1. Learning by Doing: The Tenuous Alliance of the "Maker Movement" and Education Reform

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Over the last decade, the promises of the Maker Movement—a growing public interested in do-it-yourself designing, remixing, and building using physical and digital tools—have found resonance in the field of education, sparking discussion among researchers, policymakers, and practitioners. In many of these conversations, *making* has been positioned as a catalyst for educational change—an intervention to transform the rote activities and bureaucratic structures that often characterize schooling in the popular imagination. In policy, for example, President Obama's *Educate to Innovate* campaign inaugurated a National Week of Making, where he called on students to be not just passive consumers of information and products, but to become a "nation of *makers*" (White House, 2014). In research, the *Harvard Educational Review* devoted a full symposium to "The Maker Movement in Education," featuring scholarly accounts of youth *making* practices and their possibilities for reimagining school instruction (Halverson & Sheridan, 2014). And among teachers, the National Writing Project—an organization focused on improving writing in K-12 contexts—has offered workshops and professional development on "Writing as Making," integrating tenets of the movement into classroom literacy instruction (National Writing Project, 2013). In each of these forums, *making* has been framed as an alternative to the routines and rituals of "traditional" schooling—offering, instead, a different vision for

education: learning through active, hands-on problem-solving, or, "learning by doing."

However, this narrative of *making* as a counterpoint to more conventional models of instruction elides a more complex history of 20th century U.S. education reform and the Maker Movement's place therein. While it is certainly true that many classrooms have foregrounded routine, efficiency, and standardization—what Tyack and Tobin (1994) call "the grammar of schooling"—there also exists a rich parallel tradition of "progressive" school reform, rooted in a "learning by doing" ethos similar to that invoked by the present-day Maker Movement (Cremin, 1961; Dewey, 1938). These progressive approaches have not always enjoyed unanimous public support, but as education historians have shown, their central interest in experiential learning has left a considerable mark on research, teacher preparation, and education policy (e.g. Zilversmit, 1993). For example, in the last decade, as publications associated with *making* have advocated for greater emphasis on "learning by doing," many similar conversations were already taking place across formal and informal educational spheres: from increasing attention to "hands-on" training in science and technology (National Research Council, 2012); to renewing interest in creativity and innovation across curricula (Bronson & Merryman, 2010; White House, 2014); to broadening conceptions of literacy that extend to new and non-traditional media (Kress, 2010; Lankshear & Knobel, 2009). This is not to suggest, of course, that all schools fully embody or practice these "progressive" ideals—only that such ideals have congealed as recognizable goals toward which multiple and diverse educational stakeholders are striving (cf. Egan, 2004). Given the alignment of these aims with those of the larger Maker Movement, then, we can begin to understand the current resonance of *making* not as a break or intervention in existing practice, but rather, as a recent extension of a familiar mode of progressive critique.

In this chapter, we aim to situate *making* within this larger landscape of contemporary education reform, analyzing the claims of researchers and policymakers alongside those of the Maker Movement itself. We do so in order to better understand the alliance these groups have found with one another—and to consider some of its implications as the Maker Movement continues to find resonance in education policy, pedagogy, and practice. In discussing "the Maker Movement," we limit our attention to Maker Media, Inc. and its associated figures, publications, and activities rather than all informal, grassroots activities that might be included under the umbrella of *making*. We do so not because the latter is less important, but because of the substantive role the former has already played in shaping the discourse of

making in education. While the stated pedagogical aims of Maker Media Inc. are ostensibly consistent with those of other educational stakeholders, we argue that they are internally conflicted. Though the Maker Movement maintains rhetorical alignment with the "learning by doing" ethos of progressive education, it is equally committed to cultivating social mobility through independent entrepreneurship and nurturing STEM labor for global economic competition—three educational outcomes that are not easily reconciled with one another. In this way, even as *making* and education have been positioned as unproblematic allies in the effort to reform schools, we argue that, without critical inquiry on the part of teachers and researchers, the competing visions latent in each have potential to upend progress toward effective and equitable teaching and learning.

