A Longitudinal Study of Equity-Oriented STEM-Rich Making Among Youth From Historically Marginalized Communities

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The maker movement has evoked interest for its role in breaking down barriers to STEM learning. However, few empirical studies document how youth are supported over time in STEM-rich making projects or their outcomes. This longitudinal critical ethnographic study traces the development of 41 youth maker projects in two community-centered making programs. Building a conceptual argument for an equity-oriented culture of making, the authors discuss the ways in which making with and in community opened opportunities for youth to project their communities' rich culture knowledge and wisdom onto their making while also troubling and negotiating the historicized injustices they experience. The authors also discuss how community

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engagement legitimized a practice of co-making, which supported equity-oriented goals and outcomes.

Introduction

> When you are engineering, when you are making your invention, first of all, you have to talk to people. You have to interview people in your community. You might know what the problems are, but you might not know how it matters to other people. You have to figure out how other people care, and you have to get their ideas, and learn what they know. . . . When we made our library, we had to figure out that we needed to make it. We needed to know where it would go, what it could look like, and stuff we put in it. We had our ideas, but our ideas weren't enough. —Samuel, 14-year-old maker

Samuel shared this quote with us about his efforts to build a "Little Free STEM Library" with his friend, Fall, while working in a making space at their local community center over a 2-year period. They made the library so that the children at their club could have free and unfettered access to science books and mini-maker kits designed by them. They also added blinking LED lights around the library, powered initially by a hand-crank generator and later by a solar panel, to call attention to the library, and to get kids curious about how the circuit worked.

Providing access to STEM books and resources was important to the youth. Their research showed they lived, in their words, in a "library desert," and also that many youth in their school had limited access to books or science materials. Samuel and Fall wanted to help the youth in their community to practice their reading while also having the chance to make things for their community—concerns they felt were not adequately addressed at school.

This quote also captures how Samuel framed the importance of sustained engagement with his community as a part of the process of making. He makes the point that by interviewing and talking with different people in his community, he could see the problems he cared about in new ways. Samuel also viewed his engagement with community as shaping the outcomes of his work. He needed to know where to put the finished library so that it would be accessible to others. His idea for including the maker kits was also inspired by observing how much the younger children enjoyed sneaking into the making space to play with the circuit materials.

We begin with this brief story because we are concerned with understanding the possibilities for equity-oriented and STEM-rich making for youth from historically marginalized communities. Given the proliferation of makerspaces across the country, including their growing inclusion in

school STEM settings, we seek to contribute new knowledge and practice for transforming the maker culture in ways that are both *equitable* and *consequential* for such youth. Thus, in this manuscript we report on our investigation into the following research questions:

1. *How does community engagement as a part of STEM-rich making impact what, how, and why youth make?*
2. *How do youths' making practices and projects, as enacted through community engagement, contribute to the making culture in their community making spaces in equitable and consequential ways?*

The Emerging Culture of Making: An Equity Challenge

Equity & STEM-Rich Making

For many youth, gaining access to STEM is an uphill battle. Inequality and underrepresentation of youth of color and from low-income communities in STEM persist. For such youth pathways into STEM and STEM-empowered lives remain filled with obstacles, from access to quality STEM learning experiences to opportunities to engage with STEM in ways that matter in one's life.

The maker movement has evoked interest for its potential role in breaking down these barriers to STEM learning and attainment (Martin, 2015). However, despite growing interest in equity and making, few empirical studies of *sustained youth engagement* in STEM-oriented making exist. There is little empirical evidence describing how youth are supported, over time, in working toward robust STEM-rich making projects or on the outcomes of such making experiences, especially among youth from historically marginalized communities.

We use the term *STEM-rich making* to refer to making projects and experiences that support makers in deepening and applying science and engineering knowledge and practice, in conjunction with other powerful forms of knowledge and practice, such as the funds of knowledge (Gonzáles, Moll, & Amanti, 2006) and community wisdom (Tuck, 2009) one has because of who they are, and where they have grown up. For example, there is a growing focus on the role of e-textiles (e.g., light-up fashion wear) in supporting youth makers in learning to code simple microcontrollers and to build circuits while also drawing upon knowledge of sewing and fashion (Kafai, Fields, & Searle, 2014). Bang, Marin, Faber, & Suzukovich (2013) discuss the importance of repatriating and innovating technologies in STEM-related work with indigenous youth to "dislodge" such technologies from colonial legacies. This is another way to think about culture and equity in STEM-rich making because it shows how technology can be reconstructed toward new purposes and grounded in sustaining knowledge

systems, repositioning youth as "makers" rather than "consumers" of technology (p. 710).

We recognize that a wide range of making projects are not overtly STEM-oriented (e.g., cooking, embroidery), although they could be. However, we focus on STEM-rich making precisely because STEM is a domain for whom many youth from historically marginalized communities have been denied equitable access and because the making movement claims to reduce barriers in access and opportunity in STEM.

Maker Cultures

Making and the maker movement have gained increasing attention not only in the United States but also across the world. Often housed in libraries or in their own dedicated facilities, makerspaces have flourished globally (J. Holland, 2015), proliferating in public spaces, private domains, and increasingly gaining traction in K–12 schools as a platform to promote STEM learning and creativity (Martin, 2015). One current theme in the maker movement focuses on empowerment. As the CEO of *Make Magazine* states, "You're makers of your own world. ... Makers are in control. That's what fascinates them; that's why they do what they do. They want to figure out how things work, they want to get access to it, and they want to control it" (Dougherty, 2011). While the theme of empowerment is inspiring, unpacking who a maker is, what a maker makes, what kinds of access a maker has to tools and opportunities to keep making, cannot be divorced from considering the social, racial, gendered, economic, and political conditions in which particular makers are bound. Espousing an egalitarian vision of making may symbolically level the playing field, while in reality the leveling of access and opportunities to make for some groups of the population lacks dismally.

As Nascimento and Pólvora (2016) point out, "Maker engagements with the world can easily embrace a sense of freedom and creativity to make whatever is wanted ... with no major calls for changes in this situation, or even no concrete attention to its social conditions and consequences" (p. 6). Indeed, who is a maker and in what context a maker is accessing and engaging in making experiences are very much a product of the norms and values deeply inscribed in the physicality and territories of making spaces—where making spaces are located, what tools and materials are housed within, or the identities of the maker mentors that inhabit that space. These norms and values are themselves borne of particular intersections of social (including racial and gendered), economic and political elements. In fact, we purposefully use the term "making spaces" over "makerspace" to call attention to the manner in which making takes shape (and the learning and trajectories of makers) is always in dialectic with the dynamic culture that surrounds it, rather than only the physical space itself.

There is little evidence that the dominant culture of the maker movement, as described above, has been broadly shaped by a diverse audience over a sustained period of time. While there are powerful examples of making and making spaces that serve families and youth from historically marginalized communities (Peppler & Bender, 2013; Vossoughi, Hooper, & Escudé, 2016), the statistics of the movement require caution. The median salary for those involved in the maker movement in the United States is $103,000, 97% of those who go to Maker Faires have college degrees, and 70% have graduate degrees. Only 11% of the contributions to *Make Magazine* (the periodical credited with launching the Maker Movement) are female (Brahms & Crowley, 2016). Thus, as the maker movement has become formalized, the powerful knowledge and practices of communities of color or of low-income communities have not yet become central to its discourse.

Furthermore, making that youth deem consequential to their lives or how such learning or making is supported is not well understood. Most making resources directed toward children promote the "keychain syndrome"—a reference to youth going to a maker space and 3-D printing a preformatted keychain. These kinds of making experiences are often trivial and do not involve prolonged or sustained meaningful engagement or anticipation of more complex projects (Blikstein & Worsley, 2016).

The maker movement has placed scant attention on sustained maker learning experiences, despite recent acknowledgement of the importance of such in deepening knowledge and practice in STEM (ASEE, 2016). Even when making projects support authentic engagement on a problem one cares about, there has been limited critical engagement with what constitutes consequentiality in making or for whom. For example, the projects in *Make Magazine* seldom have a community focus. When they do, there is little attention beyond the normative family unit or peer group (again mostly middle class, and mostly white). Little attention is paid to intersections of family with history, location, or a more expanded community. What constitutes community has not been a focal question in making, and yet layers of community can take on importance across people, space, and time.

Lastly, limited research within the making movement has revealed insight into maker programs' practices that support greater equity in opportunities to make (e.g., Norris 2014). For example, the studies that do exist have documented the importance of maker-educators or mentors asking questions rather than giving answers, encouraging exploration and failure, making thinking transparent, or being a connector for youth, ideas, and tools (Ryoo, Bulalacao, Kekelis, McLeod, & Henriquez, 2015). Such practices can promote equity goals because they have been shown to promote greater success in making and the negotiation of gendered and racialized identities in making (Norris, 2014). However, how these practices are tied to a culture of making is underexplored.

The shift toward culture is significant from an equity standpoint: Whose voices are valued and who counts as legitimate stakeholders in a community making space impacts how various people are welcomed, positioned, and recognized for what they know and can do as a part of shaping the learning and participation that happens there. As we consider a *culture of making*, we are particularly interested in the relationships among "I, Thou, and It"—the teacher, the child, and the world around them (Hawkins, 1974), and what it means for being together in a space. How people are welcomed, positioned, and recognized for what they know and can do in a making space shapes the culture of learning and participation that happens there. As Vossoughi and her colleagues (2016) remind us, "rather than beginning with the question who has access to making, we might start with the assumption that practices resonant with making are already present in diverse forms in all communities" (p. 218). This stance potentially positions making space educators and participants as co-constructors of culture, engaged in mutual activity that challenge normative views of knowledge production and expertise. Examining how an emergent maker culture is actively shaped in community is a productive way to unpack how youths' diverse interests and the historicized practices of communities of color are rich and legitimate resources for making.

