

Making Through the Lens of Culture and Power: Toward Transformative Visions for Educational Equity

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In this essay, Shirin Vossoughi, Paula Hooper, and Meg Escudé advance a critique of branded, culturally normative definitions of making and caution against their uncritical adoption into the educational sphere. The authors argue that the ways making and equity are conceptualized can either restrict or expand the possibility that the growing maker movement will contribute to intellectually generative and liberatory educational experiences for working-class students and students of color. After reviewing various perspectives on making as educative practice, they present a framework that treats the following principles as starting points for equity-oriented research and design: critical analyses of educational injustice; historicized approaches to making as cross-cultural activity; explicit attention to pedagogical philosophies and practices; and ongoing inquiry into the sociopolitical values and purposes of making. These principles are grounded in their own research and teaching in the Tinkering Afterschool Program as well as in the insights and questions raised by critical voices both inside and outside the maker movement.

In an interview for *The Atlantic* entitled “All Immigrants Are Artists,” Haitian writer Edwidge Danticat (2013) ruminates on the forms of artistry and reinvention embodied in the everyday lives of immigrant families. Through the story of her mother, she describes the historical conditions that simultaneously necessitated and constrained creativity and locates her mother’s seamstress in both material production and the quotidian beauty and dignity of survival: “If you can’t afford clothes, but you can make them—make them.

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You have to work with what you have, especially if you don't have a lot of money. You use creativity, and you use imagination" (Danticat, 2013, para. 8). Significant in this essay, Danticat does not recast her mother as a *maker* or use the now-popularized language of *making* to legitimate her capabilities. Rather, through what she calls "the prism of art," she locates her own work as a writer in a tradition that includes the ingenuity born of tight circumstances (McDermott, 2010), an everyday practice that was both enmeshed in racialized and gendered hierarchies and provided dynamic resources for her development as an artist.

Danticat's revelations about her parents also invite us to recognize the skill and artistry demanded by the sociopolitical realities of migration, displacement, and economic hardship. She writes, "I realize now I saw artistic qualities in my parents' choices—in their creativity, their steadfastness, the very fact that we were in this country from another place. They're like the artist mentors people have in any discipline" (Danticat, 2013, para. 9). This egalitarian view of human creativity is reflected in Eglash's (2004) introduction to *Appropriating Technology*, an edited volume that examines the role of the "lay public" in the production of scientific knowledge. Challenging the dominant view that those with greater social power produce technologies while those with less social power consume them, Eglash studies the ways communities reinvent and repurpose tools and artifacts, "often in ways that embody critique, resistance and outright revolt" (p. vii). Examples include the vernacular engineering of Latino car designers and the prevalence of environmental analysis among rural women. Grounded in distinct disciplines, both Danticat and Eglash "desettle" (Bang, Warren, Rosebery, & Medin, 2012) normative understandings of artistic and scientific ingenuity, particularly with regard to *who* we see as inventors, *what* we see as creativity, and *on whose terms* their ideas and practices are valued.

We begin with these examples to intentionally challenge what is at risk of becoming a dominant view of making in the United States. In its most narrow, branded version, making is depicted as a uniquely American activity focused on technological forms of innovation that advance hands-on learning and contribute to the growth of the economy. This perspective is typified by a 2011 TED Talk delivered by a prominent voice of the maker movement, Make Media founder and CEO Dale Dougherty. To illustrate how common it once was to think of oneself as a maker, Dougherty shares a vintage 1960 Chevrolet commercial entitled "American Maker." The ad features two white boys building a sand castle with an American flag planted at the top (see images 1 and 2). A male voice narrates: "Of all things Americans are, we are makers. With our strengths and our minds and spirit, we gather, we form, and we fashion. Makers and shapers and put-it-togetherers."

Dougherty (2011) elaborates, drawing a connection to the current maker movement by referencing the values he associates with the Chevrolet commercial: "You know, it was a sense of pride, that we made things. That the world

around us was made by us. It didn't just exist. We made it." He then shares the contemporary story of another (white, male) maker who is uninterested in school but gets involved in robotics competitions and eventually forms a company that builds robots for automobile factories. The historical forms of making Dougherty recognizes are grounded in gendered, white, middle-class cultural practices—a woman baking a pie, a grandfather making a ship in a bottle. And while Danticat describes how her mother became a great seamstress by making her family's clothes at a lower cost, Dougherty characterizes makers as just "playing with technology . . . They don't necessarily know what they're doing or why they're doing it."

Mobilizing nostalgia for a bygone era, Dougherty also positions making as an exceptional element of American identity—one that has been lost over time. The image of the sandcastle with the flag, coupled with the notion that the world around us was "made by us," extends this nostalgia to American hegemony, a time when US power and control were on the rise in the world, and to a time when Detroit (the site of the 2011 TED Talk) was characterized by economic growth rather than decline. Making, for Dougherty, is thus a means to reclaim and leverage American ingenuity toward the revitalization of American economic and political power. This is a specific, branded version of making that, much like the Chevrolet ad, is aimed at expanding markets and the profitability of companies like Maker Media (Buechley, 2013), which describes itself as a "a global platform for connecting Makers with each other, with products and services, and with our partners" (Maker Media, n.d.).

From this vantage point, the mainstream discourse of making is also distinctly economic. Practices such as taking things apart, building new designs, and testing out solutions are valued in so far as they contribute to new technological and commercial innovations. For example, the White House (2015) states that it "has continued to support opportunities for students to learn about STEM through making, expand the resources available for maker entrepreneurs, and foster the development of advanced manufacturing in the U.S." Similarly, our review of references to the maker movement in the *New York Times*, *Los Angeles Times*, *San Francisco Chronicle*, and *Huffington Post* revealed that, with a few notable exceptions, the majority of articles focused on a narrow set of actors (Maker Media, TechShop, Silicon Valley startups) and the expensive tools and projects (3D printers, robotics, drones) associated with makerspaces.¹ The forms of ingenuity present in communities that are not benefiting from dominant economic structures—such as material repair and trade, hacking, making as social or artistic practice, and economic survival—are deemphasized. The broader purpose of making, according to this discourse, is to cultivate and harness individual capabilities that will ultimately contribute to corporate agendas and strengthen existing economic structures.