Making and Education

At the outset, it is worth stating directly: education is political. Beneath the activities, assignments, experiences, and assessments—it is a process of molding individuals, of producing certain kinds of human subjects (and, by extension, of not producing others). Media theorist and progressive educator Neil Postman (1970) once said,

> In the broadest sense, a political ideology is a conglomerate of systems for promoting certain modes of thinking and behavior. And there is no system that more directly tries to do this than schools. There is not one thing that is done to, for, with, or against a student in school that is not rooted in a political ideology, bias, or notion. (p. 244)

As such, while it is common to think about education as a matter of what a student ought to *know*, the practice of education is often rooted in unstated assumptions about what a student ought to *be*. Schools are not only concerned with instilling knowledge, but also with cultivating practices, dispositions, and ways of being. This phenomenon has been explored by a range of social theorists. Foucault (1977), for example, delineates the disciplinary techniques used in school contexts to produce desirable forms of obedience and docility. Bourdieu (1990), likewise, examines how these mechanisms contribute to the creation, sustenance, and reproduction of class identities and structures of inequality. With this in mind, the recent resonance of *making* among educators raises important questions for those who study and participate in the movement: What kinds of subjects does *making* aim to produce? And for what purpose? In the section that follows we explore this first question in the context of education—analyzing how Maker Media,

Inc., the commercial arm of the Maker Movement, positions *making* not as learned content or skills, but as a learned "ethos." We then turn to the second question, examining the different ways this ethos is put to work for diverse educational stakeholders.

Making as "Ethos"

To understand the kinds of student subjects that *making* is intended to produce, it is necessary to attend to the vocabulary of the movement itself. As David Lang, author of Maker Media, Inc.'s *Zero to Maker* (2013) says, "Learning the *maker* lingo is as important to understanding the *maker* culture as speaking Spanish is to understanding Mexico" (p. 22). For those unaccustomed to the lexicon of *making,* one of its most striking idiosyncrasies is its tendency to ascribe uncommon meanings to common words. Most notable among these is the term "make" itself. In common usage, "making" is a transitive verb, paired with a particular object that receives the verb's action—for instance, a chef can make *dinner,* or a carpenter can make *a birdhouse.* However, Lang (2013) defines the term as the process of "creating or exploring new possibilities through building and experimenting with tools, technology, and materials" (p. 22). In such a framing, "making" becomes intransitive—and the object being made is subordinated to "making" as a standalone *process.* In other words, *making* becomes less an act of creation and more of a stance, or "ethos."

A similar subordination occurs in the use of "learning"—which, like "making," also commonly takes a transitive form, emphasizing some particular skill, practice, or subject-area that is being grasped or mastered. However, in the literature of the movement, this too becomes intransitive—characterized, once again, as a non-specific process by which cognition and personal growth occur irrespective of the content or activity involved. Dale Dougherty, the founder of Maker Media Inc. and the first to coin the phrase "Maker Movement," anticipates the skepticism such a vague definition might elicit from educators. In his forward to Curt Gabrielson's *Tinkering: Kids Learn by Making Stuff* (2013), he raises the hypothetical question, "But what is actually being *learned*?" then offers his response:

> [Students] are learning something and it may be the most valuable thing they've learned all week, and it may raise all sorts of questions in their minds that inspire them to learn more about what they're tinkering with, and it may start them on a path to a satisfying career, not to mention good fun on their own time, and it may put them in the driver's seat of their education by realizing their competence and ability to learn through tinkering, and they may begin to demand more of just this sort of learning opportunity. (p. xii)

In other words, the substance that is learned through *making* is not disciplinary content or skills, so much as it is an orientation: the *maker ethos.* AnnMarie Thomas, co-founder of Maker Media Inc.'s education initiative, reinforces this when she outlines the traits, values, and practices she sees as most necessary in formal and informal learning environments: curiosity, playfulness, willingness to take risks, persistence, collaboration, and optimism (2014, p. 5). Together, these traits constitute a model disposition toward learning that Dougherty (2013) refers to as "the maker mindset"—a phrase that has found traction among educators and researchers who are, likewise, interested in fostering creative impulses toward design, play, and innovation among students (e.g. Honey & Kanter, 2013).