Conceptual Framing

We ground our work in cultural views of learning and development that places human interaction and activity at the center of analysis (Vossoughi & Gutiérrez, 2014; Engeström & Sannino, 2010). We take the stance that there are "no cultureless or neutral" ways of being in the world (Bang et al., 2013). Here we conceptualize culture as dynamic yet made up of routine practices—a "usual way of doing things" through a "history of involvement"—in which individuals and communities engage, rather than reductive (and typically deficit-oriented) views framed by membership in particular groups (Gutiérrez & Rogoff, 2003, p. 21).

Such a cultural view foregrounds how learning is a *relational activity* in terms of time (past, present, future), place (previous and current home) (Leander, Philips, & Taylor, 2010), and power (Gutiérrez, 2008). Here, given our focus on culture, we explicitly invoke an anthropological view of relationality (Eckert, 2016), where relationality asserts both interconnectedness and difference through how we subjectively construct ourselves and the other. Focused on more than vertical movement (e.g., novice to expert), this dynamic and critical view illuminates the ways in which learning takes shape in how people, ideas, tools, resources, bodies, and relationships move and remix as people engage in social practice toward new futures. New forms of hybrid knowledge and practice arise as people move

horizontally, from place to place, widening what counts as expertise (Vossoughi & Gutiérrez, 2014).

From this cultural perspective making can be considered a dynamic multipractice, involving the processes of reauthoring and remixing practices from a wide range of experiences (Kafai et al., 2014). Such a multipractice approach can be productive, as it can value historically "feminized" practices, such as crafting alongside more traditionally "masculinized" practices, such as electronics (Buchholz, Shively, Peppler, & Wohlwend, 2014, p. 283). These cultural processes involve shifting making practices toward hybrid epistemological and ontological ends (Bang et al., 2013). As Holland and Lave (2009) argue, "in practice, material and symbolic resources are distributed disproportionally across socially identified groups and generate different social relations and perspectives among participants" (p. 5). The nature of knowing in STEM, making, and the role of community are always under negotiation as different individuals reproduce and resist the narratives at play there. We are thus interested in how new routines, ideas, relationships, and ways of being become legitimized in practice.

We also ground our work in intersectionality (Crenshaw, 1991; Nash 2008), an important lens when taking a relational and dynamic view of learning because of how it calls into question power and position. Intersectionality foregrounds the multidimensionality and complexity of forms of oppression that can operate in concert but in varying degrees, in subjugating individuals and people groups. Interconnected oppressive forces do not operate in a linear, cumulative manner. At the same time, intersectional studies caution against overstressing individual "uniqueness" without structural, power analysis (Rios, Bowling, & Harris, 2016). Intersectionality not only highlights the tangled webs of oppression, but also urges the formation of dynamic alliances toward social transformation, once these interconnecting webs can be named, identified, and understood. Therefore, beyond delineating the complexity of systemic oppressive forces, a social transformative goal underlies intersectionality (Unterhalther, 2012).

Intersectionality foregrounds the ways in which systemic oppressions play out in human interaction and activity. How youth move practices, tools, and ideas from various places of their lives to their work in their making spaces, or how they move their work in their making space in its various forms to other places are shaped by local and historical narratives and structures related to race, class, and gender (Haan, Leander, Ünlüsoy, & Prinsen, 2014). That is, youths' interests are reflections of their lived experiences in the world and how they have learned to navigate those experiences through local power geometries. Youths' experiences can expose and challenge *normative views of making* while also building a making community that legitimizes their lives. However, how connections and interests are interpreted by others impacts determinations of who can make, and where making matters. Finding meaningful participation in making can be an ongoing struggle

for individuals as they negotiate relationships between personal and historical narratives regarding participation with STEM-oriented making when these experiences differ from the norm (D. Holland & Lave, 2009).

Thus, central to our own concerns are how unequal distributions of power impacts how learning and doing in making take shape *across* the powered boundaries of gender, race, and class, and its impact on youth. To understand maker learning in practice requires one to pay attention to the power dynamics that shape how youth are recognized for what they know and can do. Despite the espoused "democratizing effects" of making, how youth leverage their knowledge of community concerns and values could be positioned hierarchically by the teacher/adult facilitator or peers, even if such practices have a role in making (e.g., Calabrese Barton, Tan, & Greenberg, 2017). These unequal distributions of power can impact whether one sees oneself as capable and welcomed in STEM or making.

This combined stance therefore calls attention to equity-oriented considerations in making, for it foregrounds the ways in which individual experiences in making intersect with systemic forces through sanctioned power hierarchies and practices. It emphasizes that making always takes place in spaces and times influenced by institutional, societal, and individual histories. It also emphasizes how making involves the process of reauthoring and remixing practices from a wide range of experiences, located in the home, community, and school among other places, toward reorienting social relations and knowledge hierarchies.

Maker Communities and Methods

Community-Centered Making

Our study is grounded in middle school youths' experiences in two community-centered making space programs in Michigan and North Carolina, over the course of 4 years. The MI maker program has been active since 2007, however, it has slowly taken a more direct focus in "making" from a more general focus on "engineering" since 2013. NC's maker program began in 2014 with an explicit making focus. The making space programs are housed in youth clubs, which are community-based clubs that have a focus on youth development, homework help, and sports for youth from low-income backgrounds. Both clubs serve predominantly (> 95%) multigenerational African American communities alongside much smaller percentages of white and Latinx youth.

We selected these partner institutions because they: (a) centralize equity in STEM in their programs, (b) offer programs that promote sustained experiences in making, and (c) recruit a diversity of youth (e.g., age, ethnicity, SES, gender) into making, including homeless youth, youth of color, and low-income youth.

An open-door policy was held in both sites for the making programs. Youth were recruited by club directors for a variety of reasons—an interest in STEM, a need to keep a youth occupied, and friendship groups. These were not drop-in programs, but rather sustained afterschool programs. Youth participated in weekly making sessions for a full school year, with many participating for 2 and more years. Given the nature of youth lives, many moved in and out of these programs as their lives allowed (e.g., some youth faced transient housing situations, had transportation issues, or had arts or competitive sports seasons at school). For example, Samuel, the student whose story is presented in the introduction, once missed 2 months' of programming because he lacked transportation to his club. In most cases, the youth who left the programs completely were the ones who moved away from the area or stopped their participation at the youth club for reasons often beyond their control.

In our research and development roles, we worked collaboratively with youth club staff to establish making programs over time, with the goals of supporting youth in learning about STEM-rich making in culturally sustaining ways. We sought to engage youth iteratively and generatively in making activities by incorporating youth-led community ethnography. We conjectured that a community ethnography approach to making might provide a way to support youth in embedding local knowledge and practice more explicitly into making. While we codesigned activities with this main conjecture in mind, we did not know how this approach would work in particular or the implications it had for what, how, or why youth might make, since community-insider data would reside primarily with the youth and not with us. For example, when youth decided they were interested in safety concerns, we worked with them to design an open-ended survey they could give to community members to solicit their experiences and ideas about safety, but youth had input into whom they wanted to survey.

We have been particularly interested in community-centered making, and this is the primary reason we sought to work with our partners. In this study, *community-centered* carried three interrelated meanings. First, the making spaces were housed in community centers and followed norms for participation reflective of those community spaces. For example, programs were inter-age (generally ages 10–15), supported flexible movement in and out of programs due to transient life circumstances while also promoting sustained engagement (as explained above), and involved youth in ongoing codesign of experiences.

Second, the two focal making programs sought to create spaces for youth to interact with the broader community served by the youth clubs. While the design of the experiences were meant to support youth in engaging with their communities in making, we did not know how this would play out beyond our design ideas. For example, early on in the making process, youth were encouraged to interview community members and peers on

pertinent issues that they thought they could address through making prac-
tices. Community members were sought out by the youth because of exist-
ing relationships the youth had. This involved an organic approach of
extending the net of relations that individuals within the space had.
Taking such community funds of knowledge as initial research sources,
youth moved through iterative making design cycles of further online and
community ethnographic research, making/prototyping/testing at their mak-
ing spaces, with critical feedback sessions with community experts.

As part of refining the problems youth decided to solve, making space
educators encouraged youth to engage with community dialog through
ongoing observations, surveys, and informal conversations to learn more
about the challenges/problems that community members faced and the
kinds of advice/ideas they had for solving those problems. Youth were
encouraged to talk with peers at their schools, club, and around their neigh-
borhood. They were also guided to conduct open-ended surveys of their
parents, friends' parents, and other youth and adults around their club,
schools, and neighborhood. They were supported in identifying and system-
atically observing locations and contexts of safety concerns as timing and
safety allowed (e.g., observing—with help from adults—a playground
where bullying occurred). Each week, making space educators helped youth
to analyze their stories, interactions, and other data they collected, discussing
patterns and exploring stand-out ideas together as learning partners.

Third, making space educators periodically designed activities or events
that brought community members into the community center to provide
feedback or help on projects. For example, youth participated in multiple
feedback cycles with different community constituents—and coordinated
these feedback sessions with different points in their making design
cycle—to solicit the types of technical and/or social input that could help
them move their design work forward. This sometimes took on a more for-
mal tone as youth presented their projects to various stakeholders (e.g., local
engineers, parents, community members, and peers) who provided written
feedback, or when youth involved various community members as proto-
type testers. Sometimes these feedback cycles were more informal, as vari-
ous community members visited youth at their workstations and engaged
in idea-generating conversations.