The ideological distance among the narratives presented by Dougherty, Danticat, and Eglash sets up the central problem we seek to examine in this



Image 1. Title screen of film titled “American Maker, Presented by Chevrolet.”



Image 2. Two white boys building a sand castle.

article: the tensions and possibilities for equity-oriented education within the current maker movement and the ways we might reconceptualize making as a pedagogical practice that is grounded in the histories, needs, assets, and experiences of working-class students and students of color.

The Maker Movement

As a self-defined grassroots movement of backyard and kitchen tinkerers, hackers, designers, and inventors, the maker movement includes a range of perspectives on the definitions and purposes of making. As reflected in Dougherty's talk, corporate and governmental entities (MAKE Media, Maker Faires, the White House, the Defense Advanced Research Projects Agency, Chevron, etc.) often advance a branded version of making, first as an economic enterprise and second as an educational endeavor. There is also a growing number of makers, educators, and researchers who self-identify with the movement and leverage the resources opened up by the first group to advance various educational agendas, such as engaging young people in personally compelling, creative investigations of the material and social worlds (Braahms, 2014; Martinez & Stager, 2013); democratizing access to the tools, skills, and discourses of power previously available only to experts (Blikstein, 2013; Halverson & Sheridan, 2014); and expanding participation in STEM fields through interest-driven, multidisciplinary learning environments (Martin, 2015). Finally, there are educators and researchers who engage in making and related practices but, for various reasons, are critical of the broader movement and are sometimes reluctant to identify with it.

We position ourselves with the third group and seek to examine critiques of the maker movement in order to begin articulating an alternative conceptual and pedagogical framework. In so doing, we aim to be mindful of the heterogeneity within and across these groups while identifying the dangers present in the uncritical adoption of branded versions of making, particularly with regard to their implications for educational equity. We also intentionally reach outside the movement to bring in alternative voices, like Danticat and Eglash, who articulate critiques we see as germane to our argument.

We begin by describing how making has been conceptualized across these various actors, foregrounding popular critiques from a range of economic, pedagogical, and feminist perspectives. We then consider how equity has been conceptualized in the context of the maker movement and to what extent it connects to existing research on the role of race, culture, epistemology, and power in learning. This discussion carries over to the final section, where we elaborate the alternative principles we believe need to be engaged by educators, researchers, and policy makers if the current movement is to meaningfully confront and transform—rather than reproduce—educational inequities.

As researchers and educators, we are engaged in making programs with young people from economically and racially marginalized communities in

the United States. More broadly, we locate ourselves in research on culture and learning that is explicitly aimed at social and educational transformation (Bang & Medin, 2010; Gutiérrez, 2008; Nasir, Rosebery, Warren, & Lee, 2006). With this article, we intend to raise issues that we see missing from the literature on making and to pose the questions we hope to pursue, with others, to help construct transformative visions for educational equity. Ultimately, we argue that the ways making and equity are conceptualized can either restrict or expand the possibility that this movement will contribute to intellectually generative and liberatory pedagogical practices for working-class students and students of color.

Conceptualizations of Making and the Maker Movement

Martin (2015) traces the maker movement to the founding of *Make* magazine in 2005 and the first Maker Faire in 2006, maintaining that “the basic activity of making grows out of longstanding hobbies and crafts such as woodworking, sewing, and electronics” (p. 30). For Halverson and Sheridan (2014), the construction of physical objects and the ways people increasingly share their processes and products in both physical and digital forums make the movement distinct from earlier computational and Internet revolutions. Honey and Kanter (2013) define making as “building or adapting objects by hand, for the simple pleasure of figuring out how things work” (p. 4). This view of making as an essential human need and capacity is reflected in popular media. As Alison Arieff (2015) writes in a *New York Times* editorial entitled “Learning Through Tinkering,” “I’m a huge fan of modern conveniences. But as we’ve become so disconnected from where things come from, from the knowledge, resources and effort required to fulfill even the most basic needs, I believe we’ve lost something essential (if intangible).” Arieff begins the piece by describing a unit her daughter’s third-grade class was studying on “pioneers,” through which the class learned about self-sufficiency and resilience. Here, it is important to note that Arieff does not address the settler-colonial dimensions (Calderon, 2014) of pioneer practices and identities; nor does she unpack who “we” refers to in statements such as “we’ve become so disconnected from where things come from.” In other words, the essay assumes the universality of European-American middle- and upper-class experiences, a standpoint from which to reconnect to working with one’s hands.

There is historical precedent for such assumptions and forms of erasure. The early twentieth-century Arts and Crafts movement and associated progressive reforms in education were similar reactions to the Industrial Revolution and textbook-centric curriculum. This largely European and North American artistic movement was critical of mechanized, factory-based production and advocated for a return to traditional craftsmanship. Similarly, progressive educators of the time, such as John Dewey, sought to cultivate communal forms of pedagogical activity that connected the hand and the mind. As Rose (2014)

notes, “Our discovery of making and tinkering is a rediscovery, one that seems to emerge in reaction to social and economic trends that leave Americans yearning to use their hands” (p. xxiv). While Rose appreciates the maker movement’s attention to the cognitive skill and content of physical work, he also describes the resurgence of making as a “middle-class movement”:

Working-class folk have not had the luxury of discovering making and tinkering; they’ve been doing it all their lives to survive—and creating exchange networks to facilitate it. Somebody across the street or down the road is a mechanic, or is wise about home remedies, or does tile work, and you can swap your own skills and services for that expertise (p. xxv).²

Barton, Tan, and Greenberg (in press) similarly describe the movement as an “adult white, middle-class pursuit” shaped by leisure time and economic resources. Further, while making was a core part of vocational education throughout the twentieth century, it “never carried the status or buzz it does now that it is more the domain of middle class kids—and includes sexy digital technology” (Rose, 2014, p. xxv). We agree with these critiques and believe they raise larger questions about the modes of inclusion practiced by the maker movement—which often reach out to and invite in participants who may have a very different historical and economic relationship to making and working with one’s hands. In the process, working-class communities of color are once again positioned as targets of intervention rather than sources of deep knowledge and skill, and dominant communities are reinscribed as being ahead, with something to teach or offer rather than something to learn.