As this "maker mindset" and the attendant terminology of *making* are taken up in discussions of teaching and learning, it is worth emphasizing that this perspective—one that situates learning as an orientation rather than the absorbing of discrete facts and figures—has a longer history in the field of education. While Maker Media publications play up the subversiveness of the "maker ethos" as a foil to the mindlessness of discipline-specific, teacher-centered instruction in traditional schools, calls for similar orientations abound. From "computational thinking" (Papert, 1980, 1996) and the "scientific mindset" (Kalman & Aulls, 2003) to the ethos of "new literacies" that animates youth practices in emerging digital environments (Lankshear & Knobel, 2009)—each of these recognizes learning as a social process rooted in action, and by extension, sees education as a means of cultivating orientations that allow students to effectively navigate this process. Importantly, each of these "mindsets" bolster their respective claims by situating themselves in the larger historiography of "progressive education"—a pedagogical approach popularized by John Dewey that foregrounds the experience of the learner over the content being learned. With this in mind, we can begin to see the Maker Movement not as representing a hygienic break from the education of the past, but as an outgrowth and extension of experiential learning and progressive reform.

All of this speaks to the political ideology of the Maker Movement in education and the work it does to shape particular kinds of student subjects. Positioning "making" and "learning" as orientations rather than activities linked to specific content illuminates the constellation of qualities that the movement aims to produce in an ideal *maker*: creativity, spontaneity, curiosity, resourcefulness. Further, *makers* are to be self-motivated in following their desires and interests, and flexible in navigating the structural, organizational, and logistical challenges that might stand in their way. The irony, of course, is that while the literature of the movement positions these traits as

subversive, there are few (if any) educational stakeholders who would object to students exhibiting such qualities. Indeed, even some of the most rigid federal reforms of the post-war era were couched in language that foregrounded similar dispositions (Rudolph, 2002; Urban, 2010). The "subversiveness" of *making*, then, appears to be less about the tangible consequences it yields for education reform, than it is about the discursive work that it does when juxtaposed with the popular image of schooling as joyless, routinized, and teacher-centered. Whether these descriptors are accurate representations of how most classrooms operate is beside the point—it is a narrative that people believe, and as a result, helps fuel the need for the counterweight of "progressive" reforms, of which *making* is the latest iteration (cf. Labaree, 2004). With that said, the continuity between *making* and earlier iterations of progressive reform does not mean there are no important differences in the ways these alternatives position students or theorize schooling. In the section that follows we examine how different educational stakeholders leverage this *making* ethos for diverse, and at times, conflicting purposes.

Aims of Education in the Maker Movement

While it is clear there is an overlap in the language and aims of the Maker Movement and certain historical progressive reform efforts, it remains to be see why the ethos of *making* has found the resonance it has across educational stakeholders, including those not typically aligned ideologically. Throughout the United States, researchers, policy makers, principals, and teachers have called for maker-based programs and initiatives in both formal and informal learning contexts—from library makerspaces and after school programs (Vossoughi, Hooper, & Escudé, 2016) to school curricula explicitly designed around principles of *making* (Stornaiuolo & Nichols, 2018). A major reason for this broad appeal, we argue, is that the concept of *making* is malleable—able to be leveraged, at different times and by different actors, to fulfill a plurality of competing goals that hold weight in the current political, economic, and cultural landscape. In what follows, we elaborate on three such goals: experiential education, STEM learning, and individual entrepreneurship.

