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## CHAPTER 1

# Equity and the Maker Movement

### THE PROMISE OF THE MAKER MOVEMENT

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, proliferating in public spaces, private domains, and increasingly gaining traction in K–12 schools as a platform to promote STEM learning and creativity (Holland, 2015; Martin, 2015). Making, and makerspaces where children, youth, and adults gather to make or create an artifact—be it a simple cardboard toy or a more complicated 3-D printed avatar character with movable limbs—is spreading in a grassroots fashion across the United States and the globe (Schrock, 2014). Youth of all ages are engaging in making across contexts, including schools, science and children museums, and public libraries. Consider the following scenarios: Three middle-school youth with their parents are huddled over a tabletop at a children’s museum, using tools such as screwdrivers and pliers to take apart old toasters in order to figure out how internal “electronic guts” make the toaster work; in a school makerspace, middle-schoolers are working on a project to make light-up, felt-fabric bracelets; at a community Maker Faire, parents are bringing their children to experience making as part of their weekend family activities.

The maker movement has evoked interest for its potential role in breaking down barriers to STEM learning and attainment (Martin, 2015). One current theme in the maker movement focuses on empowerment. As the CEO of *Make*: magazine states, “[Y]ou’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). The theme of empowerment is inspiring. At the same time, it is important to ask questions about how the movement defines who makers are, what makers do, what kinds of access makers need to tools and opportunities to keep making. These questions 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 the reality is that access

and opportunities to make for some groups of the population continue to remain sporadic.

As Nascimento and Pólvara (2016) pointed 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). As the maker movement becomes codified, it is largely orienting toward individual production and consumption of new products and technologies. Maker experiences open to the public often focus on pre-set activities, with little authentic room to maneuver within the activity. The attention is on the products, not the people or the relationships formed within or across these spaces.

Who is a maker and in what context a maker is accessing and engaging in making experiences are very much products 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 born 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 how making takes shape (and the learning and trajectories of makers) always in dialectic with the dynamic culture that surrounds it, rather than only with the physical space itself.

Yet, 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. This is the focus of our book.

### **BUILDING A FRAMEWORK FOR EQUITABLE AND CONSEQUENTIAL MAKER LEARNING**

We are excited about the potentially broad range of youth-empowering practices the making enterprise may promote, such as supporting youth to take more risks and try out new ideas. We are in equal measure concerned about the lack of explicit attention on equity concerns that are salient to making’s becoming the next democratizing educational platform. *Who* is making and how are they being supported in their efforts? *What* is being made, how, and *why*? How are outcomes of making defined and measured? How we consider these questions can position some youth as central or marginal to the maker movement.

Our purpose throughout this book is to identify the hows, whats, whys, for whom, and to what ends of equitable and consequential

community-based STEM-rich making for youth from nondominant communities. In this text, we seek to build a framework for equity and maker learning in STEM-rich making, offering new ways for the field to think about making in ways that positively impact young people and communities. Access to and opportunities for making, though fundamental, are simply not enough. We also seek to contextualize this framework for equitable and consequential maker learning with illustrative cases, which can help guide the field. In so doing, we seek to address the question: What are the possibilities for equity-oriented STEM-rich maker learning and practice that takes place with and in community settings?

### Equity Concerns in the Maker Movement

**Who participates?** Let us pause and consider who, actually, is engaging in making. Currently, there is little evidence that the maker movement has been *broadly successful* at involving a diverse audience, especially over a sustained period of time. There are pockets of success around the nation where makerspaces have successfully reached a more diverse population than the trending White and male spaces (e.g., the Mt. Elliott Makerspace in Detroit). Few of these more diverse makerspaces are intentionally STEM-rich. However, these spaces are the exception and not the norm. Little research has been done on these spaces to document what is working, how, or why.