Critical Ethnography

Being critically engaged with equity, in making methodological deci-
sions we have been concerned with how we lens our work, giving privilege
to the youth with whom we work—youth whose voices have been absent in
the formalization of the maker movement. We take an unapologetic assets-
driven and "desire-based" framework (in refusal of "damage-centered
research" (Tuck, 2009) which has for too long positioned youth from

nondominant communities as in need of repair, a strong narrative in STEM education). As Tuck (2009) reminds us, "desire-based research frameworks" require epistemological shifts accounting for "the loss and despair, but also the hope, the visions, the wisdom of lived lives and communities. Desire is involved with the *not yet* and, at times, the *not anymore*" (p. 417). We hope that our efforts to document the practices and culture of youth makers and community-based making in our manuscript acknowledges the sociohistorical realities that young people face and their wisdom and agency toward social transformation for which they seek support and recognition through their making efforts (Yosso, 2005). We view the stories told of youth here as emerging manifestations of desires hoped for—the youths' agentic response to desires of the *not yet* and their efforts to reclaim the *not anymore*.

   We thus carried out our study as a critical ethnography over a 4-year period. We selected critical ethnography because of its explicit focus on participatory critique, transformation, empowerment, and social justice. We are also concerned with understanding the cultural dimensions of making programs and youths' participation. Critical ethnography is well suited to help us make sense of the cultural dimensions of making while also foregrounding and making sense of inequalities from multiple perspectives (Trueba, 1999). Ethnography places an emphasis on understanding *cultural systems*. We are interested in generating understandings of the dynamic STEM-making culture in each of the sites through representation of emic perspectives, or the insider's point of view (Erickson, 1984). We were also interested in a long-term, holistic view of the programs under study, to generate as rich and dynamic a portrait of the cultural systems at play, how they develop over time in interaction with individuals, tools, resources, and experience, and how the youth themselves learn and become as makers through this culture. This is a time- and labor-intensive research approach, but given the new and changing nature of the maker movement, we felt that conducting these longitudinal ethnographies was essential.

   Lastly, critical ethnography also provided an approach with which to "politicize" the interaction between actors and the social structures through which they act, grounded in the belief that these relationships are never neutral. That is, we work to see how culture and power play out in human action and interaction, keeping problematic the ways in which dominant narrative can frame what it means to know, do and become in these spaces. This approach was important as we attempted to make sense of how youth, who are positioned in particular ways due to race, gender, and class, engage in making space activities.

   Our multiyear focus has allowed us to follow youth through multiple making projects, as well to deepen the kinds of trusted relationships required for the depth of insight needed in ethnographic work. We do not believe that we could have documented the emerging culture of making if

we had been present for only 1 year, or even if we had dropped in and out over time. Embedding ourselves longitudinally allows us to establish legitimate presence in the communities which is essential to our efforts to identify how youths' making practices emerge, develop, and move between space and time.

Date Generation

Data were generated from 2013 to 2017 from 41 youth team projects involving 48 youth makers. Detailed field notes of twice-weekly interactions with youth were kept during the maker programs. In each site, field notes were kept by more than one researcher to allow for multiple perspectives to inform how we understand the contexts and interactions. We also conducted midyear and end-of-year "artifact interviews." Here, the "artifacts" are things youth made in their making programs and could include their design sketches, actual prototypes, and videos about their prototypes, among other things. These interviews generally lasted about 90 minutes per youth/team, and covered four categories of questions: (a) understanding the artifact (what is it, how it works, what problem it solves, what materials did you use and why, etc.); (b) participation and engagement (behind the scenes, including a step-by-step description of the process of making, along with descriptions of interactions/support youth received from peers, educators, and community members, resources used); (c) knowledge and practices (STEM knowledge and practice needed—prior and what was learned—and funds of knowledge); and (d) meaning and value (what this project says about oneself, etc.). We also conducted informal weekly conversations with a subset of youth to make sense of ongoing questions, concerns, and feel of the program, along with video/image capture of sessions and artifacts produced (See Table 1 for a summary of data generated).

The 41 youth team projects are described in Table 2. These projects reflect all major projects produced by youth in our two sites over 4 years. The 48 youth makers[1] include all youth who participated in the maker programs in the two sites, including those youth with transient participation. There is generally a 10–15% attrition rate. This is not surprising to us as the youth clubs' directors have a history of expecting participation in programming.

Data Analysis

Data analysis involved multiple stages and levels of coding based on procedures for open coding and method of constant comparison (Strauss & Corbin, 1998). Our first pass involved reading through artifact interviews transcripts (conducted yearly at mid- and end-of-year), field notes, and student work. The goal of this first pass was to open code for (a) critical moments of engagement with community in making, (b) how community

Table 1

Data Forms and Generation Strategies

Data Form	Specific Data Generation Strategy	MI	NC
Participant observation	• Makerspace sessions/activities: Video recordings of twice weekly sessions and field notes in two sites • Makerspace community events	70 hours/year 8hrs/year (average)	70 hours/year (average) n/a in years 1–2, about 8 hours in years 3 and 4
Conversation group	• As a way to debrief what was happening in the club as well as to plan for future activities	30 hrs/yr (average)	30 hrs/yr (average)
Interviews (adults)	• Conversations with maker space mentors, club leaders, involved community members, parents	12 hours/year	10 hours/year
Artifact Think aloud (youth)	• Allowing youth opportunities to talk about their engineering design work in detail (midyear and end of year)	4 hrs/gp/yr	3 hrs/gp/year
Artifact collection	• Youth's Sketch-Up notebook, 3-D Google SketchUp model of design, worksheets, prototype, movie, etc.		ongoing

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Table 2
Youth Maker Artifacts

Innovation	Description	Targeted Injustices	STEM Knowledge and Practices*	Youth Makers
1. Anti-bullying App	Crowdsourcing bully "hot zones" at school and neighborhood, layered by type and frequency	Bullying; education	Programming; GIS mapping	Chris (10)
2. Light-up football	Light-up football made of softer material, properly weighted and waterproof	Geography and climate; healthy peer relationships; urban infrastructure	Electronics; renewable energy; forces and motion; materials	Samuel (12)
3. Little STEM/Maker library	Expanding free access to books and mini maker kits	Urban infrastructure; education	Electronics; measurement; renewable energy; programming and digital skills; materials	Samuel and Fall (14, 15)
4. Light-up umbrella	To beautify and brighten to keep people safe while walking in the dark and rain	Geography and climate; urban infrastructure	Electronics; renewable energy	Ariana (10)
5. Solar-powered light-up scooter	To help kids transport safely, with short winter days	Geography and climate; urban infrastructure	Electronics; renewable energy; GIS mapping; forces and motion	Emily and Jennifer (10)
6. Heated sweatshirt	A solar-powered jacket that is fashionable and provides warmth on cold, windy days	Bullying; geography and climate	Electronics; thermodynamics; materials	Emily and Jennifer (11)
7. The Timmy	Heated, light-up boots, stylish and functional, powered by rechargeable batteries	Geography and climate; health and disabilities	Electronics; thermodynamics	Maken and Tel (both 12)
8. Rape alarm jacket	Solar-powered alarm in stylish jacket for teenage girls	Personal safety; bullying; signaling distress	Electronics	Kairee and Mirabel (11)
9. Heat Those Bodies!	Human-powered heating system for bus shelters	Urban infrastructure; geography and climate	Electronics; renewable energy; thermodynamics	Kairee (12)
10. Heat Those Butts	Solar-powered heated seat for inside the bus, creating safe, warm environment for commuters in the winter	Urban infrastructure; geography and climate; health and disabilities	Electronics; renewable energy; thermodynamics; materials	Jaida (12)

(continued)

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Table 2 (continued)

Innovation	Description	Targeted Injustices	STEM Knowledge and Practices*	Youth Makers
11. House alarm system	Alarm system to detects pressure on ground near windows to for potential intruders	Personal safety; signaling distress	Electronics; digital skills and programming	Jaida and Ajanta (11)
12. Heated birdhouse	Solar-powered heated birdhouse to provide shelter to blue jays, which do not migrate in winter	Geography and climate	Electronics; thermodynamics; bird migration; materials	Jaida, Miracle, Lianna (all 10)
13. No Phone Home	Arduino programmed shield to make calls at push of a button for families without phones	Signaling distress	Digital skills and programming; electronics	Zada and Ilani (both 11)
14. DIY videos—For Us By Us	Videos on making practices and green energy sources "by kids like us for kids like us"	Education; sexism; healthy peer relationships	Digital skills and programming (video production) + electronics; renewable energy (content of videos)	Megan and Peter (12 and 10)
15. Cautious cap	Stylish alarm hat for protection in homeless shelters	Bullying; personal safety	Electronics; renewable energy	Tonya (10)
16. Motion-sensor motorized baby gate	Motion-sensored baby gate for elderly and disabled caregivers	Health and disabilities; caregiver; personal safety	Electronics; measurement; forces and motion	Peter and Kelvin (15 and 14)
17. Solar-powered MP3 hoodie	Help peers to listen to music in their preferred choice of outerwear	Lack of childhood	Electronics; measurement	Sharon (12) and Ariel (11)
18. Light-up sneaker	Light-up shoe to prevent friends from tripping and falling when walking in the dark	Urban infrastructure	Electronics; measurement	Tamzin and Ernest (11 and 10)
19. Donator app	App to educate about homelessness and its impact on families with links to offer support	Education; urban infrastructure	Digital skills and programming; GIS mapping	Luca, Zada (12)
20. Alarm backpack	Bullying in school, danger while walking home alone	Bullying	Electronics; measurement	Lisa and Teena (12 and 10)