Experiential Education

As we have already suggested, the assumptions underpinning *making* in education are not entirely novel—but rather, an extension of earlier pedagogical modes that stress the importance of "learning by doing" (cf. Blikstein, 2013; Martinez & Stager, 2013). Such approaches are often referred to as progressive, or experiential education. As the name suggests, experiential education

emphasizes the experience of the student as the principal driver and motivator of teaching and learning. Its proponents argue that learning has value for its own sake—not just to the degree that it can be used for some larger instrumental outcome—and they often foreground tactile and material encounters as opportunities to cultivate these learning experiences.

While these methods were popularized in the work of John Dewey and the Progressive Education Society (Cremin, 1961)—their history in education reform stretches back even further. In the mid-19th century, for example, Edward Sheldon drew on the writings of Rousseau and Froebel to develop an instructional method he called "object teaching." This strategy aimed to put students in direct contact with material artifacts—wood, sugar, glass, leather—in order to help them learn about their properties and uses firsthand, through observation and experimentation (Kohlstedt, 2010). At the turn of the century, advocates of the Nature-Study Movement worked to expose students to hands-on, experiential inquiry through the building and maintenance of outdoor gardens (Armitage, 2009). In 1918, William Kilpatrick—a colleague of Dewey's at Teachers College, Columbia University—published his "Project Method," which argued that for learning to be "wholehearted and purposeful," it needed to connect students to real problems and activities (Schneider, 2014). In such models, we can see threads of the sort of experiential education that today's Maker Movement looks to cultivate.

While progressive, experiential education was, and remains, far from a monolith, Dewey's articulation—which has had the most decisive impact on education research and practice in the last century (e.g. Labaree, 2004)—combined these experiential traditions with emerging psychological and political theory. Using studies of cognitive development and evolutionary biology, he argued that students learn best when their curiosity is permitted to move them from the concrete and familiar to the abstract and foreign—thereby adding the weight and prestige of scientific discovery to "learning by doing" methods sometimes criticized for their lack of rigor (Cremin, 1961; Kohlstedt, 2010). This was the basis for his Laboratory School at the University of Chicago, which supplanted books and lectures with hands-on, problem-based activities (Egan, 2004). Importantly, Dewey also imagined a political valence to this work: progressive pedagogy was intended as a social process to develop in students a sense of civic virtue and a desire for democratic participation. For this reason, Dewey was critical of those who used schooling or the name of "progressive education" to advocate for narrow, utilitarian aims like job preparation. Such approaches, according to Dewey (1916), not only reduced education to an extension of the "industrial regime," but also "perpetuated social divisions with their counterpart

intellectual and moral dualisms" (p. 329). In other words, for Dewey, a truly progressive pedagogy marshaled experience in service of communal inquiry, and eschewed instrumental ends that sort children into stratified vocational categories.

Though the Progressive Education Association folded in the late 1950s, Dewey's politically-infused approach to experiential learning continued to enjoy favor among certain educational stakeholders. Notable among these were the scholars, teachers, and activists whose work extended the counter-cultural critiques of the 1960s and 1970s to the sphere of school reform: Paul Goodman, John Holt, Neil Postman, Herb Kohl, and Ivan Illich, among others. Goodman (1966, for example, argued against compulsory educa-tion, in part, because he believed its institutional structure could not sus-tain the open-endedness that a true student-centered, "learning by doing" pedagogical method required. Postman and his collaborator Charles Weing-artner (1969), likewise, suggested that such modes of experiential learning might necessitate a utopian re-imagining of school spaces entirely—offering the hypothetical of a school with no formal building or classes, but rather, a community support network that would allow students to explore their curi-osities and learn about civic-engagement in real-world environments. Such viewpoints reinforced Dewey's contrast between experiential pedagogies tied to democratic participation and those tied to more utilitarian outcomes.