We are also concerned that the movement may be more aligned with corporate values than social change. Writing in the *New Yorker*, journalist Evgeny Morozov (2014) questions the faith such movements place in craftsmanship, “back-to-the-land sloganeering,” (para. 4) and “making” to reorganize labor and economic production without adequately attending to the need for institutional and political change. Thus, while the maker movement is often characterized as anticonsumerist (Dougherty, 2012), Morozov (2014) laments its close relationship with powerful business and military interests, such as the Defense Advanced Research Projects Agency (DARPA), adding, “Makers, it appears, are not necessarily trouble makers.” Indeed, antiestablishment branding is often coupled with the impetus to purchase a new set of products (from 3D printers to making kits) and may serve to mask conventional corporate agendas and forms of profit making. In her essay “Why I Am Not a Maker,” Chachra (2015) expresses a similar perspective on the hierarchies reproduced by the maker movement: “Making is not a rebel movement, scrappy individuals going up against the system . . . it mostly re-inscribes familiar values, in slightly different form: that artifacts are important, and people are not.”

Chachra (2015) also juxtaposes the kinds of human activity that tend to be valued by the movement with the everyday practices that have been the historical domain of women: mending, repairing, teaching, and caregiving. The

success of the movement means that these practices are cast as less valuable or that they must be reframed as making in order to be legitimized: “Describing oneself as a maker—regardless of what one actually or mostly does—is a way of accruing to oneself the gendered, capitalist benefits of being a person who makes products.” Her critique of the pressure to identify as a maker exemplifies the views of those who are engaged in practices of engineering, design, and education but who choose to dis-identify with the broader movement so as not to be subsumed by its (patriarchal and capitalist) values.

These arguments highlight the normatively valued forms of learning and creativity that have been both challenged and reproduced by the maker movement. Thus, while a number of researchers celebrate the range of identities, practices, and learning environments made available through making, less attention has been paid to the measures of valuable human and educational activity reproduced by the movement in its current form and their consequences for equity-oriented pedagogy and research. While the branded version of making is not the only strand, it often functions as the starting point that other definitions must answer to, particularly with regard to securing funding for educational programs and related research projects. We explore the alternative starting points that might shape how we define and study making through a wider set of cultural histories, values, and epistemologies.

Making and Educational Equity

Largely in response to critiques of narrow representations of making, questions of diversity and equity are increasingly at the forefront of making discourse. As Halverson and Sheridan (2014) argue, making as an educative practice has the potential to help transform what counts as learning and legitimate “a broader range of identities, practices and environments,” a shift they describe as “a bold step toward equity in education” (p. 503).

We agree that there is a need to transform what counts as learning and that making can play an important role in this expansion. However, we question the idea that the maker movement—and specifically its forays into the educational sphere—has, thus far, represented a bold step toward equity. As Barton, Tan, and Greenberg (in press) note, makerspaces that have reached beyond dominant populations “are the exception and not the norm,” with “little research documenting what is working, how or why” (p. 30).

Further, current conceptualizations of making and equity have not adequately wrestled with the cultural, political, and economic tensions and contradictions reflected across the narratives introduced above, leading at times to the reproduction of historical inequities. For example, Dougherty’s TED Talk posits the need to reimagine schools to look more like the robotics competitions that inspire children like the young maker in Detroit. This image of the white, male student whose interests and talents are marginalized in school can be seen as the original imagined audience of the movement’s educational

designs—one that many have since sought to diversify (Buechley, 2013). Yet, the fact that a progressive educational movement born in the twenty-first century begins from a narrow set of cultural experiences, and has since sought to expand “diversity” and “inclusion” from that center point, exemplifies one of the central tensions we seek to problematize.

To elaborate, educational programs animated by “access” and “inclusion”—what Gutiérrez and Jaramillo (2006) refer to as the “sameness as fairness” approach—tend to design making activities and environments with seemingly neutral or universal learning goals that are implicitly rooted in the experiences of dominant populations (such as frequent Maker Faire or museum participants). This process of design is typically followed by efforts to expand participation, thereby limiting equity to outreach and diversified participation rather than the critical examination and potential reorganization of the activities and pedagogies themselves.

Further, while animated by equity concerns, questions such as “Who has access to making?” fail to examine the assumptions that already inform the ways the question is framed. This question implies that making writ large is synonymous with the ways it is defined in the current maker movement and that this form of making is a historically novel and inherently desirable activity that should be practiced by all students and communities. Spurred by efforts to delineate and market an emerging field, these assumptions align with an interest in setting making apart from other forms of creative human activity. Indeed, we have witnessed a number of conversations among researchers and educators working to demarcate “what counts” as making or tinkering. While these conversations represent efforts to develop a more precise definition of making, the problem emerges when we fail to consider definitions that are rooted in distinct historical and cultural genealogies or to attend to whose voices are absent in the room. This inattention makes it difficult to recognize the cultural and socioeconomic assumptions already embedded in seemingly neutral making activities (such as 3D-printed catapults or night-launch rockets). We also worry that this approach overlooks the tensions of assimilation and cultural self-denial consistently navigated by working-class youth and youth of color and positions those who identify with the maker movement as privileged cultural and intellectual gatekeepers.

In grappling with definitions of making, the research literature often references Buechley’s (2013) analysis of the narrow representations within *Make* magazine across the first nine years and 39 issues of its publication (2005–2014): 85 percent of the magazine covers featured white boys and men, with a focus on robotics, electronics, and vehicles. While the response to this watershed critique has led to a greater focus on representation (e.g., expanding the diversity of makers featured on the magazine cover), less attention has been given to the call for interrogating what is recognized as making. This tension is akin to earlier trends in multicultural education, where nondominant cultural practices were incorporated in tokenized ways (through food and holidays or

the incorporation of nonwhite characters in children's books) as opposed to the reorganization of learning based on deeper understandings of students' repertoires of practice, such as community-based forms of storytelling or scientific inquiry (Gutiérrez & Rogoff, 2003; Medin & Bang, 2014). Thus, we argue that close attention to who students are—and what they experience as cultural, historical, and political actors—alters and shapes the pedagogical design and practice of making in consequential ways.

