the traits they or their parents had and figuring out why such things happened. By including their identities and their histories into the lesson, scholars saw that their humanity and identity mattered in the curriculum being taught to them.
>
> (Melanie, STEM Microteaching Reflection, July 2020)

Melanie perceived the summer camp participants as whole individuals who were capable of engaging in science instruction. She protected the learning environment and sought to nurture their curiosities through interactive and relevant science lessons. Melanie even positioned them as geneticists as they learned about how genes are inherited and other hereditary conditions. Pre-service teachers' participation in the microteaching process shaped their understandings of how Black and Brown students experienced science and ways to construct safe online spaces. Teacher candidates, like Melanie, embraced emancipatory pedagogies that validated the humanity and identities of students as an approach toward abolitionist teaching. This focus informed the development and execution of their lessons, even in online learning spaces.

Teacher candidates developed science lessons that honored participants' cultural capital through critical readings, discussions, and reflections. As the MAT students explored abolitionist teaching and the educational survival complex, their lessons began to have an intentional and explicit focus on students' diverse cultural backgrounds. Teacher candidates challenged traditional interpretations of cultural capital that uses a deficit lens and places judgment on Communities of Color. By taking community cultural wealth (Yosso*, 2005) into consideration, they created spaces for students' cultures and forms of capital to be validated within the STEM lessons. The microteaching experience provided teachers candidates with opportunities to test out new approaches without accountability

pressures related to high-stakes testing. The classroom culture and lessons were not divorced from students' individual cultures, interests, and needs. In an interview, Isabella stated,

> It was definitely one of the hardest things that I had to do because I had never lesson planned. I enjoyed constructing lessons that weaved in culture and relating science to who people are. That was awesome. In my education, I didn't learn about not one Hispanic scientist growing up. I feel like there's some disconnect between me and my Mexican culture.
>
> (Isabella, Semi-Structured Interview, November 2020)

In the methods course, we disrupted what mattering meant within the context of science classrooms. Dr. Love describes mattering as civics because it is the quest for humanity. Teacher candidates reminisced on their own schooling experiences—the invisibility of their cultures and the contributions of scientists who looked like them. This lack of cultural inclusion and validation of their lived experiences as students served as a driving force to honor the camp participants' cultural capital. In developing their lesson plans, they intentionally centered students' identities and cultures.

During Jamal's individual microteaching experience, he utilized the fifth grade NGSS standard, LS1A, to demonstrate students' understandings of how plants have different parts (roots, stems, leaves, flowers, fruits) to help them survive, grow, and produce more plants. He used the social justice standard, ID.3–5.5, in which students examined how their families do things the same and different from other people and groups and know how to use what they learn from home, school, and other places that matter to them. After completing this lesson with rising 4th and 5th-grade scholars, he wrote the following reflection,

> The particular science standard touches on students recognizing different patterns and physical characteristics of leaves and that different cultures and regions may use leaves for other purposes and functions. This is where the idea of asking students "what can people use leaves for?" and adding in the piece of *The Art of Pusô: Palm Leaf Art in the Visayas* excerpt in the lesson. What made this more meaningful was that this was an experience from my actual culture and background, and we used actual photos from my home Island back in the Philippines in different ways that different cultures may use leaves and the meaning it has to my culture.
>
> (Jamal, Individual Microteaching Reflection, July 2020)

This pedagogical practice invited children to think about their own cultures and provided a validating space in the curriculum. Students were intrigued by the term *pusô*, and Jamal explained how it is how rice is cooked and served on intricately woven palm leaves. Jamal reflected on his explicit and deliberate decision to introduce students to a little of his culture and stated,

> When teachers allow for all lessons to relate to students recognizing different cultures and acknowledging their cultures and the contributions that their ancestors have brought to society, they begin to see themselves within the lesson.
>
> (Jamal, Individual Microteaching Reflection, July 2020)

As Jamal opened up to his students and exposed them to how his family's everyday actions were related to science, students examined their own families' connections to plants. While students could identify different parts of a plant and basic survival needs, the lesson's

strength was in learning about many different plants, uses within their homes, and some students' experiences growing their own flowering plants and vegetables. Jamal, like many other teacher candidates, thought deeply about honoring students' cultural capital and providing space in the curriculum to also embrace his own.

Discussion

According to Feiman-Nemser (2001), the future success of preservice science teachers consists of their own science schooling experiences coupled with their teacher preparation programs. Ill-prepared teacher candidates who enter classrooms with little to no awareness of the educational practices may harm their students' success. Well-prepared preservice and in-service teachers with multiple positive theory-driven experiences have the potential to change the trajectory of their students' lives. Darling-Hammond (2014) suggested a secret sauce to teaching that mixes teaching theory with methods to assist teachers with classroom decision-making. This is especially important because Black and Brown students are more likely to be taught by novice teachers, categorized by having three or fewer years of experience (Chaltain, 2014). Therefore, the knowledge, skills, and experiences received in their degree programs are critical to prepare teacher candidates to become highly effective certified teachers. Furthermore, changing student demographics call for more in-depth teacher preparation and professional development that provides context and content-specific experiences.