While it would be anachronistic to suggest that these 19th and 20th cen-tury iterations of material-based "learning by doing" were direct examples of *making*, or even proto-*making*, this is the genealogy that Maker Media publications frequently invoke to contextualize and justify the proliferation of *making* in education reform and practice. AnnMarie Thomas (2014), makes this connection when she writes,

> The Maker Movement, and the self-identified makers who are at the heart of it, are celebrating many of the qualities and actions that educators have long been trying to promote: lifelong learning, self-directed learning, communication, col-laboration, creativity, and design. (2014, p. x)

Others in the movement make more explicit links to this history of experi-ential pedagogy. Most Maker Media book publications, for example, include a chapter on the origins of *making* that maps its development onto the lin-eage of progressive pedagogy—usually starting with John Dewey, extending through Goodman, Postman, and the "radical romantic" reformers of 1960s and 1970s, and culminating in the work of computer scientist Seymour Pap-ert, who is often fashioned as "the godfather of *making*" (e.g. Gabrielson, 2013; Martinez & Stager, 2013).

Researchers, likewise, have explored the intersection of *making* and the history of experiential learning. In his book, *Making is Connecting* (2011), media scholar David Gauntlett devotes an entire chapter to elucidating the ties between the modern-day Maker Movement and the work of anarchist philosopher and educational theorist, Ivan Illich. Gauntlett interprets the core of Illich's best-known educational works, *Deschooling Society* (1970) and *Tools for Conviviality* (1973) as centering on the distinction between the pro-cesses of "schooling"—that is, "conformity to rules and memorization of a set body of knowledge without necessarily learning or understanding"—and a true education, which is driven by the impulses of experiential, "learning by doing" (Gauntlett, 2011, p. 168). Gauntlett argues that *making* is an exten-sion of this latter category—a "humanizing" activity that allows individuals to express themselves in "authentic" ways that are not normally sanctioned by industrialized environments, like schools. Similar beliefs—and connections to Illich's work—are echoed throughout the literature of Maker Media, Inc. (e.g. Lang, 2013; Thomas, 2014). Even the slogan for the company's educa-tion initiative—"Every Child a Maker"—suggests that there is an inherently human value in *making* that necessitates that it be developed in every stu-dent. By invoking this history of progressive, experiential education, then, the Maker Movement aligns itself with this larger tradition that aims to produce students who see learning as something valuable for its own sake, tied to dem-ocratic engagement, and distinct from any larger utilitarian outcome.

STEM-based Learning

In addition to experiential learning, many within the Maker Movement high-light the capacity of *making* to aid in the instruction of particular disciplinary content—especially forms associated with science, technology, engineering, and mathematics (STEM). In some respects, this pairing follows logically: *making* activities are well-aligned with STEM education as both increasingly foreground the use of emerging digital and physical prototyping technolo-gies, such as 3D-printers, microcontrollers, and laser cutters. Because of this explicit and visible link, many of the practitioners and researchers who cele-brate the promise of the Maker Movement for education reform are those whose work already sits at the intersection of STEM and education—research-ers in the learning sciences, for example, or those who train pre-service and practicing PK-12 STEM teachers.

But the connection between STEM and *making* is not limited to univer-sity research and classrooms, it also circulates in broader policy discussions—especially as philanthropic and federal initiatives continue to seek education reforms that might stimulate national growth in STEM enterprise (cf. Honey &

Kanter, 2013). Of course, this is not a new phenomenon: there is a long history of post-war and Cold War policies that configure science and technology curricula and instruction for the purpose of bolstering labor in STEM sectors—perhaps most famously in the National Defense Education Act of 1958 (Cohen-Cole, 2014; Phillips, 2015; Rudolph, 2002; Urban, 2010). But initiatives with similar goals have continued to flourish in subsequent decades—from the emphasis on rigorous content standards and the growth of standardized testing in the 1990s (Atkin & Black, 2003) to the more recent publication of the National Research Council's (2012) *Framework for K-12 Science Education.*

Importantly, these efforts to reform and expand STEM education are not only concerned with improving the quality of disciplinary content and instruction, they are often framed in terms that align such reforms with the future of the nation itself—in particular, its competitiveness in the global market. For example, Thomas Kalil (2013), the Deputy Director for Technology and Innovation in the Obama administration, has written about the potential for *making* to not only improve students' learning, but to promote the "economic well-being" of the United States by training up future STEM workers. He argues that the *makers* produced through such reforms will not only help to address the "grand [science and technology] challenges of the 21st century"—such as the decline of fossil fuels and the proliferation of cancer rates—but will also help increase the potential for technological innovations that create new industries and jobs and, by extension, promote national economic growth (pp. 13–15).