(continued)

Table 2 (continued)

Innovation	Description	Targeted Injustices	STEM Knowledge and Practices*	Youth Makers
21. Geodesic play dome	Lack of play structures at the community club, lack of privacy at the community club; desire to "make something big"	Lack of childhood	Electronics; measurement; materials	Sharon (14) and Ariel (12)
22. DIY fidget spinner	Lack of fun in school; need to address fidgeting; lack of funds to buy a fidget spinner	Lack of childhood	Measurement; digital skills and programming; forces and motion; materials	Soul (13)
23. Recycled talking bear	Lack of soft toys; reused parts of a dissected toy from previous activity	Lack of childhood	Measurement; materials	Xavier (12)
24. Scratch game	Lack of digital games for younger children at the community club	Lack of childhood	Digital skills and programming	Ernest (10)
25. Electric art	Lack of youth-made art pieces to decorate the walls of the community space	Healthy peer representation	Electronics; measurement	Amanda (12) and Janice (11)
26. Robotic arm	Low-cost toy made from recycled materials	Lack of childhood	Measurement; materials	Kamden (12)
27. Hydraulic robotic claw	A low-cost toy for youth at the club made from recycled materials including cardboard, skewers, 10ml syringes, and plastic tubing	Lack of childhood	Electronics; measurement; materials	Joash (10)
28. Multistorey doll house with LED lights	3-story toy doll house made from recycled materials with furniture, balconies, and a staircase, "ceiling lights"	Lack of childhood; caregiver	Electronics; measurement	Sasha (11), Gloria (11), T'Shona (11)
29. Cardboard safe	Cardboard safe made of recycled materials to store personal items of value when one lacks privacy in a household	Lack of privacy	Electronics; measurement; materials	Kristi (12)

(continued)

Table 2 (continued)

Innovation	Description	Targeted Injustices	STEM Knowledge and Practices*	Youth Makers
30. Light-up pillow	A soft pillow with an LED light as part of the design	Caregiver	Electronics; measurement	Sasha (10)
31. Light-up panda soft toy	A soft toy panda with light-up eyes	Lack of childhood	Electronics; measurement; materials	Tobey (11)
32. Puppet theater with LED lights	Low-cost puppet theater made from recycled materials and interchangeable scenery, lighting and pulley curtain system	Lack of childhood; healthy peer representation	Electronics; measurement; forces and motion; materials	Ernest (9), Teena (11)
33. Light-up headband	Creating light-up hair accessories from scrap fabric material for the girls in the community	Poverty	Electronics	Ariel (10)
34. GETCity4Real	Open-access YouTube station to make DIY videos accessible to the world	Healthy peer representation; education	Digital skills and programming (video production) + electronics; renewable energy (content of videos)	Jamel, Curtis, and Shanna (11 and 12)
35. Dog designer rescue kit	Crafting designer dog purses with useful items for helping a homeless pet	Poverty; caregiver; education	Electronics; materials; animal and animal care-giver needs	Jelie, Lejia, and Rala (all 12)
36. Greenhouse group	Solar-powered greenhouse to produce healthy after-school snacks for youth at the club	Health and disabilities	How plants grow; healthy eating; measurement; materials	Sincere and Kyra (12)
37. Duct tape tie	Fashionable tie to record body temperature at the neck and ambient room temperature: A hygienic solution to prevent passing of germs	Health and disabilities	Electronics; digital skills and programming; materials; spread of infection diseases	Amira (12)
38. Eye Can	Small robot with handle to help elderly and disabled to pick up small objects	Health and disabilities	Electronics; forces and motion; materials	Emorie (12)

(continued)

Table 2 (continued)

Innovation	Description	Targeted Injustices	STEM Knowledge and Practices*	Youth Makers
39. FANcy Hat	Fashionable hat with solar pow-ered fan to keep one cool while in church services	Health and disabilities	Electronics; renewable energy; materials	Faith (12)
40. Phantom jacket	An alarmed jacket powered by wind turbines built onto the shoulders of the jacket	Police brutality; geography and climate; bullying	Electronics; digital skills and pro-gramming; renewable energy	Samuel (13),Jamae (12)
41. Solar phone case charger	Hinged, solar paneled case where panels can be angled to absorb maximum radiant energy	Signaling distress	Electronics; digital skills and pro-gramming; renewable energy	Quentin (13) and Caitlin (14)

*Key for STEM knowledge and practice:
1. Electronics: standard circuits, paper circuits, e-textiles (all involve simple, series and parallel circuits; power requirements, loads/outputs, switches)
2. Thermodynamics: heat, insulation, and relationship to work/energy
3. Renewable energy: power sources, energy production, energy transformations
4. Measurement: angles, lengths, weight
5. Materials: properties and uses of materials
6. Forces and motion: push/pull, gravity, aerodynamic features
7. Programming and digital skills: app building, Arduino programming, 3-D digital sketching
8. GIS mapping: in-putting and layering data; big data
9. All projects include survey analysis, conducting fair tests, and design iterations

ideas and perspectives imprinted on their making work and onto STEM itself, and (c) critical design moments and how those were resolved. For example, we looked for moments where youth appeared "stuck" in their making designs as indicated in our field notes, their making notebooks, or in their descriptions of their design work in interviews and conversation groups. We also looked for shifts in engagement, such as when youth began to stay longer or shorter periods of time at their club, visited during nonprogram hours, took projects home, or sought more extensive help from others. Weekly conversations were held between the authors on these insights to work toward 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 making notebook.

Our second pass involved overlaying on initial analysis examinations of tensions and connections among the various youths' forms of engagement in making and generally how youth talked about and framed what it meant to participate. With the help of our theoretical framework, we worked to make sense of the relationality between youths' efforts to move, repurpose, or remix the ideas, practices, and resources they leveraged within these events and educators' pedagogical practice. This axial phase of coding focused on uncovering relationships and connections between the youths' making and the pedagogies that emerged from the data. The relationships and connections identified in this second stage of coding, in turn, guided our selective coding and became categories and themes from which our example cases were selected for a final round of analysis and presentation.

Findings

In this section, we develop two main claims about how community engagement impacted the process and product of youths' making, thereby shaping an emergent equity-oriented making culture. First, making with and in community opened opportunities for youth to project the ordinariness of childhood and the rich culture of their communities onto their making while also highlighting the historicized injustices they experience in the world and the symbolic and physical violence they sometimes experienced as a result. A critical aspect is in how youth sought to reclaim their experiences, lives, and communities in more complex and agentic ways than what dominant narratives imply. Second, community engagement as a part of making legitimized a practice of co-making. The practice of co-making supported equity-oriented goals by (a) making accessible new tools and community wisdom for collectively negotiating and rewriting injustice, (b) reorganizing traditional knowledge/power hierarchies for making, and (c) increasing opportunities to be recognized. Collectively, these ways of being

and making promoted and reified youths' voices and power in shaping the maker culture to be authentically their own, unlike that of the dominant maker movement. In building these claims, we draw examples from the 41 cases studied for this article, summarized in Table 2.

Relationality to People, Communities, Activities, and Timescales

Situating Problems and Solutions Within Community

Through their making, the youth identified and responded to problems that affected them but were also deeply linked to their community's unique history and context. For example, youth noted a desire for improving access to books and toys, making and sharing how-to videos made "by us for us," and designing fashionable clothing with unique and functional features.

The youth imbued their making projects with wisdom and hope in ways that drew upon their community insider knowledge and experience. Youth shared hopes that their projects might help "kids make friends" (e.g., light-up football), "have fun and be less stressed" (e.g., fidget spinner), or "play with scooters outdoors in the late afternoon or evening when it is dark" (e.g., light-up scooter). It also mattered to the youth that responding to these concerns in their making showed others that they "care" (e.g., Phantom jacket) and wish to "help people in our community," (e.g., light-up umbrella). The youth noted that their projects "show how hard we work" (e.g., Little Free Library), that "we know a lot" (do-it-yourself green energy [DIG] videos), and "help make you comfortable" (e.g., heated bus system). Their projects showcased their desires to become community makers since the youth believe they "have good ideas" (e.g., Phantom jacket) and that "we are makers too" (DIG videos).

Across maker projects, youth targeted justice-related concerns broadly, including childhood ($n = 10$), geography/climate ($n = 9$), urban infrastructure ($n = 8$), health/disability ($n = 8$), bullying ($n = 7$), sexism ($n = 5$), healthy peer relationships ($n = 5$), education ($n = 5$), caregiver responsibilities ($n = 4$), distress ($n = 4$), policy brutality ($n = 1$), and privacy ($n = 1$). How the youth layered these concerns mattered in how they named their making efforts.

For example, several youth sought to make projects that addressed transportation—to and from their making club, their schools, friends' houses and home—a perennial concern for many youth. Yet, youths' making projects further called specific attention to how sociopolitical and geographic histories intersect in their efforts to address transportation problems, such as how a limited urban infrastructure causes unique problems when living in a very cold climate and in a place with short days in the winter. For example, several youth chose to address concerns about getting hurt in the dark because their interview and observational data showed that "where we live it gets dark really early in winter" and "lots of our streetlights don't work."