Alternative Visions: Toward the Critical Theory, Practice, and Research of Making

Building on these critiques, how might we reconceptualize the educational practice of making in ways that place equity at the center? We argue that an equity-oriented approach to making treats the following principles as *starting points* for research and design: critical analyses of educational injustice, historicized approaches to making as cross-cultural activity, explicit attention to pedagogical philosophies and practices, and ongoing inquiry into the socio-political values and purposes of making. We ground this framework in our own research and teaching in the Tinkering Afterschool Program³ (Vossoughi, Escudé, Kong & Hooper, 2013) as well as in the emerging interventions and debates among critical voices within the maker movement. We highlight examples that illustrate the educational possibilities and forms of liberatory practice that can emerge when key learning goals and values are explicitly conceptualized through the lens of culture and power.

Critical Analyses of Educational Injustice

We work from the premise that equity-oriented design and research must begin with a clear analysis of educational injustices and how they shape the lived experiences and pedagogical needs of young people and their communities.⁴ While discourses of equity in making are often characterized by terms like “diversity,” “access,” “inclusion,” and “opportunity,” there is seldom sustained attention to racialization, discipline, and the school-to-prison pipeline (Elias, 2013; Nasir, 2011); to deficit thinking as tied to tracking (Oakes, 1999) and narrow forms of remediation (Cole & Griffin, 1983); to curricular and pedagogical models that marginalize the cultural practices of students (González, Moll, & Amanti, 2005); or to the disproportionate impact of high-stakes testing on working-class students and students of color (Rose, 2011). In our view, efforts to broaden participation without explicit analysis of such injustices advance the implicit arguments that access to normative making and STEM learning opportunities is sufficient for bringing about equity, and that equity *looks like* individual success within the current system (e.g., increasing the number of underrepresented students in the STEM pipeline), rather than the collective reimagining and transformation of the system itself.

How and why are explicit analyses of educational injustice necessary for developing more equitable forms of making? First, like Morozov, we are concerned that a focus on new learning tools and activities without attention to corresponding structural changes will reproduce existing inequities. For example, our work with educators has led us to recognize the crucial role of guided reflection as a core element of robust professional development. Writing and talking about the pedagogical details of moment-to-moment interactions with students often surfaces deficit-oriented assumptions and creates the space to codevelop more equitable practices. Yet, this time for reflection is hard to come by and is systematically underfunded, particularly in schools and communities hardest hit by budget cuts and other forms of economic disinvestment. A similar tension emerges when inquiry-based forms of learning come up against accountability measures that limit the room for alternative pedagogies in schools and increasingly constrain curriculum in afterschool settings (Nocon & Cole, 2006). From this vantage point, high-quality making activities and tools alone will not unsettle existing inequities if we do not simultaneously challenge disinvestments in public education and call for the structural changes that would meaningfully support all teachers and students. Failing to name these inequities can lead to educational designs that can only be incorporated by well-resourced schools and programs.

Second, advancing making as an alternative to standardized, test-centric education without also confronting discourses of failure, persistence, and grit risks replicating deficit views of students. For example, researchers and educators often highlight the ways making can support the *process* of learning by encouraging intellectual risk taking and iteration. This includes reframing frustration and failure as fundamental to the recursive feedback that characterizes making, rather than as problems to be avoided in the search for one right answer (Blikstein, 2013; Petrich, Wilkinson, & Bevan, 2013). There is a shared value here around the ways students iterate by studying the actions and movements of their creations (Martin, 2015) and imagining how things could be beyond how they are (Ackermann, 2010). In the Tinkering Afterschool Program, educators often presented imperfect examples (a faulty scribbling machine or a sewn science notebook that artfully incorporated a “mistake”) as a way to model the power of process, invite students to publicly discuss how they might approach a problem, and emphasize the importance of ideas over final products. Such principles hold great potential for widening narrow definitions of success or intelligence (Vossoughi et al., 2013). However, Martinez and Stager (2013) caution against confusing “iteration with failure when in fact any iterative design cycle is about continuous improvement, keeping what works, and improving what doesn’t.” They argue, “This is learning, not failure” (p. 70). Because, as Martin (2015) notes, some students and schools have been systematically labeled as “failures,” the term (legitimately) carries negative connotations and may not be so easily reframed (Ryoo, Bulalacao, Kekelis, McLeod, & Henriquez, 2015).

We also question the ways terms like “persistence” or “grit” are used to frame desired responses to frustration within making experiences. These discourses tend to individualize historical inequities and omit other crucial factors, such as the quality and meaning of the task itself, the presence or absence of intellectual safety, or the kinds of cultural differences and microaggressions students may be navigating within a making environment (Kohn, 2014; Norris, 2014). As educators, if our response to frustration is always “persist,” we forfeit the opportunity to interpret these moments as an indication of what needs pedagogical attention or curricular change. The broader context of educational injustice, therefore, has consequences for how practices such as iteration are conceptualized and mediated.

Finally, explicit attention to educational injustices is essential to developing a pedagogical sensitivity to the ways they can reemerge *within* making environments. For example, we have observed that making activities are sometimes framed as rewards for good behavior, thereby reconstituting the practices associated with ability grouping and tracking. In the Tinkering Afterschool Program, we experienced a turning point when our research surfaced the ways a student who was perceived as “off task” was receiving narrow forms of assistance and few opportunities for authorship as compared to other students. Examining this dynamic allowed us to develop more responsive and respectful approaches to working with this student and others. Thus, despite equity-oriented goals, deficit ideologies are often tenacious and fluid, demanding ongoing reflection and action.

Questions that can support educators and researchers in identifying such inequities might include: Who has access to more intellectually complex activity within this space? Are there gendered or racialized patterns of tool use, participation, or assistance? Are multiple pathways and ways of knowing supported or marginalized? What kinds of mentorship are available to help youth navigate everyday encounters with racism and other forms of marginalization? And if and how do making environments attend to the histories of practice young people are involved in? These questions exemplify the alternative approaches to design and pedagogy that grow from the explicit analysis of educational injustice.

A Historicized Approach to Making as Cross-Cultural Activity

Medin and Bang (2014) problematize the ways “science education recognizes and values practices that white, middle-class scholars bring to the classroom, while ignoring or even overtly discouraging the science-related practices” of other cultural groups (p. 240). They argue that equity in science education will not be achieved as long as science itself remains “pure and beyond examination” (p. 240). Here we consider the implications of this argument for the maker movement and argue that equity will not be achieved as long as our definitions of making remain “pure and beyond examination.”