Perhaps because of how persistent this alignment of education reform, STEM development, and national competition has been, many of those within the Maker Movement have staked its promise on its ability to generate student interest in STEM careers. Not only is this delineated among the chief goals of Maker Media Inc.'s education initiative (Thomas, 2014), but the company has very publicly aligned itself with government programs designed to build and reinforce pipelines between formal and informal education and STEM industries. These include the Defense Advanced Research Projects Agency's (DARPA) Manufacturing Experimentation and Outreach (MENTOR) and AmeriCorp's Maker VISTA programs, which bring *making* to high school students in urban and rural districts for the purpose of training a more robust and diversified national STEM workforce (Kalil, 2013).

Even those *maker* activities that are not explicitly related to science or technology—designing, playing, and tinkering, for example—are often framed in the movement's literature as a means to increased engagement with STEM disciplines. Bennett and Monahan (2013), for example, argue,

> Design is not necessarily an efficient way to teach specific STEM content. It is, however, a powerful way to kindle a desire to learn that content … At the heart of every good design problem is the opportunity to bump up against rich STEM content. (p. 36)

Thomas (2014), likewise, argues that "the Maker Movement presents real opportunities for increasing technical literacy and reintroducing people to the arts of *making* and tinkering" at a time of "increased emphasis on STEM in PK-12 curriculum" (p. x). In this way, even as advocates of *making* highlight its potential for undirected, experimental play, this ethos is often justified by highlighting its capacity to lead students toward more directed engagement with STEM activities. In *Design, Make, Play: Growing the Next Generation of STEM Innovators* (2013), editors Honey and Kanter argue that "presenting science as a creative, hands-on, and passionate endeavor" can "enable young people to fall in love with science and technology" (p. 2). Kalil's (2013) contribute to the same book even suggests that "companies concerned about the lack of students with strong STEM and manufacturing" should "support makerspaces in schools and afterschool programs" so that "more students will become excited about excelling in STEM subjects and pursuing STEM-related fields" (p. 15). As such, even when it is not explicitly focused on STEM content, *making* as an educational activity can be seen to support the larger project of STEM education, and its associated goal of nation-building through the maintenance and development of STEM industries.

Entrepreneurship

While not as prominent as the emphasis on experiential learning or STEM development, there is a third undercurrent in the literature of the Maker Movement that foregrounds individual entrepreneurship and social mobility as an educational end. Chris Anderson, the former editor of *Wired Magazine*, highlights this promise in his book, *Makers: The New Industrial Revolution* (2012). Anderson's argument, as his sub-title suggests, is that *making* signals a new form of business enterprise, and that "the industrialization of the Maker Movement" will lead away from traditional mass-manufacturing models and toward an emergent model he terms "personal manufacturing" (p. 41). This theory runs through the Maker Media, Inc. literature as well. David Lang (2013), co-founder of OpenROV—a *maker* community focused on underwater robotics—builds on Anderson's idea, saying, "In the new maker economy, a makerspace membership is the new entry-level job" (p. 155). Elsewhere, he elaborates:

> Large corporations are watching this [*making*] trend, too, and making big bets that this new form of distributive, small-batch manufacturing takes hold … In a

time when job and career uncertainty are at an all-time high, it's refreshing to see a budding industry ... with so much potential. (p. 14)

In accounts like these, *making* is positioned as an inoculation against a changing industrial economy—one that positions individuals to "move up" and take advantage of this volatile landscape of production for personal financial gain. This idea is further reinforced in Maker Media Inc. book publications, where the final chapters are often devoted to strategies for taking products to market and building a consumer base (e.g. Kemp, 2013; Lang, 2013). Similarly, the link between *making* and manufacturing can also be seen in the expansion of commercially-focused makerspaces that have spread through United States cities in recent years. Many of these explicitly identify their role not in terms of STEM training or experiential learning, but rather, as support systems to develop start-up businesses (e.g. NextFab in Philadelphia or the Staten Island Makerspace), or as idea incubators for local industry (e.g. the GJMakerspace in Grand Junction, CO).

