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Co-making against antiBlackness

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ABSTRACT

This article focuses on how Black girls counter the antiBlackness that pervades the culture of STEM/making through their STEM-rich, community-engaged co-making practices. As youth engage each other, their communities, and the world, they make in ways that respond to a critical awareness of the world as it is, and with a desire to agentically author a world that could be. Using participatory critical/relational ethnography and lensed through ideas on antiBlackness and Black feminist inquiry, we documented what, how, and why the girls co-make in their maker clubs. Findings explore how the girls negotiate antiBlackness in STEM and their social worlds through community-engaged co-making. We show how the girls' co-making involves radically-open margin work stemming from their occupation of the liminal spaces between antiBlackness STEM/community margins, enacted in solidarity with each other and their communities towards desired futures. Implications for supporting justice-seeking cultures of STEM-rich making are offered.

Introduction

> The racist stereotype is Black people are not listening to science. That is untrue. Maybe it's the other way around, like science is not listening to us. I wish people could see what I could do, like what I am doing at home. Making home-made hand sanitizer and masks, caring for my elders. (Jazmyn, 15-years-old)

Jazmyn's experiences are not unique. Many Black youth want to be rightfully present in STEM-rich making as whole people with valuable and powerful knowledge and experiences. She centers her caring connections to family and community, including familial wisdom and strength, as she navigates STEM/making in a multi-pandemic, and her hopes for a more just world, especially with respect to racial injustice.

Jazmyn's quote urges the field to consider why the equity focus in maker education is inadequate. While still nascent, the emerging equity agenda in maker education focuses on access and inclusion. In response to the field's initial tight focus on White, educated men, many maker programs now focus on providing Black youth with tools, resources, and technical support to make.

While this makes visible the constrictive boundaries of the emerging maker enterprise in terms of how access and opportunity are mediated, it elides the history of injustice on Black bodies *writ large* and the educational opportunities of Black youth. In maker education most research does not detail how entrenched power structures within STEM/making normalize White supremacy (Kirkland, 2021). Equity as a construct in educational research has been de-racialized, and can inherently turn back towards antiBlack outcomes (Dumas, 2016). A focus on equity may bring Black youth into makerspaces, but neglects—if not suffocates—their intellect, spirit, desire, and histories of experience through "spirit murder" (Love, 2014, p.302). The histories and wisdom in making by Black communities, and others marginalized by dominant culture, borne out of necessity and desire, and the

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ingenuity in youth it inspires, are marginal if not invisible/antithetical, to the goals of access and opportunity (hooks, 2000).

This article seeks to advance a justice agenda in maker education that shifts attention from remediating the individual to remediating the system. We focus on how three Black girls with whom we work, counter the antiBlackness that pervades STEM/making. We argue their STEM-rich, community-engaged co-making practices offer powerful insight into what a more justice-seeking culture of STEM-rich making may be. In building this argument, we foreground the girls' agency to leverage the power of making alongside their experiences and historicized understandings of the world to take action on what they care about, to resist White hegemony in STEM/making, and to share different truths for themselves and their worlds.

We intentionally use both terms—*community-engaged* and *STEM-rich*—to set up a necessary tension and existing connections that have been historically elided, towards advancing justice-centered efforts in maker education. We foreground how maker knowledge/practice is localized and distributed within community (hooks, 2003), by which we mean the necessary know-how to make involves Black girls' already present knowledge and wisdom (Evans-Winters, 2019). We call attention to the importance of access to STEM knowledge and practices in supporting making processes and in the functionality of made artifacts, though we note this as a fraught process given the colonial and racialized history of STEM (McGee, 2021). These tensions push us to witness youths' brilliance in critiquing, re-mixing, and re-imagining the resources and tools of STEM alongside their powerful community wisdom as agentic acts.

We ask: How do Black girls engage in STEM-rich making in justice-oriented ways that center their whole lives across communities?

Centering justice in maker education

People have always been making in ways that matter to them and their communities (Vossoughi et al., 2016). However, not all maker programs acknowledge these histories or support such meaningful making. There are structural inequities and forms of oppression that limit opportunities to make in ways that matter, including the powered relationalities that govern makerspaces (Gollihue, 2019).

The makerspace movement remains dominated by White, male, middle-class adults, led by those with the leisure time, technical knowledge, and resources to make (Halverson & Sheridan, 2014). The dominant maker culture reflects White, patriarchal, middle-class values in its discourses, practices and tools of making. One example is the entrenched focus on making culture and associated practices that accentuate perspectives on and practices of making conceived through dominant ideology and focused on the contribution to markets, but not necessarily to the well-being of people and communities (Greenberg et al., 2020). The commodification and commercialization of maker knowledge and skills limits attention on the *already-present* critical cultural dimensions of making that foreground human dignity, community livelihood, and the public good (Gaskins et al., 2021). Such practices also decenter love and joy as elemental to making (Worsley & Roby, 2021)

Critically-oriented maker education researchers have critiqued these dominant frames to broaden what counts as making, who makes, where, how, and why (Calabrese Barton & Tan, 2018). Gollihue (2019) describes the importance of privileging the maker over making, in her documentation of the relational and embodied approaches to making. Barajas-López and Bang (2018) describe how Indigenous maker programs centered on clay making cultivate a culture built around socially and ecologically just nature-culture relations, where "knowing, being, and doing are simultaneously unfolding and are essential/defining elements in the practice of material storytelling" (p. 17).