In this spirit, we ask, what does a historicized view of making as cross-cultural

activity open up with regard to design, pedagogy, and research? First, rather than beginning with the question of 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. As Gutiérrez argues, “Inventing, making, tinkering, designing, are indigenous practices, that is, practices that originate and occur naturally in particular ecologies” (Schwartz & Gutiérrez, 2015, p. 577). Rather than working to “bring” making to nondominant communities, this assumption of human ingenuity (McDermott & Raley, 2011) positions researchers and educators as learners, inquiring into the ways of asking, knowing, and relating involved in existing forms of making. Drawing on our earlier discussion of Danticat and Eglash, such inquiries might also involve noticing how extant making practices are rooted in community-based forms of surviving and thriving.

Second, this approach can help reframe how we understand who is and who is not participating in spaces such as Maker Faires. While discourses of equity in the maker movement often focus on diversifying participation, less attention has been given to the reasons people choose not to participate in particular spaces and how those reasons may be rooted in critique. If we suspend the assumption that participating in sanctioned makerspaces is inherently desirable, we may open ourselves up to recognizing and learning from the communities of creative practice people already participate in and to troubling simplified discourses of interest and engagement. These discourses often position particular populations as interest deficient rather than asking after the environments themselves and seeking to understand people’s subjective experiences and critiques (Nasir & Vakil, in press).

This view does not preclude considering how young people’s interest-driven activities connect to robust educational or professional pathways (Ito et al., 2013). Indeed, a number of scholars illustrate both the intellectual depth of everyday linguistic and cultural practices and how these can be meaningfully connected to academic concepts and identities (Gutiérrez, 2008; Lee, 2001). This includes supporting students in appropriating the tools of power toward new ends. Within making environments, this perspective can inform the materials, tools, and activities selected, as well as the ways teachers talk about making activities and identities. For example, creating environments that model and invite students to share stories about familiar practices (such as the intergenerational use of sewing machines, kite making, and home electronics repair) can support new ways of noticing the scientific and artistic dimensions of their everyday activity (Vossoughi et al., 2013), making connections to as well as expanding disciplinary knowledge, and recognizing the intellectual complexity of historically gendered practices such as sewing (Kafai, Searle, Martinez, & Brayboy, 2014). As Buechley, Eisenberg, Catchen, and Crockett (2008) argue:

In addition to asking “how can we get girls and women to participate in traditional computer science and support them once they are there?”, we should ask:

“how can we integrate computer science with activities and communities that girls and women are already engaged in?” (p. 431)

Such questions shift the discourse away from deficit orientations (Why are girls less interested in computer science?) and toward epistemological frameworks that begin with what is significant to students.

Thus, approaching design in ways that build on and expand everyday practices is quite distinct from designing activities based on dominant cultural norms and then working to broaden participation. This shift becomes particularly essential as the maker movement expands into schools and develops its own forms of assessment. The field is poised to define what counts as learning in the context of making. Situating these efforts in a deep understanding of learning as cultural activity will be crucial to challenging rather than reproducing deficit ideologies.

Finally, efforts to draw borders around making set up *making itself* as the goal of educational practice, rather than treating making as one among many tools that can productively intersect with other rich forms of learning. Narrow definitions of making also demarcate which educational environments are considered makerspaces (and can therefore access related sources of funding) as well as *who* counts as a maker and who does not. From our perspective, this trend is not inevitable and could be reorganized in productive ways by intentionally treating the practice of making as open to local adaptation, critique, and appropriation. This shift also requires a clear understanding of the role of the teacher in making environments.

Explicit Attention to Pedagogy

A growing number of studies describe the pedagogical skills that support making, including knowledge of materials, tools, and processes; strategies for supporting meaning making and the complexification of ideas; and an understanding of participants' prior knowledge and interests (Brahms, 2014; Gutwill, Hido, & Sindorf, 2015). Petrich et al. (2013) note the importance of providing opportunities for teachers to experience activities and tools as learners prior to and alongside engaging young people in making activities. Critiquing approaches to technology that treat “computers and software as black boxes where the inner workings are hidden to users” (Kafai, Fields, & Searle, 2014), the research literature also highlights the transparency of materials and activities as a core pedagogical value (Pepler, 2013).

While there is increasing attention to the role of facilitation and transparency across studies of making, we have also noticed significant limitations in the analysis of pedagogy as it relates to discussions of equity. First, empirical studies of learning in the context of making tend to foreground individual learning processes rather than joint activity or explicit analyses of teaching (Vossoughi & Bevan, 2014). This tendency suggests that pedagogical structures were either absent or minimal or resulted from a methodological and

conceptual decision to minimize explicit attention to pedagogy, even if it was a significant part of the learning process. When educators are mentioned, they are consistently framed as “facilitators,” “guides,” or “coaches,” a discourse that tends to treat the word “teacher” and the practices associated with being a teacher as inherently didactic or problematic.

We worry that an overreliance on child-centered pedagogies that emphasize the avoidance of direct assistance overlooks the powerful role intentional teaching can play in challenging deficit ideologies and cultivating substantive experiences of intellectual dignity (Espinoza & Vossoughi, 2014) as well as the need to make pedagogical structures visible within research, design, and professional development. To illustrate this point, we have crafted two different accounts of the same interaction captured during our video-based research on afterschool tinkering. The first vignette describes the experience of one student as he explored circuitry.

Vignette 1. Circuit Boards: Individual Learning Processes

Arthur (seven years old) was exploring circuitry using a series of blocks with electrical components.⁵ He became excited when he realized that some of his lights were lit even though they weren’t directly connected to the battery, and he called others over to point out that some lights worked “without even batteries.” He then became fascinated with a battery tester that was available on the table and took a break from his circuit building in order to test all his batteries. After this detour, he periodically switched off his circuits and spoke about the need to save their energy.

Arthur then decided to move around the room to check out the work of others. He spent some time as a guest at Aeden’s (nine years old) circuit. Aeden pointed out interesting aspects of his own circuit boards (such as a small fan with rapidly spinning foam blades), and Arthur joined in the investigation. Aeden’s own engagement with circuits seemed to ebb and flow on this day.

Arthur then added more boards to his original parallel circuit. When he added a particular motor, he noticed that it affected the intensity of light from some of the lightbulbs. This threw Arthur into his final investigation of the effects his circuit boards were having on one another.