Likewise, as Kairee, the heated bus system designer, described: "People cannot afford warm coats even if that is what they need. People also use public transportation because they need to get to places. Some people are not able to walk long distances, especially in the winter, because of disabilities. Bus stops are cold. We have had to stand at bus stops many times." Jaida, the other heated bus system designer stated that they decided on this problem because their "mom drives a city bus," and they had been riding the bus "since we were babies." They had deep and personal knowledge of the needs of bus riders and drivers, including how the bus route that runs through their part of the city is underserved, with people having to wait "a long time" for their bus to come.

In working toward their designs, youth foregrounded a respect for insider knowledge and experience. In describing his anti-bully app prototyping process, Christopher emphasized his efforts to incorporate crowdsourcing so that users could add information on where bullies "hanged out and their exact locations" so that he could map these "bully zones" onto a GIS map. Tonya drew on her homeless shelter experience and peer interviews to design a light-up, alarmed cautious hat that youth could wear at a shelter, with a carefully embroidered heart design to "make it more attractive." In her interviews, she discussed how homeless youth at her school were made fun of. We see in her cautious hat how she simultaneously addressed the stigmatization and safety of homeless youth alongside a deep care for others.

In a more detailed example of these complex orientations, Samuel and Fall's Little Free Library design sought to spread access to books and mini-maker kits, materials for which they found great power and joy. As Samuel noted, "I love paper circuits! . . . Now I finally understand how to do circuits, and I can make something I can use at home." Here we see their desire to spread the things they cared about juxtaposed with their concerns about living in a library desert. Samuel and Fall had observed many younger children sneaking into their making club to use their materials to make, and they talked to approximately 75 club-attending youth about whether they had a library card. Fall explained the problem this way: "It is hard for our parents to take us to the library. Lots of kids do not have library cards, either. Even if we find a book we cannot always bring it home and we also cannot keep it for a long time at home. If we get a book, we probably can't return it on time, and then that costs money, and we can't check out another book."

As they delved into the project, over 2 years, Samuel and Fall began to see that the problem went beyond geographical access: libraries themselves were prohibitive by design. Most youth did not have transportation to a library, but even if they did, some could not produce the needed documentation to acquire a card. Other peers who had been to the library before could not check out books anymore because they owed late fines they could not afford to pay. Both youth also noted that STEM books were important for

both learning to read and learning STEM. That Fall had been labeled a "struggling reader" in school further punctuates this point. As she elaborated: "Another thing we have been thinking about is that there are no books for us to read about science and engineering and how to do different projects at home. We were also thinking that along with the books on how to do science and makerspace projects at home. Lots of kids do not have the materials that they need to do the projects."

We believe that not only were these projects visible forms of youth negotiating the intersecting inequalities they experience, but also v*isible manifestations of responses that might transform the system for them*. Many of the youth projects offered new resources and even new infrastructure—as we see with the library—when a history of inequality has prevented their access. In their immediate spheres of influence, youths' making innovations directly and tangibly brought transformations. Samuel's light-up football was put to use by his peers at the club during the winter months. The geodesic dome built by Sharon and Ariel sits in the common area of the community club, where younger peers have been using it as a play and rest structure. More importantly, the youth recast the too-often "singular" and "pathological" readings of their lives (Tuck, 2009, p. 413) through making in ways that embrace the complexity of their experience and the wisdom of their status as community insiders, demanding new orientations to making.

Intersectionalities and Injustice

One aspect of negotiating injustices is in how the youth began to both describe and respond to their problems as tied to different intersectional experiences of injustice. They began to describe interconnections among the different injustices and their actions and interactions in relation to them at both the individual and systemic level. Across the examples we have shared thus far, the youth viewed their design work as tackling multiple, related problems tied to racism, classism, and sexism in their lives.

For example, youth linked racial and gender injustice with the challenge of gaining legitimacy in making. James and Megan designed DIG videos on using green energy sources for making projects, such as solar panels and piezoelectric pads (small pads that convert vibrational energy into electric energy). Their idea for this project grew out of their frustration with finding useful information on how to use piezo pads online. As Megan explains, "I have been thinking about this for the last 2 years, since I really first started to come to [the maker program]. The problem was that we had to read materials [online] written for adults. Some students will not have a problem reading but some will. We eventually got [our project] to work, but it took a lot of extra time. It would help if we had materials that were kid-friendly." Megan's understanding of the culture of making grew out of her participation over 2.5 years. After experiencing "too many times" when she could

not find makers like herself on the internet, she decided to do something about it with James.

As Megan and James interviewed other youth in community about the problems they identified, they expanded their rationale to address new related scales of concern: the stereotyping of people like them (girls of all ethnicities and African Americans) in STEM. As they stated in their project description, "People say that African Americans and girls, it doesn't matter your race, are not interested in STEM. Did it surprise us that most of the videos we did find were done by white men? Not really. . . . We wanted to see videos made by people like us. We also want to show people like us that we can do this work, too. Our videos will be made available free on [our] YouTube station." They also noted the lack of STEM resources for people in their community to do STEM because of local economies and practices. As James wrote, "In [city] there are not many afterschool STEM programs, and definitely not many kid-friendly makerspaces. Where will kids learn these skills? In our videos, of course!"

Here we further emphasize the importance of longitudinal participation in identifying intersectional experiences of injustice within making and to which making can respond. If Megan had not participated over years, she may not have identified a pattern, but rather accepted the reality as is. Having time and the tools to see and reflect on these challenges mattered. Most youth did not begin their design work with these intersecting ideas in mind. Many youth, at first, were not sure of what project to work on. Over months, their participation in surveying community members supported them in noticing which concerns were most salient, where, when, and for whom. While these connections were not made solely through these surveys, the approach created the space for new questions to be opened and new discourses to be legitimized, among both youth and teachers. The ensuing multivoiced perspectives allowed youth to identify and name intersectional injustices that they might previously have accepted as the norm, such as how public libraries have rules that disproportionately marginalize low-income youth.

In another example, we see how Samuel designed the Phantom jacket to ensure safe commutes to school, the club, and friends' houses, in response to the challenge of bullying and police brutality. The Phantom jacket had a noisemaker hidden inside so that if someone tried to bully the user, they could press the noisemaker's button to set off the alarm. The noisemaker was powered with batteries, which could be recharged with wind energy from wind turbines on the shoulders. The jacket was also fashionable with an image of a phantom on the front, a hood on the back, and a sleek black color.

Samuel's idea for designing a Phantom jacket grew out of a community survey that he and his peers conducted to learn more about the safety concerns of community members. The survey comprised seven questions including "What are some of your safety concerns?" "Where are the areas

that you think safety is most important?" and "What are some ideas that can help you solve those safety concerns?" Using an online survey design program (SurveyMonkey) and a tablet computer (iPad), over the course of a week, program youth surveyed 62 people in their community, including peers and staff at the club, families, teachers, and school friends.

The survey data provided Samuel an opportunity to identify six safety issues that concerned his community, including "walking" "transportation," "school," "driving," "stealing," and "food." He also noticed that approximately 75% of the participants "felt unsafe on the streets" as they commuted to school, home, and other places. As he stated, "yeah, people walk and sometimes they say it's not safe to walk, so it's, like, 75% of people that walk and they say it's not safe to walk. So I just thought I'd make the jacket for them. And so it will keep them safe so they don't get hurt when they walk." He was particularly concerned with kids having to walk in the dark, especially where he lived because, as he noted on the survey responses, people stated things like "it is like dark most of the time in winter," "almost no one has rides to the club," and "it's dark. Sometimes you can't see fire, lockdowns, bullying, guns."

Samuel came up with the idea of making a "jacket that calls for help if you are getting bullied." When he shared his findings with his friend Jamae, who lived near him and went to the same school, Samuel reported that Jamae agreed with his concerns but had ideas for improvement. Jamae was concerned that he and his peers did not have safe transportation in the dark or clear protection from police brutality.[2] This dialogue led Samuel to shift his thinking from the "jacket that called for help" to the Phantom jacket—a jacket that helps to protect you by "making you invisible" (hence the black color of the hoodie for camouflage). The conversation also led Jamae to join the maker club and work on the jacket with Samuel.

Samuel's jacket was created the year after he made a light-up football, meant to keep his peers safe while playing in the dark. As he said of the jacket, "I saw with the football that I could make something that would help. With my jacket it goes further. Like, it actually really is saving people." While we do not know if his jacket is actually saving lives, Samuel brought intersecting injustices into focus in his project—systemic racism manifested in the form of police brutality in the larger society, systemic racism manifesting as policing clothing choice in school (no hoodies allowed), and the issue of bullying in school. That Samuel went on to discover the library desert with his friend Fall (introductory extract) is further evidence of the cascading nature of deeper and more nuanced insight into intersectional experiences of injustice when engaged over years.

Often this movement challenged the maker-educators to reconsider their own views. As one educator said with respect to the Little Free STEM Library, "I had not considered the multiple layers of challenges in book access. I noticed at least six concerns raised by the youth: the location and

hours of libraries, the need for proof of residency to get a library card, the cost of overdue books, whether one feels welcomed in a library, and access to things other than books, like maker kits. The library desert is just the tip of the iceberg.''

Co-Making

In this section we discuss how the youths' making work was supported by processes of co-making with and in community. We suggest that co-making supported the youths' equity-oriented goals by (a) making accessible/legitimate new tools and community wisdom/funds of knowledge useful in collectively negotiating and rewriting injustice, (b) reorganizing traditional knowledge/ power hierarchies for making, and (c) expanding opportunities to be recognized.