We call attention to practices and relationalities in making—what it means to be and do in making, in interaction with what one has access to in a makerspace. Whose lived lives and communities—past, present, and futures—are valued, and who/what counts as legitimate makers/making, all matter in how people are welcomed, positioned, and recognized for what they do in a makerspace. We are specifically interested in what it means to *be with* and to *maketogether*—co-making. Co-making is

embodied in the kinds of real and symbolic spaces that allow for one's presence and the legitimization of inputs and contributions in one's making work, across the making process (Calabrese Barton & Tan, 2018). While this includes the visible actions and processes that are the stuff of making (e.g., youth co-developing criteria for making projects, progress, and outcomes), it also speaks to aspects of making rendered invisible, uncontested, or unimportant by dominant culture rather than what is good, right, and just. Co-making also concerns itself with power, as connections/differences emerge in how people and materials relate (Shivers McNair, 2020). This stance positions makerspace educators and participants as co-constructors of culture, engaged in shared, though at times disruptive, contested or contentious, activity that challenges normative views of knowledge production and expertise. Co-making is not just about involving different people in making, but is a rendering of making that puts epistemologies, ontologies, and histories in dialectic engagement.

A focus on community-engaged STEM-rich co-making shifts the gaze from access and inclusion to the practices, relationalities, and spaces youth develop as they use their STEM, maker, and community wisdom and knowledge.

Conceptual framework

Reckoning with the antiBlackness of education structures

More educational thinkers and practitioners are taking up the fundamental work of reckoning with systemic racism in education. As educators confront the devaluing of Black lives that routinely occurs across educational spaces and structures, antiBlackness theorizing urges we center the meaning and resultant manifestations of normalized violence on Black bodies (Warren & Coles, 2020) in the "afterlife of slavery" (Hartman, 2008, p. 6). Dismantling systems that produce mass incarceration, constrained opportunities, limited access to education and healthcare, and a shortened lifespan necessitates such centering. Dumas (2016) posits that education policy and practice are sites of antiBlackness, a continual devaluing of Black children in education. Schools embrace antiBlackness and can trace it to their foundation. We argue this is also true in maker education. Thus, centering and critically reckoning with violence against Black youth includes seeing how they are "forcibly thrusted to the margins" (Jenkins, 2021, p. 113)—disproportionately disciplined, surveilled, and bodily removed from environments of learning (McGee, 2021).

Drawing on a framework of spatial imaginaries—the phenomenon in which socially constructed ideas shape material practices that create spaces for reinforcing those ideas in a positive feedback loop, Jenkins (2021) asserts that "the antiBlack spatial imaginary marks Black bodies as undesirable and therefore extractable from spaces and places" (p. 119). AntiBlackness is manifested in educative spaces. This is systematically and continuously occurring in makerspaces as well.

Engaging with margins towards supporting and standing with black education spaces

Warren and Coles (2020) suggest that Black Education Spaces (BES) can facilitate the healing of Black students from antiBlack assaults by developing resistance to counteract antiBlackness. Simultaneously, Jenkins (2021) explicitly points out that "such spaces cannot exist when educators are subjecting Black youth to 'spirit murder'" (Love, 2014, p. 302), and that the possibilities of designing such BES is contingent on the reimagination of spaces of learning towards disrupting antiBlackness. Reimagining is crucial when considering how Black youth are marginalized in their embodied existence across learning spaces while non-Black educators have been socialized into the norms of a society built on antiBlackness. Knowing we hold positionalities as both reproducers and resistors (Tuck, 2009), we have seen youth seek out and co-construct spaces to resist antiBlackness in their making, and we interrogate when and how this occurs in relationship with makerspace pedagogies to support and stand with youth efforts.

We set this interrogation in dialogue with bell hooks' (1989) construct of marginality as "a site of radical possibility, a space of resistance" that offers a lens to "see and create, to imagine alternatives, new worlds" (p. 20). We conjecture margins are a productive idea for educators to recognize, take up, and engage. Within the context of this work, marginality is both a position and place of resistance needed to occupy the current times with hopes of and dreams of something different.

The all-encompassing reach of antiBlackness into the lives of Black youth means they occupy multiple margins simultaneously—schooling, disciplinary content areas, and the communities in which they live. Existing simultaneously at the crux of varying margins position Black youth with a nuanced perspective. We looked from the "outside in and from the inside out," focusing on center as well as margin. We sought to understand both (hooks, 1989, p. 20). How Black girls reclaim margins as sites of radical resistance and possibility can be powerful for informing how we seek to stand with BES.

Methodology

We employed a critical and participatory relational ethnographic approach over two years. Our work is rooted in exposing, critiquing, and transforming inequities associated with social structures and labeling devices as fundamental dimensions of research. Our work also is participatory as we sought to include multiple voices in the research process. These commitments are central to justice-oriented research with Black girls who have been "positioned" as in need of repair. This approach provides a way for us to understand *changing boundaries* and *disrupted processe*s while politicizing how we come to comprehend them.

Context

Our study is grounded in a midwestern makerspace in Great Lakes City. An open-door policy is used for the making program at this club, meaning that any youth with interest in the club are welcomed. When youth may miss a day or a month or more due to school, sports, or familial issues, they are welcomed back with open arms. Club directors and maker educators encourage youth to join for many reasons, including STEM interests, friendship groups, and encouraging new experiences. Youth participate in weekly sessions for a full school year, with many participating for 2+ years. In our research+practice roles, we worked collaboratively with Club staff to engage youth iteratively and generatively in making activities that involve the community—embedding local knowledge and practice more explicitly into making. As youth identified design problems, we co-designed activities with them to support them in engaging their community in providing insight on ideas/projects they named.