This episode reflects forms of observing and reporting on learning that we have noticed in various introductions to making, including at conferences where making is featured, such as FabLearn, Association of Science and Technology Centers (ASTC), and Digital Media and Learning. Here participants’ individual investigations and learning outcomes are foregrounded alongside attention to peer interaction and collaboration. Such accounts highlight the forms of inquiry and thinking evident within the process of making, thus creating new resources for activity design and formative assessment. These include the ways authentic questions and investigations emerge through direct engagement with materials and scientific phenomena and the ways knowledge about the workings of electricity become consequential to achieving purposes

that are authored by participants themselves (Blikstein, 2013; Pepler, 2013). Compare this version of the story with the following vignette, which highlights Arthur's interactions with a teacher in the setting:

Vignette 2. Joint Activity

Arthur worked with Walter (a teacher) to explore circuitry. Arthur became excited when he realized that some of his lights were lit even though they weren't directly connected to the battery. He then called others over to point out that some lights worked "without even batteries." Using Arthur's own phrasing, Walter affirmed and then reframed this statement, helping to clarify what was happening: "without even batteries going directly to those light bulbs."

Arthur then asked Walter about a battery tester that was available on the table. After Walter explained the uses of the tool, Arthur became fascinated and took a break from his circuit building in order to test all his batteries. Following this detour, he periodically switched off his circuits and spoke about the need to save their energy.

Arthur then decided to move around the room to check out the work of others, a practice that is encouraged in the setting. He spent some time as a guest at Aeden's circuit. Aeden pointed out interesting aspects of his own investigations, and Arthur joined in the experiment. Aeden's own engagement with circuits seemed to ebb and flow on this day, which the staff later discussed as potentially stemming from his need for a greater challenge. During the end-of-the-day debrief, one staff member committed to working more closely with Aeden the following week.

Arthur then added more boards to his original parallel circuit. Walter commented that Arthur had built an "elegant circuit" and offered suggestions for ways to test and try out solutions. Some of Arthur's solutions surprised Walter, who said that he was also learning from Arthur's ideas. When a particular motor was added, Walter pointed out that it was affecting the intensity of light from some of the light bulbs. This threw Arthur into his final investigation of the effects his circuit boards were having on one another other.⁶

In contrast to Vignette 1, the unit of analysis in Vignette 2 is one of joint activity. While similarly highlighting the ideas that emerged within Arthur's investigations, this lens treats thinking as a social activity, one that is intentionally mediated through the teacher's interventions. Here, explicit attention to pedagogy foregrounds the generative role of elders and mentors in young people's development, makes the art and skill of teaching transparent and available for other educators, and treats the development of social relationships as a primary rather than secondary aspect of making activity (DiGiacomo & Gutiérrez, 2015).

This lens allows us to consider the making of social relations as interwoven with the making of artifacts. However, we see this distinction as one that must be carefully developed and documented rather than taken for granted as an innate feature of making environments. Actions such as Arthur's decision to walk around and check out other students' circuits or the brotherly stance

Aeden took with regard to Arthur's curiosity about his circuit have a history. We might study this history by asking, If and how is collaboration encouraged and modeled in this setting? How did students interact with one another's projects early in their participation as compared to later points in their trajectory? Such detailed accounts of the process through which alternative social relations come to be would help illustrate how knowledge and assistance become readily accessible to all participants as well as the ways competitive interactions (those more likely to reproduce raced/classed/gendered hierarchies of intelligence) can be altered and reimagined. As Nasir et al. (2006) argue, a deep sense of social belonging is a key marker of equitable learning environments.

Also, we worry that discussions of transparency within making tend to focus on the transparency of activity design (such as the use of materials that make scientific phenomena or engineering solutions visible and investigable) rather than on the complementary forms of transparency afforded through pedagogical talk and apprenticeship. Arthur's fascination with the battery tester, for example, emerged from Walter's explanation of how it works—a move that made the teacher's knowledge of the tool available for Arthur to draw on in his investigation. Furthermore, Walter's decision to encourage what could be seen as off-task behavior was intentional and tied to his knowledge of how this added expertise could deepen Arthur's learning, as well as to his rejection of pedagogies that emphasize behavior control.

Yet, the tendency to focus on the transparency of tools rather than pedagogy suggests that high-quality making activities will *themselves* serve as the teacher within a process of self-directed learning. In our view, self-directed learning can easily slip into a meritocratic, pull-yourself-up-by-your-bootstraps approach to education. In this case, Arthur's journey through the activity can largely be seen as successful. Thus, the descriptions in Vignette 1 are framed in ways that attribute this success to Arthur. However, had Arthur had a difficult time with the activity (as was sometimes the case), the focus on his individual learning process could easily turn into a story of Arthur's struggles rather than an examination of the pedagogical supports and relationships available in the environment. The contrasting depictions of Aeden's experience across the two vignettes reflect this tension. In Vignette 2, moments of disengagement are attributed to the lack of support Aeden received from educators that day. The staff interprets Aeden's response as a reflection of his need for a greater challenge, and they commit to working with him more intentionally. Thus, empirical analyses that foreground teaching can make visible the specific forms of reflection and pedagogical responsibility necessary for equitable teaching. The analytic focus in the making literature on activity design over and above pedagogical design also resonates with Chachra's (2015) critique "that artifacts are important, and people are not."

Finally, we are concerned that the maker movement is adopting a narrow version of constructionism as its theoretical seed, rather than drawing from

critical developments in constructionist theory that include social and cultural perspectives. Extending Piaget's constructivist focus on individual sense making and experience, constructionism posits that learners construct understandings of the ideas that are embedded in the creation of personally meaningful artifacts (Papert, 1993). For example, the "turtle" in Logo turtle graphics was designed to help learners explore geometry by providing ways to think about the formation of shapes as processes that they could relate to physically and control through creating procedures (Papert, 1980). Early visions for the possibilities that programming (now "coding") could offer were as much about supporting epistemological pluralism as they were about providing new ways to explore disciplinary ideas (diSessa, 2000; Turkle & Papert, 1992).