Engaging in making with and in community centralized co-making. Co-making involves norms and routines that create spaces for and help to legitimize input from many different people across time and settings, such as youth codeveloping criteria for making projects/progress, valuing students' and community members' input toward shaping project process and outcomes, encouraging project work to occur in many different places, drawing upon the resources in the places, spending large chunks of time on supporting youth in negotiating their own ideas with others, and sharing ownership of the making process and project. *We want to be clear here that co-making is not just about the involvement of different people in the process, but a rendering of making that puts different planes of knowledge and experience on a shared level.*

Take how youth defined, and then refined, the problems they hoped to solve through their making as an example. In their projects, several youth indicated that their designs were inspired by people and events in their lives. Youth acknowledged that these people and events sometimes gave them initial project ideas—as we saw with the interviews and surveys providing inspiration for the light-up football, the heated jacket, and the light-up umbrella, to name a few. Youth also acknowledge that wide community input during the initial prototyping process led them to take new directions in their work and changed how they thought about who owned the project.

For example, the Timmy project shifted from a heated shoe thought up by two boys to a light-up heated boot created by, at one point or another, 12 boys.[3] As one of the lead boys stated "At first we were going to make a heated shoe cuz [our teacher] has a broken ankle and we did not want her toes to get cold." However, they modified their project: "the Timmy is for people that can't afford shoes, people that don't have boots for winter, like homeless people that we see in [our] city. Our product is very useful for winter and for people that have cold feet, or just want to look cool. And we'll be coming out with heated or cooling house slippers to keep you warm or cool depending on the time of the year."

The Timmy, a Timberland® boot outfitted with heating elements on the interior soles, LED tube lights around the outer sole, and powered by rechargeable batteries hidden in the tongue of the boot, took the boys 6 months to successfully prototype. The project first began to take its new direction when Maken and Tel would leave their maker club after only about 30 minutes of work to play basketball. (It was the only time in the evening that the court at the community club was open to free play). When they played ball, they talked about their project, and their basketball mates would follow them back to the maker club after free court time was over. We noticed that the visiting friends would help with some tasks, often calling out and laughing with impossible scenarios for the boys to consider: What about if you miss the bus and have to walk to school? What if you really need them but you can't pay for them? This engagement with peers outside the making program slowed the group's work down significantly, but it also led to design considerations that advanced the boot toward better addressing needs of their peers: Fashion, affordability, and comfort. The two boys (and one friend who officially joined the project) were asked to modify their design sketch to include these new ideas, labeling them under new inputs for "technical" and "social" considerations. This sketch provided an important space as it allowed the boys and their maker-educators to return to conversations about how to address these new concerns.

We also point out that one of the maker-educators felt that Maken's departure from the making program after 30 minutes to play ball was a distraction to other youth. However, another teacher noticed that his basketball playing opened a pathway for him to share his work with his peers, bringing them into the club. Such tensions of coming to realize how youth author novel pathways to co-making (potentially seen as disruptive) are powerful if validated.

Co-making Made Accessible New Tools, Community Wisdom, and Funds of Knowledge for Negotiating and Rewriting Injustice

We illustrated in the first section how making projects became tools for youth to negotiate injustices. Here we show how co-making provided new tools for making, including community wisdom and funds of knowledge.

Ethnographic tools, employed by educators and youth as part of the making process in order to engage with community, such as dialogic and structured interviews with community members, observations, and member checking and feedback on project development, made this movement possible. The youth's project work took place in the making space *and* in various community spaces, through surveys, conversations, interviews, and observations (e.g., while waiting for the bus in the cold, playing at the playground, walking to school, with friends on the basketball court, with parents, siblings, and grandparents), through actual movement of the

physical making (e.g., testing prototypes in real community spaces, bringing in duct tape prototypes made at home). This movement of project work enabled youth to more directly leverage a wider range of knowledge and practice toward their making projects. We view this as an important form of movement in that as youth talked with community members and brought their critiques to bear on their projects, they also moved *ideas* about their making from one space to another, in equitable and consequential ways. This pushes beyond leveraging existing funds of knowledge in two ways. One, as the youth sought to directly ground their work in multiple systems of relationality incrementally, previously distal threads of insider knowledge gained currency as funds of knowledge now relevant to informing youths' making design. Second, we see how different threads of funds of knowledge intersect to provide youth with multiple perspectives that impact making design trade-offs. For example, these ethnographic tools assisted youth in recognizing those problems as part of broader, entrenched challenges that their community members had struggled with or negotiated over time.

Community dialogue was essential in supporting one group of youth understanding problems of homelessness with more complexity and nuance than is easily reached without such person-to-person interaction. The Donator app group had initially approached the problem space of homelessness as a one-dimensional issue focused on providing specific resources to individuals in need. Well-intentioned, some group members had a limited understanding of actual peoples' stories, concerns, and tensions, even though they had peers in the program who had been homeless. Interviews with one maker-educator who had experienced homelessness herself—and also with housing campaign organizers and homeless shelter directors—helped Donator app designers Zani and Luca develop a more multifaceted, more tangible, and more human understanding of what it means to be homeless at the individual and systemic level. Here we see the girls' efforts to visit homeless centers, talk to friends and staff who are or had been homeless, and investigate the issue online, as a way to move and coalesce ideas across spaces in ways that transformed their own views and their projects. As a result, the girls began to discuss the issue in terms of housing rights at national, state, city, and individual levels, and they explored how they could leverage their own experiences with both housing resources and digital technologies to engineer a potential solution. Zani and Luca connected what they learned from their interviews and research to a simulation game they played on their phones, inspiring their design of an app that would not only connect users to volunteering and donation information, but would also take users through the lives of individuals who had experienced homelessness. Through their use of critical ethnographic research tools, the girls transformed their own knowledge of their problem space and moved their community-informed knowledge outward

to other spaces to educate and empower other community members as fellow housing rights allies.

A second example shows the importance of educators reweaving community and family perspectives back into making projects. When Jennifer and Emily got stuck on how to design a nonbulky heated jacket, one of their maker-educators reminded them of a funny video diary they made earlier on insulation, and she suggested that they go back and watch it to get some ideas. The girls watched and laughed at their video, breaking down tensions that surfaced at the frustrations of their project. The video involved a reflection on Jennifer's experiences at home with their fireplace and the insulation her father had put around it. The fireplace became central the previous winter when their home was without electricity for two weeks due to a powerful winter storm. She explained, "when we had that big snow storm here and everyone's power went out. The silver lining, I seen a lot of it, because we had to put it in our fireplace. We had to put silver lining around it so the heat would stay in it, but it wouldn't burn anything outside of it." Jennifer and Emily asked us if we could get them some "silver lining" material to help them to try to "keep the jacket warm" with smaller and less bulky heating elements.

In a third example, we see how conversations at home led parents to share their expertise, which shaped youths' experiences in making. Peter and Kelvin wished to help elderly, wheelchair bound babysitters. Both boys had extensive experience with babysitting responsibilities, and Peter knew of elderly caregivers who had difficulty manipulating tension baby gates. The two boys sought to hack an ordinary baby-gate to make it motion-sensor activated. The project was complex and required expertise not possessed by either youth or the maker-educators. When unsure of how to proceed, Peter suggested his father might be able to help. Peter's father, a carpentry expert, shared advice on how to take apart a tension baby gate using particular tools that will retain the integrity of both gate panels. A local maker-educator also visited to learn how to mechanically hack the gate, and then, in turn, showed the boys how to consider different ways to mobilize one panel while keeping the other fixed during a community feedback session. With this input, the boys were able to spend extensive time testing different mechanisms with different-sized motors, fishing line, Lego blocks, and wheels, before a prototype with a moving panel on wheels was completed after 6 months of work.

In each of these cases, maker-educators resisted telling youth how to proceed from a solely making standpoint but instead sought community resources to support youth in refining their designs—returning to video diaries, valuing basketball time and visits by friends, and inviting parents, physically and through story, into the space. These were made possible because the design process enacted in these spaces asked youth to seek ongoing input from community at each stage in their making process. Through

co-making, the youth had new ways to see, use, and legitimize the wisdom and the funds of knowledge of their community.

Co-making Led to More Porous Boundaries Toward Expanding Opportunities to Be Recognized

That the "walls" between the making program and the youths' worlds appeared to grow more porous is an important aspect of the developing culture of their making spaces. Porous boundaries mean that people, ideas, and resources flow more easily between the making space and other worlds, and that nontraditional knowledge and practice (funds of knowledge) are valued in the making space. We believe these points are substantiated in the two previous sections. Here we focus more on how these porous boundaries provided opportunities to be recognized for one's developing STEM-rich making expertise.

When Chris brought his anti-bully app (which included a crowdsourcing component to layer on new data inputs from users) to school to show his science teacher, she asked him to present his idea to the class. He told the students he made his app so that they (and others) could contribute to it. "It won't work good unless you add to it." When he did so, his peers exclaimed how important his project was; they exclaimed he was "changing the world," "would be famous," and "why can't we do stuff like that here [in school]!" This short interaction brought on by connecting Chris's out-of-school STEM-rich making with Chris's in-school science activities gained Chris more formal recognition from teacher and classmates while also showing his science teacher possibilities in looking across spaces in youths' STEM experiences. When Samuel brought his Phantom jacket to school to show his science class, an activity scaffolded by his maker-educators, his friend, Darrin, walked to the front of the room with him to help him demonstrate because he "helped to make the jacket too." Darrin had stopped into the club making space a few times to mess around with Samuel and gave ideas on where to put the phantom image on the jacket and the location of the shoulder turbines. After the class visit, and Samuel and Darrin's newly shared recognition, the two boys began to plan new projects together, and Darrin attended more regularly until his family moved to a new city.