The makerspace is located in a vibrant, long-standing community center, with a focus on youth development, homework help, and sports, and where we have partnered for over 15 years. The club serves a predominantly (>95%) multi-generational Black community. Collectively, we do not represent this community, even if we have been members of the community for years, and this fact necessitates and inspires a continual engagement with literature and ideas we bring to bear in this article. We are a group of diverse women, in terms of our age, race,. and ethnicity, country of origin, home language, professional experiences, and locations. One of us is Black, two of us are White, and one is Southeast-Asian Chinese. We are all university researchers and STEM-maker educators.

Three of us are also multi-year members of our partnering community and educators in this makerspace. Over years/decades we have built relationships with many of the youth and their families, participating in family functions and witnessing the children we love grow up as friends and in some cases as extended chosen family. We also have sought to learn alongside community elders to develop relational wisdom that we lack by not growing up here and not sharing in lived experience or identities. One example, of many, is the relationship we built with Granny, a community elder, who runs the kitchen and cooks meals for the youth everyday. Most people, adults included, call her Granny. She is not in charge at the club, but her opinions matter. As one youth explained in 2009,

"You have to run everything by Granny or it might not work out." We took that to heart and started checking in weekly with Granny. Check-ins became conversations, and cover a vast terrain from news on our families, to critical dialogues on maker projects and the pandemic, and her vast knowledge and wisdom of the needs of the children.

Our core intention and commitment to stand with the youth and families we work with, love, and respect leads us to interrogate what it means to be with and bear/bare witness to each others' lives (Wilcox, 2021). This includes interrogating how we navigate social-spaces of making in our on-going efforts to inform and disrupt our own varied unintended complicity in the racialized powered-dynamics of STEM/making (Garcia, 2020). We approached this work knowing our positionalities lead us to have only partial understandings of the knowledge, practice, wisdom, and experiences of the Black girls centered in this article. As scholars and educators who have worked together for years, and have built sustaining and caring relationships, we seek to critically engage each other to learn from and critically self-reflect through each other's insights, perspectives, and narratives.

Participants

This analysis focuses on three Black girls, Nila, Keke, and Amara, although their stories reflect the observed experiences of many youth makers in our programs. We offer a brief introduction of the three youth here, but as we share their stories later, we introduce them more fully. Keke and Amara are 13-year-old twins. Amara, according to her twin Keke, is the "quiet" one. Amara is seeking a future as a pulmonologist specializing in pulmonary embolisms, a condition from which her grandmother passed away when she was young. Described by her twin Amara as the "crazy" and "loud" one, Keke sought to "take back power and freedom" where she experienced a loss of it. She discovered a love for engineering through a hobby of "breaking stuff to see the inside" and to see how things worked and how they were assembled. Nila, 12, loves art, dance, being outside, and video games. She excelled in drama—having the lead in the Lion King in her sixth grade class performance. She also loved her maker club, stating, "I love that it's a non-judgmental space" and "I am great at soldering, making signs, and science."

Data generation and analysis

The study took place over two school years. We conducted four roughly 90-minute conversational interviews with the youth (two interviews/per year over two years) focused on their maker experiences, moments that stood out, and their learning/actions in the club, guided by youth stories and the directions they took those stories. We generated field notes focused on educator-youth interactions, youth engagement, and educator actions for each maker session (twice weekly during the school year). We also kept information on attendance, norms, and routines of programs and materials. For each girl, over 12 weeks during the second year, we co-generated maker portfolios where they and we collected images and videos of their favorite work, maker planning documents, annotations about how their making sessions went as a way to center their perspectives on what mattered to them. We met weekly to discuss and co-assemble these, keeping youth-led notes on their work in google slides.

Data analysis involved multiple stages of coding based on critical approaches to grounded theory (Charmaz, 2017). Our first pass involved reading through artifact interviews' transcripts and fieldnotes to open code for markers that identify margin-work, including the physical, ideological, and socially constructed spaces of STEM and maker education that seek to separate and marginalize through the use of language and power and that reify dominant histories and master narratives. We noted when youth illuminated these margins in how they critiqued, remixed, and reclaimed STEM/making with their ideas, perspectives, physical materials, geographical locations, and relationships with community members.

We also coded for how markers from which margins were made visible and brought into dialogue during STEM-rich co-making; and how margin-work impacted what/how/why/for whom youth chose

to make what kinds of artifacts. Weekly conversations were held between the authors on these insights to work towards a more expansive consensus. Differences in view were debated until new meanings were generated. A detailed list of emergent open codes were kept with analytic memos, which we then brought to bear on other data sources, such as group conversation transcripts and various student artifacts not included in their portfolios.

Our second pass involved re-examining our initial analyses for evidence of antiBlackness as related to the margin-markers identified during open coding and youths' response through co-making. In how youth engaged in co-making, we looked for evidence of margin-work that showed youth operating from a stance of "radical openness" towards more just, social futures. We analyzed for any relationality between youth's efforts to move or repurpose the ideas, practices, and resources they leveraged to engage in justice-oriented margin-work to counter antiBlackness. This phase of coding focused on uncovering relationships and connections between the youths' making and pedagogies that emerged from the data. Relationships and connections identified in this stage guided our selective coding, and became categories and themes, from which our cases were selected for a final round of analysis and presentation.