Constructionist approaches to learning are foundational to the maker movement, as reflected in projects that begin with learners' interests and the historical resonance between the technological tools that are popular in contemporary makerspaces (i.e., laser cutters, Arduinos) and the original ideas that shaped programmable media for children. It is therefore possible to envision work with technology in makerspaces as similarly opening up new ways of thinking about disciplinary ideas and fostering epistemological pluralism. For example, investigations of mathematical ideas could be conducted in physical, digital, and fabricated forms, each open-ended enough for personalized expression yet structured enough for scaffolding toward specific ideas (Hooper & Freed, 2013).

In our view, connecting these dots requires intentional forms of pedagogy. Yet, historically, constructionist perspectives have not treated explicit attention to pedagogy as central to learners' engagement with new ideas. The role of the teacher within constructionist pedagogical designs is generally to facilitate engagement with new tools using a process of making projects that reflect learners' interests. Constructionist approaches are often contrasted with direct forms of teaching, such as Initiation-Response-Evaluation (IRE) models, whereby the teacher asks questions, students give responses, and the teacher evaluates those responses (Cazden, 2001).

However, there are existing threads within constructionist research suggesting that the theory and its application could benefit from a more nuanced perspective on the role of direct assistance (Delpit, 1986) and the social organization of making environments. Hooper (2008) examined the role of cultural context and teacher-student interactions in the emergence of computational ideas as expressive tools. Critiques of constructionism have also called for reexamining the theory's focus on individual learning. Ideas such as cultural constructionism (Hooper, 1998), social constructionism (Shaw, 1995), and socioconstructivism (Ackermann, 2010) represent efforts to merge constructionist theory with sociocultural perspectives (Nasir et al., 2006; Rogoff, 2003). Treating sociocultural experience and interaction as *constitutive* of individual and collective sense making opens up more nuanced views of pedagogy, including moments when explicit forms of teaching are appropriate and generative.

A sociocultural critique of constructionist practice also helps caution against the fetishization of tools such as 3D printers and Arduinos as all that is needed for robust and equitable forms of making. As with the pitfalls of technology use in schools, we worry about designs for makerspaces that may be full of tools but void of the rich pedagogical philosophies and practices needed to support all students (Philip & Garcia, 2013). There are excellent models of programs that have been engaging in making activities with nondominant populations, such as the California-based Community Science Workshops and Techbridge or Making 4 Change in Michigan and North Carolina. We argue that these settings succeed because they prioritize sociocultural contexts and nurture the development of social relationships and collective sense making as interwoven with the critical appropriation of disciplinary tools and ideas (Barton et al., in press).

The Sociopolitical Values of Making

Finally, the buzzwords associated with making in the US context—“innovation,” “STEM workforce development,” and “global competitiveness”—have implications for teaching and learning. Prominent voices within the US maker movement also tend to describe the artifacts young people make as “products” and treat innovation as synonymous with democracy and positive social change.⁷ We challenge this assumption and highlight groups both inside and outside the United States who are developing alternative visions and frameworks.

First, scientific experimentation and invention are not politically neutral or benign activities (Medin & Bang, 2014). There is a long history of research within science and technology studies that examines the role of Western science in colonialism, military interventions, and the oppression of communities of color (Harding, 1993; Nelson, Tu, & Hines, 2001). Yet, the politics of technology and innovation—and what they mean for the pedagogical design of makerspaces—is largely unexplored within the literature. For example, the emphasis on robotics and drone technology is often criticized on the grounds that it puts forth a narrow, gendered definition of making with little mention of the militaristic and ethical implications of such technologies. In examining the relationship between the US military and STEM education, Vossoughi & Vakil (in progress) express concern with corporate and military investments in making; question narratives that tout innovation yet deemphasize critical thinking, social analysis, and the arts; and highlight the voices of makers and educators that expressed opposition to partnerships among MakerED, hackerspaces, and DARPA.

In light of this larger context, we argue that there is a need for research on making that treats learning as a sociopolitical process (Barton et al., in press; Booker, Vossoughi, & Hooper, 2014; Santo, 2013). Existing models for this approach include a recent graduate course examining the ethics and social impact of design at the Massachusetts Institute of Technology Media Lab, *Unpacking Impact: Reflecting as We Make*. Oakland’s Youth Radio provides

another example; in their research on youth media production, Chávez and Soep (2005) argue that “the process of transforming lived and imagined experiences into original expressive works for significant audiences can provide a resource for young people to rewrite the stories that are told about them, against them or supposedly on their behalf” (p. 410). Rather than beginning from a generic principle of youth authorship, a common theme within literature on making, or treating conventional forms of media production as politically neutral, Chávez and Soep consider the pedagogical approaches that are most responsive to their students’ sociopolitical realities. The meaning of authorship itself therefore shifts to involve explicit attention to the rewriting of dominant narratives about youth of color and their communities.

Second, the conflation of innovation with democracy aligns with the growing economization of education and of public life more broadly. As reflected in the 2015 White House statement on making, educational initiatives are increasingly framed as economic initiatives, and US makerspaces often emphasize the access to tools and technologies needed to pursue individual commercial endeavors.⁸ Brown (2015) considers what this economization of everyday life means for social and relational domains, such as education, writing, “Neoliberal rationality disseminates the *model of the market* to all domains and activities—even where money is not an issue—and configures human beings exhaustively as market actors” (p. 31). She continues, “every aspect of human existence is produced as an entrepreneurial one” (p. 65).

In seeking out alternatives to this “neoliberal rationality,” we analyzed the mission statements of a number of makerspaces, hack labs, and collective arts spaces in Latin America.⁹ In Mexico, CASITA (Autonomous Center for the Intercultural Creation of Appropriated Technologies) runs workshops where participants repurpose bicycles into pedal-powered machines like blenders and other practical tools. Its mission statement reads: “We believe that it is important to learn, reproduce and innovate the techniques that are ecologically prudent, but also socially just, culturally appropriate-able, economically accessible and, whenever possible, technically reproducible.”¹⁰ Such statements highlight the activities that take place, and their benefits to the people who participate, over and above descriptions of the physical space and its material assets. Un/Loquer, a hackerspace in Medellín, Colombia, describes its mission as contributing to the world by “creatively redefining technology”: “We take apart and occasionally abuse technologies in search of understanding how they work in order to propose and construct devices for new uses. Included in un/loquer are empirical scientists, neighborhood inventors, cacharreros empedernidos [veteran tinkerers], engalladores de carretas [embellishers of horse carriages].”¹¹ Such descriptions draw on the historical practice of repurposing available technologies for uses outside intended systems of consumerism (Eglash, 2004), signaling a shift away from corporate interests and toward community needs. Although we recognize that there are many groups in the United States engaged in parallel efforts, we also believe the mainstream dis-

course of the maker movement has much to learn from the forms of imagination and political possibility reflected in these statements.