Second, we point out that the locations of porous boundaries fostered by co-making led youth to share project ownership. This is evident in the two examples above but is particularly visible in how Kairee and Jaida resolved some tensions they encountered as they worked on their heated bus system. The girls could not decide whether to heat the bus seats or the bus stop. Jaida insisted on making the seats in the buses warmer—"my mom always gets cold when the bus door opens to let people in." Kairee wanted to make the bus shelters warmer—"bus stops are cold." As they rode the bus, they surveyed people both waiting and riding. They took

careful notes of the number of bus shelters on their route and their conditions, the number of seats on each bus and their condition, and the concerns that riders had. They talked to non-bus riders and tried to figure out if their project ideas would encourage them to start riding. As Jaida explained: "there are 53 seats on every standard bus. . . . 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. We know this from a survey that we took around our neighborhoods."

Through this ethnographic process, they began to see their project as having two connected parts, addressing the needs of the whole community, not just the people who currently rode the bus. At the same time, by having their ideas expanded about project ownership by involving many different community members, they found themselves with more challenging technical considerations to solve. They began to see that a heated bus stop should be accessible to a wide range of riders with different physical abilities and needs. Kairee suggested that the system should include "high-wattage halogen lamps" to heat the bus stop while also including "surface heating elements like a heating pad" on the bus shelter's bench. Porous boundaries between the different youths' salient but previously less connected communities—school, community maker club, different community spaces—led to increased recognition of youths' expanding making expertise even as the mobility of resources between these spaces enhanced youths' making designs in increasingly complex ways.

Co-making Reorganized Traditional Knowledge/Power Hierarchies

Welcoming new and diverse perspectives as a part of design allowed new opportunities and structures for youth to be recognized for their experiences and relationships. The previous examples illustrate maker-educators becoming colearners alongside youth as outsiders provided help and insight at critical moments. It is important that forms of community and family funds of knowledge served to resolve both complex technical problems as well as social design elements. When Peter's father helped the boys hack the gate, it opened possibilities for testing motors not previously thought structurally possible. When Samuel's mother argued strongly for Nerf material for his football, it made locating the batteries at the ball's center of gravity a solvable problem. When the basketball friends who helped with the Timmy demanded that the shoe be stylish, comfortable, and affordable the group had to reconsider types of heating elements and battery storage.

Yet youths' making was valued for both the technical quality of their innovations and for how their lives were deeply ensconced as an integral part of their design. Having multiple forms of expertise and ways to enact these toward solving injustices were both a process and product of co-making. As one teacher who had been working with youth for 4 years stated,

"in spending time in youth-owned spaces, I have changed as a person who is now more aware and more awakened to how little I know and how much I can learn from youth." Another teacher stated, "I first worried that the girls were being so loud and disruptive as they ran in and out of the club room. Then I realized that the lobby was a major social space, and their movement got other kids asking them about what they were spending all their time on. I had to begin to see that movement is essential in the girls being girls *and* being makers." These quotes illustrate how co-making can support multiple perspectives as well as flatten power dynamics.

Lastly, while maker-educators may hold deep knowledge of some practices and ideas needed for the youths' making designs to be successful, they did not always have the same level of knowledge of community or specialized applications to help youth solve particular problems. Youth took note of their maker-educators' need for their expertise in guiding them forward. As Zae noted: "At first I didn't really know what [the maker club] was. I got it mixed up with [robotics club]. And so I said I was going to join robotics. Which, in robotics we had to follow instructions on how to build things and in [our maker club] we actually have to change the instructions a little bit . . . cuz [maker-educators] wouldn't know how to do it without us."

Discussion

Our findings suggest that community engagement as a part of STEM-rich making promoted equity-oriented outcomes through helping to make visible community wisdom and funds of knowledge as sources of disruption of intersectional injustices and enabling the practice of co-making. While we were committed to community-centered making, what that entailed and the different ways community-centered making took shape were primarily driven by the collective making community. In particular, co-making was principally shaped by the youth. Anchored in co-making, this maker culture reflects youths' values and desires—making toward a more just world. Such a culture legitimately repositions community wisdom and funds of knowledge as sources and spaces within which to make. It also makes possible new opportunities to leverage STEM knowledge and practice alongside community wisdom and funds of knowledge as maneuverable hybrid tools for pushing back against the injustices youth hope to solve.

As we reflect on the ways in which community engagement supports youth in STEM-rich making, we begin to see the salience of relationality in fostering a culture of making that is equitably consequential. The previous literature on cultural views of learning and human development calls attention to the importance of relationality in terms of the ways in which learning takes shape in how people, ideas, tools, resources, and bodies move and remix across time and space as people engage in social practice toward new futures. We found this to be true in our study as well.

However, our findings suggest that we need to consider further the ways in which relationality matters, particularly toward transformative ends. We are concerned with how relationality attends to transformation of the structures that define and constrain relationships (such as power dynamics, geographical proximities), the kinds of access to resources, activities, and tools bound to particular relationships, and how relationships can shift as structural and resource, activities, and tools shift. We see these forms of relationality supporting an expanding maker culture with opportunities for coconstructing new spaces to imagine new social futures. However, tensions also arise as a part of this process. We discuss these points below.

Relationality and Expanding a Maker Culture

The youths' practice of co-making was geared toward relationality. That is, the youths' making practices were grounded in their own locations in the world, as youth growing up in historically marginalized communities but with broad cultural wealth and a hope for using their making work to advance their communities. We view such relationality as critical in the sense that the youth leveraged upon their sustained making work to heighten their own and others' awareness and understandings of intersectional experiences of injustice. We also view such relationality as connected in terms of how youth were related to the issues they are investigating, to other youth involved in the project, to community members they interview, and to adult mentors, as well as to the broader systems of power that shape their experiences in the world as young people of color growing up in lower income communities. Such relationality also attends to the intersectionality (Crenshaw, 1991) between youths' lives across spaces.

The youths' co-making practices involved mobilizing the knowledge and relationships from across the spaces of their lives into their making as essential for advancing their STEM work. In so doing, youth relied on their relationships with peers and adults to define the making problem with more clarity, and engaged in ongoing dialogue with community members and maker-educators to finesse their projects. This integration of community knowledge and practice with STEM making was viewed as necessary for projects to be successful. Here, the role of digging more deeply into STEM took on local significance rather than reflecting a school and/or white male culture, reflecting modes of dynamic learning (Leander et al., 2010) and intersectionality (Unterhalther, 2012).

We saw this integration in how Jaida and Kairee described what they needed to know to make their bus warming system work for all riders, in the specific content of the DIY videos made by Megan and James, and in the weeks-long struggle to figure out the correct power requirements for a solar-powered heated jacket, among others. In our findings, we illustrated how this promoted the practice of co-making. Here, we see co-making not

only shifting the culture of making toward legitimizing multiple forms of expertise and spaces of making, but also foregrounding the urgency of making toward justice-oriented ends.

This shift toward relationality as a framing cultural dimension is important because it requires consideration of how youth sought to transform relationships among themselves, the content and practice of making, and their making peers, teachers, and community toward who they are and want to be (both individually and collectively), and the possibilities for their making work (Engeström & Sannino, 2010). The problems youth sought to address *were emergent of their locations and histories, rather than the interest* of any given individual. When youth such as Samuel (light-up football) or Jennifer and Emily (light-up scooter) gathered data about the length of days in their northern-city location, the location of nonworking street lights in their community, or how their friends kept out of trouble after school, this information contributed to their project designs as well as to how their design was received by others. We see here how such relationality is not purely social; it is also grounded within geohistorical dimensions regarding length of days and urban infrastructure. The politics of urban decay and inadequate services disproportionately affecting poorer constituents was also important. As these projects made visible such forms of relationality, they also became resources to build on. Such expanding relationality legitimized the possibilities for broader purposes and goals in making and in the social and materials resources that could be used in making.

In particular, the design approach leveraged within these two making spaces grounded in community engagement offered youth opportunities to build relationality into their making culture. Building relationality into making, by leveraging tools of community ethnography to support community engagement, further *legitimized* movement of ideas and resources from one space to another as a necessary part of making. Community engagement offered youth a way to see and understand their own relationality—that is, how youth are related to the issue they are investigating, to other youth involved in the project, to community members they interview, and to adult mentors, as well as to the broader systems of power which shape their experiences in the world as young people of color growing up in lower income communities. They had multiple opportunities to see patterns of concerns within their community that further offer questions to help them seek and reinforce relevance to their communities—both as they consider the social, political, and ethical dimensions of the problems and solutions they hope to tackle, as well as the importance of their work toward community development.

This view is more than access and opportunity to making (e.g., Martin, 2015), and more than recognizing other ways of knowing, or experiences in the worlds of making (e.g., Peppler & Bender, 2013) where most equity-oriented attention is paid. This view has a disruptive dimension that focuses on challenging historicized inequalities as a part of making.

The implication that follows suggests that how youth makers are supported in examining their concerns (nested within broader community considerations) shapes not only their development as makers but also the making culture. This intersecting approach reframes making in terms of both process and outcome. This culture supports the deliberate departure from predesigned making activities (e.g., make a robot that draws for you with these materials) indicative of the "keychain syndrome" (Blikstein & Worsley, 2016) previously described in order to best support making projects that authentically contribute to the improvement of conditions for youth. Furthermore, this culture supported deeper engagement in STEM knowledge and practice when community perspectives or needs demanded more robust designs. When the Timmy (heated light-up boot) was not comfortable, the youth makers needed to revise their heating element design, a particularly complex technical challenge.