Findings

Findings explore how Keke, Amara, and Nila, negotiate antiBlackness through margin work as part of community-engaged co-making. Through unpacking the girls' margin work, and our roles as educators standing with them in that work but also complicit in systems working against them, we conjecture on multiple margin occupations as a possible Black Education Space (BES) to stand with and engage.

We locate the sites of antiBlackness in (1) STEM and (2) the larger communities of which girls are a part, where Black lives are perpetually devalued. We conjecture community-engaged co-making is the "how" and "what" of the girls' radically-open margin work—when they pull from their particular wisdom from existing on these margins, through "looking both from the outside in and the inside out" (hooks, 1989, p. 20). We unpack the why, for whom, and to what ends of their innovations to pursue insights on margin-work as productive resistance, with what kinds of hoped-for outcomes that disrupt antiBlackness.

Troubling AntiBlackness in everyday life

Below we explore margin work as investigating and documenting experiences to trouble mundane, quotidian, antiBlackness in everyday life.

The daughters of a city bus driver, Keke and Amara joined forces to imagine, design, and build a heated transportation system design project for people who commute by bus to take purposeful action in support of their community through their making. Amara's maker work was grounded in local knowledge, grown in shared community space, and consequential in concrete action. She co-opted traditional STEM learning and practice for results "that actually matter" "in the real world." For Keke, maker work helped her to understand her capabilities as a STEM expert who rightfully belonged in the real world of STEM.

During the first year of the study, the maker program focused on making for just, happy, and healthy communities. Keke and Amara decided to address multiple aspects of bus transportation frustration in their city. Individually they picked different aspects of the bus system to work towards a system-wide solution. They explained in their written project description:

> Bus stops are cold. Some of them have shelters, some don't. The ones that don't have shelters are colder than the ones that do. Sometimes the shelters are colder too, because they don't have doors on them. We have had to stand at bus stops many times before, to ride our mom's bus. In the wintertime, it is always freezing.

Maker educators supported the youth in working with community members to better understand the problem space they identified. For example, beyond drawing upon their own experiences as bus riders, the girls interviewed community members as they waited for and rode the bus. They documented bus shelters on their route, the number of seats on each bus, and the conditions of each of these. Amara explained:

> There are 53 seats on every standard bus . . . Not only that, but several people who do not currently ride the bus told us that they would be interested in riding the bus if they knew that the bus came equipped with heated seats.

Bus riders shared views on their riding experiences as they waited for and rode the bus. This process reflects a shift from normative practices where municipal transportation units might seek input in public meetings, if at all. The girls' learning was enacted as communal engagement, oriented towards disrupting power relations as they made visible their critical and humanizing awareness of fellow bus riders. This reflects, as Freire (1970) described, a political and radical ethic of solidarity as foundational to learning.

Using these insights, the girls redesigned multiple components of their city's public transportation system to address multiple dimensions of winter rider comfort simultaneously, including being cold, uncomfortable, and tired while waiting for and riding the bus. As they engaged community members, they learned alongside each other and members of their community about the technical and social dimensions of this racialized problem space.

The girls were attuned to the long waits experienced at bus stops, and the long rides people took as they commuted. It is well-documented that U.S. public transportation systems actively enact systemic racism; that White and Black riders have differential access to ridership, shaping their abilities to move around their city (Rankin et al., 2015). That it takes youth, like Amara and Keke, over an hour to commute to the club from home via public transportation, when car transportation would take around ten minutes, reflects the racialized challenges youth face. Furthermore, while the girls didn't document how the bus stops on their commutes differ from those in more economically advantaged and White neighborhoods, the information they documented reflected what has been found elsewhere—that bus stops in Black neighborhoods tend to be poorly marked, and contain no weather shelters or seats, and the buses themselves are older and less comfortable. The girls' critical co-learning with their fellow bus riders demanded an awareness of the borders of antiBlackness—how knowledge systems collide and elide in ways rendering particular acts of making possible.

Amara knew their mom's job acted as a window into their city's racial and economic injustices, through experiences witnessed and through stories their mom shared. "I get on the bus enough to know. I see it every time I get on." "Plus I hear my mom talk about a whole bunch of stuff that be happening on there." As they discussed their knowledge on this issue, empathy for other community members' personal and systemic struggles surfaced clearly. This project was not just learning for learning's sake. Bus design held enormous implications for people in the city, "especially if they don't have a car," Keke added. In their work, the girls received members of their community as their own, with a responsibility to care for and be with each other, foregrounding the always, already, and imagined present(s) in the contested border work of seeking common ground.

Amara explained: "With that project, there was a purpose. People need it to get where they're trying to go. You shouldn't just make something because you like to make it. It should have some type of purpose." The abstraction of school science, "pure research," and the self-interest of corporate making were wastes of time for someone who saw tangible community needs for innovation every day. Amara's making work felt important to her because the problem space was important to her community.

Disrupting antiBlackness centers of STEM & larger community

Next, we explore margin work as engaging in novel practices to disrupt "antiBlackness centers" of STEM and the larger community.

How the girls made sense of the challenges faced by riders led to each of them to engage differently in making that mattered to them and their desired futures. Amara concentrated on the on-bus riding and sitting experiences, and Keke focused on the waiting-in-the-cold experiences. Keke prototyped a human-powered heated bus-stop while Amara designed a solar-powered heated seat cushion. For example, Amara's solar-powered, heated seat cushion design was meant to provide some soothing comfort to "tired and sore" riders' "old, tired legs" at the end of a long work day. She learned how to use a sewing machine with the help of a makerspace mentor, and applied this skill to sew a heater circuit through a self-made fabric-covered cushion that connected to a hand dial for individual rider temperature adjustment.