Importantly, the alignment of *making* and personal manufacturing also extends to the ways the Maker Movement literature discusses education reform. Kalil (2013), for example, links market innovation with *making* in schools. He writes, "Makers are becoming entrepreneurs, leading the development of industrial robots, 3D printers, and smart devices that integrate hardware, software, sensors, and Internet connectivity," and as such, he argues that by engrafting *making* into the curriculum and practice of classrooms, "more students will be empowered not just to get a job, but to create the industries and jobs of the future" (pp. 14–15). In this way, the aims of *making* as expressed in the movement's literature are not only concerned with developing a skilled workforce that can join already-existing modes of economic growth, but also with producing neoliberal subjects capable of creating their own economic opportunities in the national and global marketplace.

Internal Conflicts

In parsing these three threads in the literature of the Maker Movement—experiential learning, STEM development, and personal entrepreneurship—we can see how some of their competing impulses might have implications as *making* is integrated into education research, policy, and pedagogy. While the stated aim of the movement is the cultivation of students who embody "the maker mindset" (Dougherty, 2013), the vagueness of *making* in its intransitive form allows it to be taken up by diverse stakeholders in service of multiple contradictory purposes. We conclude by analyzing these inconsistencies in order to better understand their consequences when applied in educational contexts.

One of the clearest demonstrations of how movement's internal incongruities have been layered together and presented as a coherent educational vision is in Dougherty's (2012) own articulation of *making* education. In an article section titled "Expanding to education, business, government"—itself a testament to the ways these disparate institutions are tangled together in the literature—Dougherty begins by citing the influence of Deweyan progressive education on the movement, saying, "[Dewey] extolled the virtues of learning by doing, and contemporary science of the brain confirms the importance of tactical engagement and of using our hands in the learning process" (p. 12). He then transitions to discuss how the Maker Movement has gone about expanding this sort of experiential learning, detailing Maker Media Inc.'s partnership with DARPA to prepare "student populations that are not well-served" for future participation in STEM careers (p. 13). Dougherty then concludes with the story of a 14-year old who exhibited a product at a Maker Faire that was similar to a home-automation system that a large semiconductor company had spent millions of dollars developing. According to Dougherty, there were two morals to this story. First, that STEM-companies can benefit enormously by "embracing the Maker Movement"—in particular, by attending Maker Faires and providing STEM jobs to those students who inhabit the *maker* ethos. And second, that a 14-year old with these abilities "doesn't need a big manufacturing facility or lab anymore" in order to become a personal entrepreneur. In the span of just a few paragraphs, we can see all three of these differing purposes for education—experiential learning, STEM training, and personal entrepreneurship—layered together and presented as mutually supporting facets of *making* education.

Yet despite the surface-level coherence that Dougherty grants to these tangled purposes, there is danger in conflating their aims without recognizing the ways they are tied to conflicting tensions—not just in the Maker Movement, but in the larger history of education reform. According to sociologist David Labaree, there has always existed a fundamental ambivalence about whether American education "should be considered primarily a public good (one that is inclusive, providing shared societal benefits) or a private good (one that is exclusive, providing selective individual benefits)" (1997, p. 5). Labaree argues that the history of United States education has can be narrated as an effort to negotiate the contradictory pressures these impulses exert on schools, teachers, and students. Such a framing makes legible some ways that educational *making,* as articulated in the literature of the movement, is also braided together with these discordant aims. For example, while it may