Relationality and Expanding Social Futures

Few studies deeply consider what undergirds youth making, especially as it relates to their social futures. Yet, the youths' critical engagement with community is apparent in the issues youth chose to tackle (e.g., bullying and a higher risk of rape often targeted at the more vulnerable youth populations in which the youth have membership). Through the collaborative nature of their co-making (from recruiting the help of outside peers who are experts in the issues at hand to soliciting help from expert family members who do not necessarily recognize themselves as "makers" but who nonetheless possess relevant making expertise, e.g., sewing, carpentry), youth challenged the notion of who can be named a maker. They broadened the boundaries of a "local maker community" to include salient others who might not be tapped as germane resources in a typical STEM-focused maker program.

By engaging with community as part of their making practices, the youth placed new attention on making as a process not just of producing new artifacts, but also of co-constructing *new spaces for imagining new social futures* (DiGiacomo & Gutiérrez, 2016). Such space-making involves renarrating past experiences and projecting new futures where they are powerful producers and critics of STEM and their worlds. This work was made possible by dialog fostered by engaging making with community, in response to injustices faced by community. We believe this approach fundamentally departs from previous work on facilitation in making in its attention to how making *maps onto lives, relationships, and spaces over time*.

We also suggest that making itself, when fostered through community engagement, more than being responsive to community needs, further reifies those needs for others to acknowledge, while presenting directionality toward the future. This matters now, more than ever, as the challenges faced

by young people continue to be framed as their individual, stand-alone, problems, rather than a system in need of remediation.

Jurow and Shea (2015) remind us that understanding what matters to people requires us to make sense of how their lives are shaped by and shape social and institutional practices, and within that, the possibilities for imagining new forms of life. In terms of the youths' making practices and projects, we see how their work required attention to both social and spatial scales of justice (or injustice), that when addressed through an ever-expanding network of co-making, created a greater possibility for collectively organized and valued social futures (Jurow & Shea, 2015).

The youth in this study engaged in expansive forms of making that enabled them "to become designers of their own social futures" (Gutiérrez, 2008, p. 156). We believe that emphasizing relationality in making spaces means acknowledging youth as individuals with concerns grounded in location and history but also with the agency to act. When youth and maker-educators engaged in conversation around problem definition and solution design, youth were encouraged to present as many perspectives and relevant points of view as they deemed significant. As a further move to transform the maker culture to co-making with youth, the maker-educators began to work toward deliberate mindfulness in keeping the relationality focus in these dialogues, which helped attend to inclusivity and sought to broaden perspectives. Youth held very different ideas—from each other and from what maker-educators anticipated—about what mattered in the community. By soliciting for and validating youths' varying nodes of relationality, maker-educators were able to support youths' agency in framing the community safety problem space for themselves. Instead of responding to parameters laid out by their teachers, the youth, through community ethnography, framed salient safety issues for themselves to investigate and innovate.

With consequential and equity-oriented making as their object, youth leveraged everyday and STEM knowledge from a variety of sources and in many different forms, making possible incremental movement toward new imagined futures for themselves and their communities. In these new imagined futures, youth have a voice and place in STEM, and their communities enact power toward social transformations. These futures are nonreductive, "grounded in the idea that change in the individual involves change in the social situation itself" (Gutiérrez & Calabrese Barton, 2015).

Implications: Negotiating Tensions Inherent in Relationality

There were tensions, often profound, that pushed back on the more expansive forms of relationality discussed as a part of fostering an emerging maker culture that is equitably consequential. Figuring out how to negotiate these tensions are where the implications of our study chiefly resides. First,

there is the relation to materials. While the maker programs make every effort to procure the necessary materials and resources youth need for their projects, materials that change along with their iterative design features, sustaining funding and acquiring a range of materials in the moment is challenging. Further, the youth are cognizant of designing innovations that fit within the economic realities of their communities for whom they are designing. Youth have eschewed more expensive making materials in favor of items accessible to their community (e.g., Peter and Kalvin rejected using littlebits snap-together electronics [www.littlebits.cc] components for their baby-gate project, due to cost).

Second, there is the tension around what we have referred to as sustained engagement within a context of complicated lives. Interrupted attendance was not unusual due to both living situations and demands from home and school. These interruptions can precipitate frustration for the youth as their making sometimes progress through fits and spurts, and maker-educators are often required to engage in tailored catch-up activities with interrupted youth. Interrupted youth also often felt behind when they rejoin the maker club and witness the progress their more consistently attending peers have made. Yet such interruptions appear to be reconciled by an approach to sustained making that expands the boundaries of making: one can frame the complexities of living as integral to the wisdom to make, to suggest what sustained making can encompass for youth living their lives in their context. When Samuel missed 2 months due to transient home conditions, he used that time to "think and think" about his project. Upon his return, he had a maker teacher who framed that thinking as essential to the critical work of making.

The adult maker-educators across the two sites took a firm anti-deficit stance toward the youths' making and had experience working with youth in educational settings. As the goal of both sites was to co-negotiate a community maker culture that empowers youth-makers, explicitly engaging in community ethnography with the youth was a pedagogical commitment adult maker-educators made. Their expertise in supporting youth in crafting surveys and interview questions were instrumental for facilitating the community ethnography process. However, educators had to negotiate their own insider-outsider (insider to community making club, outsider to communities) positioning when helping youth analyze and make sense of community data. While educators sought to always privilege youth voice and insights, they had to negotiate their own impetus to suggest solutions too quickly. Figuring how when to foreground the adult maker-educator identity (having more expertise than youth in making-related issues) and when to foreground the community insider-outsider identity (having fewer insights than youth in community issues) was challenging and involved continual evaluation.

Lastly, as the youth drew from and expanded their relevant funds of knowledge threads directly related to their making, owning and reliving these threads throughout the making process also served to remind the youth of a positionality marginalized by systemic racism and classism and the degree to which they are entrenched in matrices of oppression. Adult maker-educators also experienced tensions alongside the youth as they sought to understand the viewpoints of the youth and engage in uncomfortable conversations as part of the emerging maker culture at the community clubs. However, negotiating these tensions is necessary for the youth and adult maker-educators to cultivate an authentic, empowering community-based maker culture grounded in justice-oriented norms, practices, and goals.

Conclusions

> "I feel like it will be super cool. People will love it. They'll say, "Who made this?" It was me. Then they'll ask me like, "The tiny person always in the background did this? I'll say, "Yeah, I did that. . . . This girl knows how to have fun, how to get down and smart when she really needs to. This girl can be fun. She could build things. She could make the world a different place and help everybody else learn how to have the type of fun she has and stuff. Little kids can do ginormous work!" —Jennifer, 11-year-old maker

Equity-oriented making is never separate from individual and social histories that unfold across space and time. Who can make and who cannot, whose knowledge matters and whose does not—all are a part of making itself. Everyday decisions in makerspaces inscribe not only what counts as authentic "making," but also youth identities as makers, participants, collaborators, community-members, young people *who legitimately belong in this makerspace*, signifiers that endure as historicizing elements shaping the emerging culture of the youth makerspace. We argue that youth making anchored in community engagement—as we sought to design for but longitudinally studied the evolving impact of—is a productive way to both honor youths' histories while fostering their agency. Through this agency, the youth determine how and where their emerging histories, reified in in-the-moment experiences through community ethnography, can be developed in more just ways.

Our study expands how the field frames an equity-oriented culture of making (e.g., Blikstein & Worsley, 2016) by highlighting that when youth have opportunities to engage community as a part of their making work, they have a legitimate platform to integrate basic questions of social justice and equity *as a part of—not apart from*—the technical and social dimensions of their making work: "Who is their making project for? Whose knowledge counts in their making project? Who takes part in defining the problem, data collection, interpretation, and analysis? Who owns their making project,

and to what end? Engagement with these questions suggests a depth of movement as youth sought to bring their making work back into communities to improve their designs and to contribute to community

A major lesson in this study is that supporting youth in co-making in community, in expansive and sustained ways, situates knowledge production within local contexts in decolonizing ways, disrupting normative power dynamics among youth, adults, and context. Through the iterative process of engaging community as a part of making, youth drew from their local knowledge as oppressed *and* empowered insiders and forced attention on typically silenced narratives around low-income communities such as inadequate resources for childcare, homelessness, rape, and bullying. These narratives are often alien to typical public makerspaces (Norris, 2014). The youth claimed empowering spaces for themselves by using the tools of community ethnography and the resources and practices in making to bring to the open, often through tension-filled negotiations, the particular injustices in which they and their communities suffer.

Through their community-centered making work, youth demanded the widening of boundaries around the makeup of a community making space, in dialectical relationships with the salient identities of community youth makers. The landscape, population, and practices of a community making space are reshaped as a result. Who youth makers are, what issues they care about, who other stakeholders could be, with whom youth-makers can collaborate, what resources are sanctioned, and what approaches to take toward making an artifact are renegotiated in ways that foster equitably-consequential making for the youth. We believe that equity in STEM-rich making is possible when cocreated in locally centered, community making spaces where youth can be empowered to collaboratively frame problems and design solutions to authentically address real injustices in their everyday lives.

Notes

[1]A handful of makers were not "regulars." That is, they dropped in and helped out periodically. If youth dropped in only a few times, we did not include them on this list.

[2]This conversation happened in a week of protests against police brutality in Baltimore, a highly visible concern and conversation topic among the youth in both clubs.

[3]Only two boys are listed in Table 2 in reference to this boot: One joined the project later, and the other 9 contributed ideas and actions but only on a sporadic drop-in basis.

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