Amara's heated seat design was built from years of experience as the daughter of a city bus driver. This experience provided Amara with productive imagination from real frustration she experienced as a Black girl who depended on public busses. She knew from personal experience that bus seats were uncomfortable: "If you stay on there for long enough because your stop is far, then *no*," she stated emphatically, refusing the injustice of a sore behind on a cold, hard seat she felt and witnessed countless times. While unpleasant in itself, Amara understood this seat design issue could become one indignity too far for someone already having a particularly rough experience: "Sometimes you have to hop off and hop on another bus and there's no seats, or it's hot, or you have to stand, or it's cold."

Keke designed a pedal generator-powered, radiant halogen and conductive heating system for bus stop shelters. To avoid forcing riders to pedal for warmth, the design incorporated a rechargeable power storage system. Keke used an old shoebox to represent a bus shelter, outfitted with a 12 V heat lamp, a 5 V heating element on a cardboard miniature bench, and a hand crank representing a bike-sized pedal generator.

As Keke completed her work, she volunteered to write descriptions for both of their prototypes. Her descriptions included relevant physical science concepts she had learned along the way:

> It heats with high-Wattage halogen lamps (radiant light energy) that will be located below the bus shelter's bench, because heat rises. Also, my system includes surface heating elements (like a heating pad) on the bus shelter's bench (conductive heat energy). Heat comes from three directions: bottom, side, and side. The radiant energy from the heat lamp comes from underneath the bench, the heating element on the bench's surface heats your body directly, and the heat also comes out from the side walls of the bus shelter, through heated wires. That's important so that your whole body can be warm, and you won't be cold.

This quote went beyond representing process/product. As someone who did not get recognized for STEM expertise in school, this was not just about their project. It was an opportunity for Keke to show off her presence in the making environment as a recognition-worthy STEM expert. Here Keke countered the antiBlackness she experienced in STEM as she recognized the importance of her experiences as important to STEM knowledge.

While the girls' shared project was meant to help the community, it also was a space for Keke to further develop presence in STEM towards her desired future. Consider the following moment. One day while working on the project, Keke and their maker educator were clicking through YouTube searching for how-to videos to figure out how to construct a circuit that would allow the hand-crank generator to power the heat sources while simultaneously recharging the batteries. Keke landed on a video of a White man who was making an auto relay. She began drawing a circuit diagram shown in the video. She alerted her mentor to her suspicion that the man had written something down on his circuit diagram that would not work for her design. (He had written the term "open contact" and she knew her circuit needed to be "closed" in order for the heat to turn on). Her mentor agreed that she was wise to create her own, different version of a circuit diagram that would accommodate her power source, switch, and resistor design needs. She moved lines around on her paper, adding written descriptions to clarify parts of the diagram that she was changing to create the kind of schematic she had in mind for her project for her circuit to work as desired.

Later, Keke photographed her diagram drawing so she would have a copy handy to guide her future circuit work. She took home the original paper version to frame and hang on her bedroom wall. When asked why, she stated matter-of-factly: "I'm a science person now." With that, she carefully folded her diagram, slid it into her purse, and gathered up her backpack to leave. Keke explained a few months later: "I thought science was so nerdy that only weird people would be into science. I always thought, 'Oh, you'd do science here and there,' but never actually become a scientist." In fact, she named this moment as "one of my top life moments with STEM" and the role it played in helping her prototype the heated bus stop.

Keke was working to counter antiBlack narratives about scientists. Keke's STEM expertise occupied and moved across the margins between antiBlackness, STEM, community, and their intersections. It was not only grounded in her life and her communities' needs, but also critically engaged the limits of STEM authorities.

Amplifying awareness of & counteracting the violence of antiBlack racism

We explore another youth's margin work to confront and call out the violence of antiBlack racism.

Nila's light-up sign hangs in her community makerspace and has been an integral part of that space for five years. The sign reads #StopRacism in large black print against a gold background and lights-up to capture people's attention. Nila made her sign out of heavy poster board, double plied with hot glue for durability. Around the sign are 40 LEDs, connected by a hidden parallel circuit powered by a hand crank generator and back up batteries.

Nila imagined this project in response to her desire to "stomp" racism. As a 12-year-old Black girl Nila was already "sick and tired" of the systemic racism she encountered daily. Nila's ideas for the #StopRacism sign emerged from a conversation the youth had in their maker club on a day Nila shared a story about her frustrations with the then president of the U.S.[1] Nila had arrived to the club that day weary. Nila recalled:

> [#45] does a lot of things that make me really mad—he breaks promises. He keeps saying he's going to build a wall and make Mexicans pay for it but he can't do that! I know people who have been bullied by other people telling them about walls. Stopping racism is really hard—people don't listen and are hard to change.

In this moment, Nila called attention to the actual *material* border of the wall aggressively acting to maintain the *immaterial* borders of White supremacy, while also acknowledging the will (or lack thereof) of people to change. Nila, like all Black youth, regularly experiences oppression (overtly and covertly) through being forced to occupy such margins, organized through societal structures, practices, and values grounded in white supremacist capitalist patriarchy.

Nila continued sharing her worries of how racism and her awareness of such, was increasing in all aspects of her young life. She recounted for the group an event that had gotten recent national prominence:

> Like the two black guys who were arrested at that Starbucks in Philadelphia? They just like showed up for a business meeting. They didn't want to buy coffee right away. The manager called the police and the police arrested them for what? For nothing. For being Black and at Starbucks.

Nila's peers and educators gave witness to and sought to learn from Nila's awareness and feelings and share their own encounters with racism. For example, maker educator, ReAnna, engaged Nila's worries to critically explore and critique racism in their community and in making. This was not without tension. ReAnna's own political and historical understanding of racism shaped how she sought to build solidarity with youth. She noted that "youth wanted to have discussions of race" but that this "felt contentious" because it was "an explicit reminder of the childhood denied Black youth." She noted, however, that making visible the how youth actively negotiate a place in

STEM and their communities was a part of the youth's realities and reminiscent for her of talking back (hooks, 1989):

> I don't think it should be on the youth to stop racism but they've taken up that work. The youth are already engaging in resistance. They are already engaging in freedom dreaming . . . they're acknowledging the problems in their community and they are defining solutions for them.

As ReAnna noted, fighting racism should not be shouldered by the youth, and bearing/baring witness (Wilcox, 2021) was one way to share while acknowledging the burden and youths' desires to take action in the here-and-now (hooks, 1989).

Nila worked to emphasize how racism was already operating in her life and, by extension, the makerspace. This created a space for her peers to join in with their own personal stories. Sincere shared a story about how his "school is racist," pointing out his principal separated people by race. Keke critically commented, "if White plantation owners hated Black people so much, why did they rape Black women?" Others shared YouTube videos and social media posts that historicized their experiences. For example, Wolf shared a rap video called "I'm not racist"—and offered a line-by-line take down of all the White guy's lines, a critique of White supremacy itself. Afterwards he suggested "that'd be good for this group to do" to analyze "I'm not a racist" social media posts.

This conversation, initiated by Nila and supported by her maker educators, reflects powerful disruptions of antiBlackness in and within community/STEM borders. Youth were experts and authorities on racism because of their own ontological experiences and those of their family and communities. They used their experience to engage in a critical praxis of disrupting the kinds of borders around knowledge and expertise enacted in STEM. Simultaneously, they coopted the STEM tools at hand to further advance their argument.

Making new spatial imaginaries through material innovation

Next, we explore Nila's margin work in making new spatial imaginaries through material innovation. Prior to the conversation described above, Nila had already been researching racism. One example of what this looked like in her makerspace was when she co-created a survey on racism with peers two months prior. Nila used STEM tools like iPad surveys to engage peers in conversations about race and racism. She gathered over 30 responses from peers, all indicating they frequently experienced racism at school, on the bus, and walking through their city. She informed us that what was important was what kids told her while they were taking the survey, pointing out numerous stories she heard about the "bullying" tied to racism.

When one of the maker educators transitioned the group from talking about racism to asking the group to think about their maker projects, Nila bridged this conversation with her earlier investigation. She had an idea for "building a huge poster that people could contribute ideas to" and "that has big light up letters that says STOP RACISM." Nila stated that her sign was "important to address racism because of who was president. She explained how this sign could grab people's attention, like the political and rentals signs posted in front yards and along the street. Her goal was to "stomp it [racism] out." A sign about stopping racism, she felt, may get more people in her city talking about racism.

Nila's margin work, like Keke and Amara's, involved contesting, negotiating, and creatively inventing new liminal spaces for making. How Nila navigated the margins of antiBlackness/STEM and antiBlackness/community worked to disrupt the antiBlackness centers of both STEM and the larger community. As Nila worked on her sign, she moved between her own historicized experiences as a Black girl with rich community knowledge shared by her peers, and particular tools of STEM. For example, her first iteration involved a sign on a single ply of poster board, with a single string of lights, and read "Stop Racism." However, her peers shared worries that the sign would not catch anyone's attention. Nila, too, worried about the exact message she wanted to send, noting that a sign by itself

doesn't stop racism. Future iterations involved adding a hashtag to position her work within a larger conversation while offering a resource for learning more. She also added new ply and additional lights for durability and visibility. Each iteration required engaging new ideas that she remixed into her project. For example, Nila explored YouTube to search for why people become White supremacists, finding the hashtag #StopRacism as useful. She worked with a maker mentor to sketch ideas for how to power as many LEDs with a single environmentally-friendly power source.

Neither Nila, nor her educators, positioned her as responsible for solving racism with her project. Rather her making about authoring new and disruptive tools *invited others* to engage in disrupting racism with her. With input from peers, mentors, her mother, and the internet, Nila developed an approach—more than just a sign—to engage her community in dialog on racism. Four years later, Nila's sign still hangs in the makerspace, and youth who attend programming have learned to turn the sign on when they feel racism was particularly affecting their day. The sign has become a symbol of needing to stop and affirm each other for who they are.

Nila's efforts speak to her agency to disrupt antiBlackness centers. When Nila used club time to name her exhaustion with racism, maker mentor, Day, supported the youths' right to make in disruption of racism. Reflecting on the multiple articulations and repositioning of race and racism in making made evident how enacting new spatial imaginaries also happens in the liminal spaces of this margin work. If one were to introduce a #StopRacism light-up sign project to youth, it would not necessarily yield the same kind of relationalities and insights that Nila's co-making did. Her making is work *on*, *of*, and *in* material and semiotic borders and the territories they are meant to protect (Shivers McNair, 2020).

Discussion

bell hooks asserts that "[u]nderstanding marginality as position and place of resistance is crucial for oppressed, exploited, colonized people" (1989, p. 21). Margins are productive sites for Black Education Spaces. From occupying simultaneous margins of STEM/making/society, Keke, Amara, and Nila took up forms of margin work to resist and perturb antiBlackness.

Exploring the co-making work of Black girls as one way that margin work can take place provides a powerful perspective for understanding antiBlackness in STEM/making and the possibilities for social change. Keke, Amara, and Nila's co-making work illustrates how they refuse the antiBlackness centered in STEM/making/society which defines, contains, and controls what it means to be Black in intersecting White supremacist cultures of STEM/making/society. The girls co-make to respond to antiBlack realities, but they also orient to what could be. Dillard (2021) reminds us that wisdom is material, spiritual, cultural, and pedagogical. Keke, Amara, and Nila's co-making is connected to their Black spatial imaginaries—their narratives and visions of Black presence in STEM/making that expose, resist, and transcend "the White gaze" on Black bodies and communities (Jenkins, 2021, p. 121). Their Black spatial imaginaries present as "not merely anti-colonialist or anti-racist" but also "otherwise" (Bates et al., 2018, p. 255). *Otherwise* calls attention to the oppressive past *and* the forward-looking wisdom to disrupt dominant narratives. The girls' co-making can be considered their spatial imaginaries of the *otherwise* which differ from and disrupt dominant and antiBlack narratives of STEM/making spaces/larger society. Their co-making is seeding new spatial imaginaries, an element of BES.

Reclaiming STEM/making

Living on multiple margins (STEM/making/society) means negotiating antiBlackness daily. The girls distilled these antiBlack experiences into a set of bearings that reclaim who makes, what making is, and the sociopolitical work of making. The bearings, rooted in the everyday living and wisdom of the girls, reclaim STEM/making in ways that refuse the antiBlackness that dominates the movement, and instead seeks new possibilities, new social imaginaries.

As the girls co-made, we bore witness to how they exerted imagination on the present and their futures. We learned to see new margins and the possibilities within them through their efforts and imaginations. As they drew from a diverse range of experiences, information, and ideas, and how these ways of knowing are historicized, they imagined possible scenarios for what they desire or what may seem likely. Keke and Amara's STEM/making was built from hours and miles of bus rides the then 12-year-old twins had taken together often on their mom's bus, and their developing knowledge as a result of these experiences. It involved months of sustained STEM engagement in their maker club. The girls researched public health, safety, and justice related to public transportation, calculated potential time spent outside based on different bus schedules across town, inquired about and calculated voltage requirements of different outdoor heating systems, read about human-powered generators, shopped for the parts to build their own, and learned about battery power storage and circuit constructing.

Community making club as a racial counterspace, a new spatial imaginary

The STEM-rich community making club served as a racial counterspace that is a feature of a BES (Jenkins, 2021). Racial counterspaces provide physical havens for Black youth to congregate and support one another while offering a reprieve from persistent racial violence (Butler, 2018). We witnessed the making club become a space to support youth efforts to decenter Eurocentric epistemological, ontological, and axiological assumptions. We saw this, for example, when Nila and ReAnna probed and then facilitated a dialogue on systemic racism. The girls asserted and created themselves in relation to how they purposefully disrupted antiBlackness via margin work. The girls engaged with different epistemologies and forms of expertise as they took up technical and sociopolitical aspects of design.

Arranging these epistemologies in proximity emphasized how the margins of community/STEM knowledges are historicized against a backdrop of antiBlackness. It also emphasized an ethic of working towards a particular social-material world and towards new spatial imaginaries where their lives and bodies mattered. The girls engaged in futuring by "dream[ing] out loud" where they "practice[d] exercising sovereignty over the directions their lives will take" (Warren & Coles, 2020, p. 389). This dreaming out loud was evident in Amara's vision of a safer, kinder ride for her community in her prototype of a heated bus seat. This dreaming out loud was evident in Nila's rigorous STEM-rich making practices, including developing STEM epistemologies with concepts of resistance, load, energy sources, and conducting design tests. Nila's dreaming out loud took shape in calling out antiBlack racism through the language of STEM-rich making.

The girls offer a vision for the kind of radically-open margin work that stems from their occupation of the liminal spaces between antiBlackness STEM/community margins, and enacted in solidarity with each other and their communities towards desired futures. Their work reminds us of how White discourses seek to claim making, while girls' actions and wisdom resist such power grabs. Their imaginative possibilities for worlds that could be put into stark relief the questions that maker educators and researchers need to be asking about why and how we frame making through our discourses, practices, and programs, and for what kinds of people. Through such radically open margin work, cultural beliefs about making can be materially reproduced or disrupted, identities established or recreated, and social relations codified or modified.

Conclusion

Keke, Amara, and Nila worked hard towards seeding new social imaginaries in STEM, making and the larger community. Rather than romanticizing youth resistance to antiBlackness, we seek to learn from how and what girls make in ways that affirms their lives. They do so in ways that call attention to the

antiBlackness they experience as Black girls, through simultaneously occupying multiple margins because of antiBlackness and misogynoir, with an active desire for change.

We do not believe that it should fall on the shoulders of Black youth to solve the forms of systemic racism they encounter. However, we note the girls' community co-making practices gave them a chance to name and rename their worlds through their making. We echo scholars who urge the education field to contend with the realities of antiBlackness (Dumas, 2016; Jenkins, 2021; Warren & Coles, 2020) and to actively consider how Black Education Spaces might be supported and sustained.