The maker movement remains a largely adult, White, middle-class pursuit, led by those with the leisure time, technical knowledge, experience, and resources to make. Indeed, the demographics of both the authors and readers (89% of authors, 81% of readers have median incomes of \$106,000) of *Make*: magazine (the periodical credited with launching the Maker Movement) show largely educated White males (Brahms & Crowley, 2016). This is troubling when we consider the speed and spread of makerspace proliferation across both formal and informal education contexts. The maker culture that is solidifying, if not challenged, will be one that is dominantly White, male, and middle-class, perpetuating the chronic inequities in education at large, and in STEM education in particular. Inability to identify with STEM due to a lack of role models from one's own community as well as alienating practices within STEM experiences has led to "identity gaps" (e.g., Eisenhart & Finkel, 1998; Johnson, Brown, Carlone, & Cuevas, 2011) in STEM education, where students of color are reluctant to pursue higher-level STEM courses, in spite of test scores comparable to those of their White peers. A White, male, middle-class maker culture is unlikely to ameliorate this longstanding problem. For decades, African Americans have made up less than 5% of the engineering workforce in the United States (Yoder, 2014). African Americans, Latinos, and Native Americans account for only 6% of the total STEM labor force, even though they represent over one-fourth of the U.S. population (National Science Foundation, 2014).

## Participation and the Culture of Making

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. Thus, as the maker movement has become formalized, the powerful knowledge, practices, and collective wisdom 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 makerspace 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 paid scant attention to sustained maker learning experiences, despite recent acknowledgment 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 we think our study reported on here uncovers the importance of layers of community across people, space, and time.

The shift toward *culture* is significant from an equity standpoint: Whose voices are valued and who counts as legitimate participants in a community making space impact 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 those relationships mean 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. Making space educators and participants can be co-constructors of culture, engaged in mutual activity that can maintain and 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 youth’s diverse interests and the historicized practices of communities of color are rich and legitimate resources for making.

### Why Focus on Equity in STEM-Rich Making?

Some critics warn against the danger of conflating making with STEM, worrying that questions about learning in making will “become synonymous with ‘Where is the STEM in making?’” (Vossoughi, Hooper, & Escude, 2016).

In framing equity in making in this book, we situate STEM squarely in the center of making and argue that STEM cannot be divorced from making if equity is the goal. For youth of color and girls who have been traditionally underrepresented in STEM, making can be a productive and empowering platform for them to get a foothold into STEM through authentic, STEM-rich making experiences. While we do not hold the position that youth of color should all be encouraged into STEM pathways, nor do we hold a singular view of what STEM engagement may be, we do take seriously the grave issue that youth of color growing up in low-income communities have been chronically underserved by society in their access to, and consistent opportunities to engage in, rich STEM experiences.

At the same time, we acknowledge the unique status with which STEM disciplines are regarded in society. This is a double-edged sword. Success in STEM is one viable route toward personal and community economic advancement for youth growing up in poverty. Success in STEM also factors into opportunities for empowered democratic participation. Indeed, one who is well endowed with STEM competencies is better positioned to make socio-scientific decisions in his or her life that can have far-reaching consequences, such as in health care and access to clean water and air. That lower-income communities of color experience the greatest levels of environmental injustice and often have the least voice in STEM-related decisions affecting their communities is further evidence of the impact of these persistent inequities (National Academy of Engineering, 2010).

Yet, at the same time, participation in STEM can be a marginalizing experience. The culture—and thus the knowledge and practices—of STEM is grounded in dominant White, male culture, and youth are expected to assimilate this culture. Without explicit disruption, expectations around forms of participation may lead to a deficit orientation toward nondominant forms of knowledge and practice, which can further position youth as outsiders to STEM-rich making.

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

However, we focus on STEM-rich making because we are interested to learn more about making projects and experiences that support makers in deepening and applying science and engineering knowledge and practice, *in synergy with* other powerful forms of knowledge and practice, such as the funds of knowledge (González, Moll, & Amanti, 2006) and community wisdom (Tuck, 2009) one has because of who one is, and where one has grown up. We are interested when such synergies allow for disruptions of expectations for what STEM-rich may mean in making. For example, there is a growing focus on the role of e-textiles (e.g., light-up fashionwear) 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, and 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.

### **Advancing Equity**

The idea that STEM-rich making may promote more equitable opportunities for learning and becoming in STEM is widely accepted. However, there is little agreement on what equity means or what the goals of equity should be in maker learning. As maker educators and researchers, we are invested in finding ways to support maker learning in ways that map onto, but also help to transform, the maker movement.

Within the field of making, equity has primarily been framed in terms of access and opportunity. Within this framing, important questions are being asked, such as: Where is making happening? What is the quality of maker mentoring or maker pedagogies? For example, some studies 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 and ideas and tools (Ryoo, Bulalacao, Kekelis, McLeod, & Henriquez, 2015). Such practices 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). How these practices are tied to a culture of making is underexplored.