appear that education for entrepreneurship and social mobility is compatible with education for developing a robust STEM workforce, the former is rooted in the idea of education as a private good, poised to improve the fortunes of individuals by equipping them to compete for jobs, credentials, and income. The latter, by contrast, is grounded in public concerns—albeit, utilitarian ones—for meeting demands of economic efficiency by filling the oft-feared "STEM worker shortage" in the United States (though, it is worth noting that some have questioned the legitimacy of such concerns—e.g. Charette, 2013; Fallace & Fantozzi, 2013; Freeman & Goroff, 2009). Further, both of these perspectives are at odds with the progressive educators so often referenced in the historiography of the movement. Dewey's (1916) insistence that the purpose of experiential pedagogy is not easily reconciled with concerns over industry and job training, for example, suggests an uneasy alignment of *making* with progressivism. Likewise, Ivan Illich—who Gauntlett (2011) cites as the inspiration for *making* culture—openly denounced the tendency for curricula and school reform to be reduced to economic ends—be it job preparation or personal financial security.

In this way, the literature of the Maker Movement brings together diverse and contradictory educational aims and packages them with an attendant vocabulary and set of practices that allow it to appear as a coherent and harmonious whole—one that can be leveraged to do different kinds of work for different stakeholders. For policymakers, *making* increases and diversifies the STEM workforce, even as it encourages personal economic mobility. For educators, it provides a way to align district and state mandates for rigorous STEM programming with the progressive pedagogical practices to which most teachers aspire (or, at least, claim to; cf. Labaree, 2004). And for researchers, it extends the philosophies of educational progressivism to new technological landscapes and, by extension, to the resources and financial supports that are often paired with STEM scholarship. The result is something eminently palatable to all stakeholders. Dougherty himself suggests this when he writes, "It is significant that [*making*] gets little resistance from superintendents and principals" (2012, p. 13)—this is, perhaps, because the concept is malleable enough to be, in a sense, all things to all people.

And yet, taken together, this diversity of aims—each catering to different stakeholders—also exerts contradictory demands on the teachers and students who are asked to carry out these ideals in the day-to-day work of the classroom. Teachers interested in integrating *making* in a school setting, for example, may do so differently if their understanding of the concept more closely aligns with STEM learning or personal entrepreneurship rather than experiential education. And of course, because these competing purposes are,

as Labaree (2012) suggests, embedded in the structure of systemic education itself, they are not easily untangled—and the momentum of the historical processes that braid them together prevents us from neatly dis-embedding one purpose from the others. This suggests the importance of reflexivity in research and teaching with regard to educational *making*. Such an approach promotes sustained critical inquiry into the different kinds of work that *making* is being asked to do when invited into school settings, and the ways its implementation reinforces and undermines the purposes for teaching and learning that may be most important to particular educators and students, schools and communities.

We believe an important step in this direction involves highlighting these internal contradictions—especially at a time when *making* programs are finding steady uptake in formal and informal educational contexts. With such a broad array of purposes—experiential learning, STEM development, and personal entrepreneurship—different stakeholders are, in effect, deploying the same terms and practices for dramatically different ends: to serve politics, markets, and individuals; to promote equity and to give certain people a competitive edge; to meet collective and personal needs. And crucially, as education historians have argued, there is a strong precedent for such tensions in the public and private aims of schooling to ultimately favor the latter (e.g. Katz, 1975; Labaree, 2012). Already, scholars across disciplines have warned that *making* could yield a similar outcome—especially considering the vast majority of those who currently participate in *maker*-based activities are white and from middle-class backgrounds (Bean & Rosner, 2014; Rose, 2014). Without a careful and intentional parsing of these conflicts then, *making* risks reproducing or reinforcing some of the same inequities that have persisted through (or been exacerbated by) previous educational movements, revolutions, and reforms. For this reason, we argue that it is necessary to not only remain vigilant in identifying the ideological conflicts between the public and private educational aims of *making*, but to actively work against the neoliberal impulses that may privilege certain aims—and by extension, certain individuals and communities—over others. Only then can the movement truly claim to live up to its ideal of making "every child a maker."

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