Drawing from these alternative social visions, as well as from Brown's critique, we ask: What kind of political and economic subject is the learner within a making environment? To what extent are students in the United States being positioned as future workers or entrepreneurs? What alternate identities and subjectivities are eclipsed in the process? In our view, the dominant framing of making as a *STEM*-oriented movement—and the vast investment in *STEM* education as opposed to arts, social studies, or literacy education—is, in part, a consequence of the organization of all spheres of social life around economic returns on investment. While we are excited by the rich intersections between scientific and artistic practice, the growing emphasis on *STEAM* (science, technology, engineering, arts, and math) also illustrates the ways arts education may be supported in so far as it contributes to scientific and economic initiatives.

Thus, we worry that questions such as “Where is the learning in making?” too often become synonymous with “Where is the *STEM* in making?” This tendency works against a wider range of learning goals and risks overlooking the various ways young people experience and value making as a multidisciplinary activity (Peppler, 2013; Sheridan et al., 2014). In our research, we have sought to move beyond a narrow focus on *STEM* by foregrounding the multidisciplinary development of ideas as interwoven with the development of social relations and new forms of agency. This focus allows us to study the genesis of diverse forms of learning and how they matter to participants, rather than starting from the premise that that learning is bound to *STEM* or to predetermined definitions of making.

In a similar vein, we notice that groups like Medellín's *Por Estos Dias* (these days) define themselves as collectives of people who engage in a range of activities related to making. This multimodal approach, as expressed by *Por Estos Dias*, serves as an opening to the genesis of larger purposes and possibilities and resonates with Chachra's (2015) critique of the pressure to identify as a maker:

*Hay días que somos un proyecto de acción social
Algunos días somos un diálogo entre disciplinas
Día tras día somos un experimento que se reimagina
No todos los días somos un proyecto de arte
PorEstosDias hacemos cosas*

(There are days when we are a cultural action project
Some days we are a dialogue between disciplines . . .
Day after day we are an experiment that reinvents itself . . .
Not every day we are an art project,
These days we make things.)¹²

Drawing inspiration from such statements, we see an expansive potential in historical forms of creative activity that are rooted in community and in contemporary making practices that are situated within the greater social and intellectual purposes of collective transformation.

Conclusion

In this article we examine the tensions we see in the maker movement as a way to support collective self-reflection and new forms of action. Currently, making is being incorporated at scale in rapid ways without adequately considering the structural changes and material and pedagogical resources required to support learning for all students. We therefore see a crucial need to create the time, space, and analytic tools necessary to embrace the complexity of placing culture, power, and equity at the center of the design and research of making. In this spirit, we propose a framework that highlights four alternative starting points for equity-oriented design: critical analyses of educational injustice, historicized approaches to making as cross-cultural activity, explicit attention to pedagogy, and inquiry into the sociopolitical values and purposes of making. Explicit engagement with these complexities can lead to a critical examination and iterative reconceptualization of key learning principles and pedagogies. We believe pedagogical designs that are animated by these principles will be more responsive to the histories, needs, and experiences of working-class students and students of color and that related forms of research will help theorize the kinds of agentic teaching and learning that can emerge within making experiences.

Notes

1. See, for example, http://www.huffingtonpost.com/christine-henseler/the-maker-movement-and-th_b_6349514.html, which contrasts with the more typical representation of makerspaces found at http://mobile.nytimes.com/2016/02/07/education/edlife/forward-tinkering-colleges-make-room-for-maker-spaces.html?_r=2&referrer=http://m.facebook.com.
2. "Introduction: Mind and Work," from *The Mind at Work: Valuing The Intelligence of the American Worker* by Mike Rose, copyright © 2004 by Mike Rose. Used with permission of Viking Books, an imprint of Penguin Publishing Group, a division of Penguin Random House LLC.
3. The Tinkering Afterschool Program is a partnership between a science museum and an afterschool center that serves children and youth from immigrant and diasporic backgrounds (Mexican, Central American, Chinese, Vietnamese, Filipino/a and African American) in a working-class urban community. Adults and teen educators work with elementary-aged children on a weekly basis to design and co-create artifacts that blend scientific inquiry and artistic expression, such as scribbling machines, stop-motion animation films, wooden pinball machines, and musical instruments.
4. We lead with the term *injustice* because we believe it highlights historical and contemporary forms of oppression—and their intentionality—in ways that *inequity* or *disparity*

- can sometimes obscure. A justice-oriented frame also opens the space to imagine and articulate self-determined solutions that diverge from white, middle-class epistemologies and practices.
5. Student names are pseudonyms. In this case, the teacher, Walter (in Vignette 2), chose to use his real name.
 6. This vignette is adapted from a description of the same interaction featured in Vosoughi and Bevan (2014).
 7. As Techshop CEO Mark Hatch (2014) states, “The real power of this revolution is its democratizing effects. Now, almost anyone can innovate. Now almost anyone can make. Now, with the tools available at a makerspace, anyone can change the world” (p. 10).
 8. See <https://www.whitehouse.gov/nation-of-makers>.
 9. We chose to focus on Latin America in order to intentionally step outside the narrative of American exceptionalism, and due to Escudé’s personal connection with Latin America as an Argentine who lived and worked there as an artist and teacher for several years. The particular focus on Colombian makerspaces is due to a recent professional collaboration between Escudé and individuals associated with both the science museum *Explora* and the makerspace *Platohedro*, through which she became familiar with the very active making/hacking community in Colombia.
 10. See <http://www.cacita.org.mx/>.
 11. See <http://unloquer.org/inicio/>. *Carretas* are homemade wooden carts, often horse-drawn. They are commonly used in Latin America by independent street vendors or collectors of discarded recyclables for resale or reuse.
 12. See <https://www.facebook.com/porestos.dias/about?section=bio&pnref=about>. This mission statement was translated by Escudé.

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