Note

1. We do not use the name of the 45th president of the U.S. in solidarity with Nila who specifically asked her maker mentors not to mention his name in her presence, and use #45 or "the Orange Duck." While she did not name it this way, we view her request as one of shutting down an act of symbolic violence.

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References

Barajas-López, F., & Bang, M. (2018). Indigenous making and sharing: Claywork in an indigenous STEAM program. *Equity & Excellence in Education*, *51*(1), 7–20. https://doi.org/10.1080/10665684.2018.1437847

Bates, L., Towne, S., Jordan, C., & Lelliott, K. (2018). What shakes loose when imagining otherwise. *Planning Theory & Practice*, *19*(2), 254–256. https://doi.org/10.1080/14649357.2018.1456816

Butler, T. (2018). Black girl cartography: Black girlhood and place-making in education research. *Review of Research in Education*, *42*(1), 28–45. https://doi.org/10.3102/0091732X18762114

Calabrese Barton, A., & Tan, E. (2018). A longitudinal study of equity-oriented STEM-rich making among youth from historically marginalized communities. *American Education Research Journal*, *55*(4), 761–800. https://doi.org/10.3102/0002831218758668

Charmaz, K. (2017). The power of constructivist grounded theory for critical inquiry. *Qualitative Inquiry*, *23*(1), 34–45. https://doi.org/10.1177/1077800416657105

Dillard, C. (2021). When Black is [Queen]: Towards an endarkened equity and excellence in education. *Equity & Excellence in Education*, *54*(1), 19–27. https://doi.org/10.1080/10665684.2020.1863884

Dumas, M. (2016). Against the dark: AntiBlackness in education policy and discourse. *Theory into Practice*, *55*(1), 11–19. https://doi.org/10.1080/00405841.2016.1116852

Evans-Winters, V. (2019). *Black feminism in qualitative inquiry*. Routledge.

Freire, P. (1970). *Pedagogy of the oppressed*. Continuum Press.

Garcia, A. (2020). "Electric word life": methodological dignity in equity-driven research. *Equity & Excellence in Education*, *53*(3), 399–411. https://doi.org/10.1080/10665684.2020.1782788

Gaskins, N., Buechley, L. & Benjamin, R. (2021). *Techno-vernacular creativity and innovation: Culturally relevant making inside and outside of the classroom*. The MIT Press. https://doi.org/10.7551/mitpress/12379.001.0001

Gollihue, K. (2019). Re-making the makerspace. *Computers and Composition*, *53*, 21–33. https://doi.org/10.1016/j.compcom.2019.05.002

Greenberg, D., Calabrese Barton, A., Tan, E., & Archer, L. (2020). Youth critically redefining maker-entrepreneurialism. *Journal of the Learning Sciences*, *29*(4–5), 471–510. https://doi.org/10.1080/10508406.2020.1749633

Halverson, E., & Sheridan, K. (2014). The maker movement in education. *Harvard Educational Review*, *84*(4), 495–504. https://doi.org/10.17763/haer.84.4.34j1g68140382063

Hartman, S. (2008). *Lose your mother: A journey along the Atlantic slave route*. Macmillan.

hooks, B. (1989). *Talking back: Thinking feminist, thinking black*. South End Press.

hooks, B. (2000). *Feminist theory: From margin to center*. Pluto Press.

hooks, B. (2003). *Teaching community: A pedagogy of hope* (Vol. 36). Psychology Press.

Jenkins, D. (2021). Unspoken grammar of place: Anti-Blackness as a spatial imaginary in education. *Journal of School Leadership*, *31*(1–2), 107–126. https://doi.org/10.1177/1052684621992768

Kirkland, D. (2021). A pedagogy for black people: Why naming race matters. *Equity & Excellence in Education*, *54*(1), 60–67. https://doi.org/10.1080/10665684.2020.1867018

Love, B. L. (2014). "I see Trayvon Martin": What teachers can learn from the tragic death of a young black male. *The Urban review*, *46*, 292–306.

McGee, E. (2021). *Black, brown, bruised: How racialized STEM education stifles innovation*. Harvard Education Press.

Rankin, N., Johnson, G., Dejanes, R., Grant, H., & Triplett, K. (2015). MARTA service cuts in hotlanta. *Race, Gender & Class*, *22*(3–4), 55–82.

Shivers McNair, A. (2020). Mediation and boundary marking. *Learning, Culture & Social Interaction*, *24*, 100290. https://doi.org/10.1016/j.lcsi.2019.02.015

Tuck, E. (2009). Suspending damage: A letter to communities. *Harvard Educational Review*, *79*(3), 409-427, 539–540. https://doi.org/10.17763/haer.79.3.n0016675661t3n15

Vossoughi, S., Hooper, P., & Escudé, M. (2016). Making through the lens of culture and power. *Harvard Educational Review*, *86*(2), 206–232. https://doi.org/10.17763/0017-8055.86.2.206

Warren, C., & Coles, J. (2020). Trading spaces: AntiBlackness and reflections on Black education futures. *Equity & Excellence in Education*, *53*(3), 382–398. https://doi.org/10.1080/10665684.2020.1764882

Wilcox, S. (2021). An offer of bearing and baring witness as pedagogy. *Equity & Excellence in Education*, *54*(1), 50–59. https://doi.org/10.1080/10665684.2020.1863880

Worsley, T. D., & Roby, R. S. (2021). Fostering spaces for black joy in STEM-Rich making and beyond. *Journal of Effective Teaching in Higher Education*, *4*(2), 118–134. https://doi.org/10.36021/jethe.v4i2.166