In unprecedented times, with shifts in traditional structures of school, the role of initial teacher preparation programs has become increasingly critical in developing highly effective and culturally competent teachers. Our programs must be situated to engage with and learn from our local communities. The virtual STEM camp offered teacher candidates with opportunities to prepare for a unique school year where students connected via online platforms. While many school districts spent the summer preparing for the safe reopening of school buildings, our teacher candidates were learning innovative strategies to engage students in online learning spaces and were subsequently positioned as *experts* within their schools because colleagues relied on them to assist with technology and student engagement. Our teacher candidates were successful in creating positive learning communities within non-traditional classrooms and connecting with students beyond the science content.

Ogawa (1998) reminds the scientific community that "there is no culture-free interpretation of science or science education" (p. 140). Therefore, science education must address culture, content knowledge, and context-specific experiences. Our methods course and larger research practice partnership effort leveraged students' community cultural wealth (Yosso*, 2005).

Nazar (2018) explored how science methods courses can be leveraged to support preservice teachers' critical uptake of youth and their communities. Findings revealed that an emphasis on equity-driven practices supported teacher candidates' conceptualizations of their future teaching experiences. As teacher candidates in this study engaged in micro-teaching experiences, they began to understand effective teaching practices and ways to include students' voices and cultural wealth into each lesson. Teacher candidates' involvement in the research-practice partnership offered an experience to engage with Black and Brown children in an online learning space that provided a low-stakes environment for

inquiry. Therefore, the RPP effort afforded a ripe context to leverage community cultural wealth and provide equitable STEM learning experiences even amid the pandemics of COVID-19 and anti-Black racism. Abolitionist teaching stands in solidarity with parents, youth, and fellow teachers to oppose oppressive policies, curricula, mandates, and reform efforts and move beyond survival. According to Love (2019), it stands on the premise that "Black Lives Matter, all Black Lives Matter, and affirms Black folx' humanity" (p. 12). This message became more evident as teacher candidates negotiated their own belonging and mattering in America during the global pandemics, while also seeking to create more liberating spaces for children during the microteaching experiences. Abolitionist teaching calls for collective freedom dreaming and focusing the moral compass toward a North Star for educational justice.

The RPP effort in this study was a conducive space for I AM STEM and the partnering university to support one another as they pivoted to online programming and courses. They learned with and from one other to implement innovative strategies that were beneficial for both teacher candidates and students as they prepared to transition into online classrooms in the fall semester.

Furthermore, informal STEM programs within communities provide a space to recognize and understand how culture and identity development inform STEM engagement and persistence. Mark (2018), in studying the experiences of an African American male within an informal STEM program, revealed the importance of recognizing and supporting the development of holistic and non-traditional STEM identities. As our teacher candidates embedded social justice standards (Southern Poverty Law Center, 2016) and culturally and historically responsive education (Muhammad, 2020) into the curriculum, they employed methods to deconstruct the educational survival complex. These standards and frameworks provided a roadmap to include anti-basis and anti-racist components within the science curriculum, which is often a toxic and exclusionary space. Therefore, centering students' histories, identities and cultural backgrounds can serve as a driving force for scientific inquiry investigations and positive STEM identity development.

Scientific or scholarly significance of the study or work

This study provided deeper insights into the microteaching experiences of four teacher candidates enrolled in an MAT program, with a specific emphasis on a methods course that directly addressed abolitionist teaching toward restorative justice. In order to emancipate STEM education, we must first think beyond the classroom curriculum to create more humanizing spaces that validate students' cultures and whole beings. This approach requires a restructuring of teacher preparation programs and in-service professional development. While national and state science standards guide our focus in terms of three-dimensional teaching and learning, the emphasis on diversity and equity is limited. Therefore, including social justice standards and frameworks that center students' histories, identities, and criticality (Muhammad, 2020) provide frameworks to develop lessons that are more reflective of abolitionist teaching.

Addressing inequities and incorporating culture in the science classroom should not be an afterthought or standalone diversity course situated within our teacher preparation programs. If teacher candidates will eventually become the teacher of record within local schools and districts, they must understand the communities in which they intend to teach

and commit to learning about children beyond just school-based interactions. As science teacher educators, we have the unique opportunity to create partnerships with community-based organizations who are serving Black and Brown children well. We can glean their approaches and learn various forms of capital that exist within the community. This approach offers a different lens for teachers to provide more authentic and meaningful science learning experiences to their students. RPPs can serve as a vehicle to bridge the gap between out-of-school time and formal schools with bidirectional relationships between research and practice.

Implications to science teacher education

To expose and dismantle racism in science education, we must reimagine the science teacher preparation programs and courses. Take the time to start critical reading groups within your departments and collectively redevelop courses. Bring in community members and get out of the academy to learn about the surrounding neighborhoods; create spaces for meaningful engagement that is mutually beneficial. In these trading zones is where true learning occurs that leverages wealth that exists within communities to disrupt educational structures that seek to socialize rather than humanize. While systemic racism is endemic and penetrates into schools and educational structures, we have the potential to create spaces where students can experience joy and restorative justice within communities and classrooms. To emancipate STEM education is to engage in the struggle toward humanity and collective healing. Rodriguez (2015) reminds us of the importance of pausing and reflecting so that reform efforts do not continue failing our students by promising one thing yet delivering another. While our teacher preparation programs remain predominantly White, the racial demographics of our student populations are becoming increasingly diverse. Therefore, as we engage in this movement toward abolitionist science teaching, we must collectively name and disrupt systemic oppression, agitate, and demand restorative justice toward direct transformative action.

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Natalie S. King is the founder and executive director of I AM STEM Camps - the research context of this study.

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