However, and importantly, studies are emerging that are critically expanding the discourse on access and opportunity, raising questions about cultural narratives that drive making opportunities. For example, Vossoughi and her colleagues (2016) remind us the maker movement tends to value forms and outcomes of making that are representative of

normative White culture, though we would add that middle-class and school-educated class values are strongly reflected in this normative culture as well. In response to these narratives, approaches to equity should include both a critical analysis of the injustices that youth makers have experiences in, as a part of promoting historicized approaches to making. Such an equity approach also frames making as a cross-cultural activity, with inquiry into the sociopolitical values and purposes of making.

We also assert that most equity discourses in maker education focus at the individual level—on who is making, whether or how that person may or may not fit into the culture of making, or how to best support makers in achieving their own goals through pedagogies and mentoring. Such approaches may improve individual youth's access and opportunity, but they do not necessarily, or at least directly, call attention to the ways in which historicized injustice manifests in the systems of power that play out in the maker movement. Equity discourses that shift from "fixing" the individual to re-mediating and transforming the system are key to reimagining an equity-oriented approach to maker learning.

Still, much more work is needed in fleshing out a stance on equity in making. If we are to promote real and sustained change for youth makers and their mentors, we need to build more robust theories of equity in making that attend to intersecting scales of injustice. Toward that effort, we consider two broad dimensions: *equitable* and *consequential*.

By *equitable*, we suggest that it is imperative that youth have empowering opportunities to engage in STEM in culturally sustaining and rigorous ways. Here we are concerned with opportunities for young people to deepen STEM and making knowledges/practices as a part of, not separate from, their own cultural knowledge and making practices. We are also concerned that young people have opportunities to connect STEM-rich making with their community and broader social issues that matter to them locally, with understandings of how these concerns may connect to broader systemic issues. This would involve supporting the practices and culture of youth makers and community-based making that acknowledge 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). 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). In short, we view *equitable* here as supporting and promoting the knowledge and practices that enable youth's agentic response to desires of the *not yet* and their efforts to reclaim the *not anymore*.

By *consequential*, we suggest that making opportunities leverage upon advancing STEM learning and participation toward transformative outcomes aimed at addressing systemic inequalities, such as supporting youth

agency to make in ways that matter to them and their communities while also disrupting power dynamics in STEM and in making. Other transformative outcomes include expanding youth's social networks for making in ways that promote greater inclusivity through engaging with a wider range of participants (e.g., peers, families, community, STEM experts), and viewing making as happening across scales of activity—such as how making involves local projects that project new discourses onto the field.

In considering *equitable* and *consequential* making for youth, we want to interrogate what it means for youth growing up in lower-income communities, especially youth of color, to engage in *sustained* making experiences in ways that position them as competent youth with valuable experiences and ideas of their own, value their identities as youth of color, and at the same time support their growing STEM and making expertise during the process.

As we will discuss across this text, the focus on sustained engagement is significant. Increasing STEM knowledge and practice in ways that can be transformed by community knowledge and experience takes time. If equity is to be centrally prioritized in the maker movement, then explicit and ongoing attention needs to be paid to youth's whole lives, including the community knowledge and wealth they bring to making alongside the systemic injustices that youth face in making and in the world. This stance builds on work in the learning sciences on teaching and learning as relational and historicized activities, by pushing beyond the focus on individual learners to also address how systemic injustices intersect with classroom practice.

### LIGHT-UP SCOOTER

To gain deeper insights of how we are framing *equitable* and *consequential* we share a brief vignette about Jennifer and Emily. Both girls joined their local community-based maker program in the 5th grade. Jennifer joined because she wanted to use the computers that she knew the club had. She thought that “science is boring,” and often complained that she was not allowed to “build” things or “use technology” in school science. However, she felt that she was good at using the computer and the Internet, and the community making club would give her a chance to learn new skills. More often than not, outside of school, Jennifer felt that no one recognized her interest or ability with technology. For example, when teachers asked questions about computer skills and the Internet during class, Jennifer was the first one to raise her hand to answer the questions, even though she was rarely called on to help. Her expertise in technology was also not encouraged at home. For example, Jennifer was interested in jailbreaking the iPhone, and she tried to jailbreak her mom's phone several times: