



What to “make” of school: revealing the conflicting institutional logics of grassroots making and formal education

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ABSTRACT

This article explores the experiences and opinions of young makers and their parents regarding the integration of maker technologies, activities, and spaces into their schools. By utilizing institutional logic theory as an analytical lens, conflicts between the values, goals, and norms of making and schooling were revealed. The findings suggest that participants view engagement with making as peripheral to, or incommensurate with, the core institutional logic of formal education. While participants showed interest in formalizing maker education, they generally concluded that making could not, and perhaps should not, be integral to school. The authors believe that the findings will help educators address these conflicts and create more sustainable, integrated, and authentic maker-based programs.

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Introduction

The maker movement has significantly influenced efforts to reform K-12 and higher education, largely by encouraging substantial investment in new technologies, learning spaces, and curricula (Gershensfeld, 2012; Honey & Kanter, 2013; Kim et al., 2018; Martinez & Stager, 2013). These efforts have been bolstered by research on teaching and learning, in addition to a renewed interest in integrating technical skills training into schools. Yet, what started within online forums and informal community workshops is now being adopted by schools, universities, libraries, and museums. Teachers and administrators who advocate for making may have little, if any, connection with the grassroots communities or understand the experiences of the school-aged young people who participate in them. This should be concerning for two reasons: First, valuable social practices and attitudes unique to making may get reduced or eliminated in the process of “translation.” Second, without those elements, maker education could be recast as yet another wave of educational technology, positioning it to be part of a tradition of highly touted, yet short-lived school reforms (Bean & Rosner, 2014).

Thus, the purpose of this qualitative study was to restore the perspectives of grassroots makers to the conversation around maker education, specifically focusing on the young adults situated at the intersection of schooling and making. We investigated the ways in which young makers and their parents experience and perceive the integration of maker activities, clubs, and curricula into their schools. Using the theoretical lens of institutionalism (Meyer & Rowan, 2006), we analyzed how their experiences, opinions, and beliefs illustrate deep conflicts between the institutional logics of making and schooling. With these findings, we hope to help redirect the efforts of maker

educators away from top-down, technology-focused strategies for school reform that have failed to create lasting institutional change and toward a more sustainable maker education model.

Literature review

The birth of the maker movement and maker education

The modern social phenomenon known as the maker movement can be traced back to the Do-It-Yourself (DIY) and hacker subcultures of the mid-to-late 20th century (Dougherty, 2012; Gershenfeld, 2012). In the 1990s and early 2000s, the arrival of consumer-grade digital fabrication tools and the information-sharing capabilities of the internet gave rise to passionate communities of amateur inventors, artists, designers, and scientists. Notable among their cultural impacts has been the establishment of shared-use workshops, often called makerspaces, in which people are encouraged to collaborate, share technical skills and knowledge pertaining to specific tools and software, and create new artifacts (Lou & Peek, 2016; Sheridan et al., 2014). By 2013, the maker movement had garnered interest from politicians and policymakers, who saw the movement as a pathway for economic revitalization via the development of high-tech manufacturing jobs (Rainwater, 2016; van Holm, 2017) and sought to import maker practices into governmental and educational organizations. Support has also reached the national level in the United States with the first White House Maker Faires (Kalil, 2015), the National Science Foundation soliciting proposals that utilize maker language (e.g., NSF Dear Colleague Letter: Enabling the Future of Making to Catalyze New Approaches in STEM Learning and Innovation), and the Smithsonian Institution even opening a youth-oriented makerspace in the National Museum of American History (Smithsonian Lemelson Center, 2018).

A host of social trends created favorable conditions for educational organizations to adopt maker-based programs. As the maker movement gained momentum, policymakers were placing increased emphasis on developing students' Science, Technology, Engineering, and Mathematics (STEM) skills and knowledge (Committee on STEM Education, 2018; National Research Council, 2012; National Research Council, 2013), which maker education proponents see as strongly linked to making practices (Honey & Kanter, 2013; Martinez & Stager, 2013). Many of these educators also argued that making is supported by a long history of learning sciences research that emphasizes hands-on, constructivist learning methodologies (Blikstein, 2013; Martinez & Stager, 2013; Papert, 1980). Finally, young makers have generated excitement by creating impressive inventions (Dixit, 2016; Goodbody, 2019) using technology to solve real-world problems, gaining deep technical knowledge, and displaying persistence and passion for accomplishing challenging tasks (Wigner et al., 2016).

The convergence of these factors have led schools, museums, libraries, nonprofit organizations, and universities to host teacher training workshops and conferences (Anzivino & Wilkinson, 2016; Maker Ed, n.d.), publish reports (American Society for Engineering Education, 2016; Kim et al., 2018), and even establish teacher certification programs (Sonoma State University, 2017) around maker education. Despite all of this activity, there is evidence that decision-makers and funders are more focused on leveraging maker technologies to increase engagement in STEM disciplines (American Society for Engineering Education, 2017; Quinn & Bell, 2013; Vossoughi et al., 2016) or taking part in a fashionable ed-tech trend (Bean & Rosner, 2014; Fyfe, 2018) than supporting the development of authentic maker cultures. Combined with the general pressures to align any curricular programs with existing standards and structures of school, it seems that maker education could diverge from the organic, social, and passion-driven elements found in grassroots making communities (Harackiewicz et al., 2016; Mathewson, 2019).

In order to prevent this drift, we need to understand the historical context and institutional forces that are changing maker education. This analysis requires a look at how the fundamental structures of schooling have persisted despite continual attempts at reform. As we will see,

elements of maker education closely fit the mold of technology-driven reform, which has a long history of achieving flashy, but short-lived change (Cuban, 2001; Papert, 1993; Winner, 2009). Then, we turn our attention to the central factor that sets maker education apart from other reform efforts: a sizeable population of young adults voluntarily engaging in many of the activities that educators hope to institutionalize in schools.

Technology-driven school reform through the lens of institutionalism

For decades, publishers, conference organizers, and academic journals have provided a constant supply of new textbooks, leadership programs, classroom management techniques, and learning strategies aimed at improving formal education (Rowan, 2006). Despite these efforts, it is far more often the case that schools change reforms, as opposed to the reverse (Tyack & Cuban, 1995). During this time, the demand for systemic change has come from a deluge of critical research, calls for reform from politicians of all ideologies, as well as the multiple generations of uninspired students. Given all of this, why have the structures, systems, and goals of school remained largely unchanged for the past 120 years (Wagner & Dintersmith, 2016)? An institutional perspective on schooling provides the beginnings of an answer.

Institutions are notoriously hard-to-define structures that have been a long-standing subject of discussion within the social sciences (Powell & DiMaggio, 1991). Despite a myriad of competing interpretations, most organizational theorists agree that institutions are persistent, stabilizing, and normative patterns of thought and behavior that are so deeply embedded in society that they go largely unnoticed or unquestioned (Jepperson, 1991; Meyer & Rowan, 1977; Selznick, 1996). Institutional theory arose in the mid-20th century as an explanation for the emergence of activities within organizations that were not directly related to its essential goals (Selznick, 1996). Later scholars reconceptualized institutions as wide-reaching entities that exist outside of organizations and act to align and reinforce structures and practices among similar organizations (DiMaggio & Powell, 1983; Lawrence et al., 2011; Selznick, 1996).

A signature characteristic of institutions is their resistance to change; in the context of school, technology-centered education reforms are an ideal example of this characteristic. Despite the introduction of many new, highly touted technologies into schools over the last century, there has been little proof of substantial improvement to learning or change in school functioning (Cuban, 2013; Tyack & Cuban, 1995). Winner (2009) refers to the repeated introduction of new technologies into schools and their subsequent failure to deliver much-prophesized transformative change as cycles of “educational amnesia.” He argues that, ever since Edison’s idea to bring “moving pictures” into the classroom, “technical systems have often been heralded as wellsprings of a marvelous ‘revolution’ that would change the basic processes of education,” despite any evidence that they improve learning outcomes (Winner, 2009). Even noted learning sciences scholar Seymour Papert, who believed that computers would dramatically reshape institutionalized education, fell prey to the cycle:

In the early 1980s... it made more sense to put the computers together in one room – misleadingly named a “computer lab” – so that all the children could come together and study computers for an hour a week... Thus, instead of cutting across and so challenging the very idea of subject boundaries, the computer was now defined as a new subject; instead of changing the emphasis from impersonal curriculum to excited live exploration by students, the computer was now used to reinforce standard hierarchical thinking... The development of computer labs seems to me a kind of immune response by School to a foreign body; the logic of the process was to bring the intruder back into line with School’s ways (Papert, 1993).

From the fixation on establishing school makerspaces to the development of maker curricula, the story of maker education already has strong parallels to the introduction of computers in schools. By mandating alignment to existing content, standards, and pedagogies, schooling can legitimize new technologies while also neutralizing any threats the social dimensions of making may pose to the current order.

Young makers: at the intersection of institutions

Although the challenge facing maker education now is like that faced by computers a generation ago (Papert, 1980; Resnick, 2012), there are important differences. Unlike past reform efforts, maker education derives from a set of learning-oriented practices that are being enacted in grass-roots communities, many of which include young adults. While those practices often embrace new technologies, they also implicitly challenge many institutions of schooling, including the educator–learner relationship, the nature of assessment, and the legitimacy of peer collaboration. Since maker education derives from an organic social movement, it can claim its own set of institutional elements (though they are far less widespread or socially embedded).

One of the more recent advances within institutional theory suggests that institutions constitute implicit “logics” which guide people’s actions, interactions, awareness, and judgments (Greenwood et al., 2009). Individuals are often subject to multiple institutions simultaneously. When these institutions dictate significantly different evaluations or decisions regarding the same phenomenon, the resulting conflict can reveal their underlying logics. Given their engagement in both schooling and making, young makers and their parents have a rare perspective on both institutions; as such, a better understanding of their experiences and opinions may help educators create more authentic, enduring, and meaningful maker education programs.

Methods

The following questions guided the design of the study and analysis of the data:

- RQ1. What kinds of experiences have young makers had with making in school?
- RQ2. How do young makers and their parents view the integration of making into school?
- RQ3. What challenges for institutionalizing maker education do these experiences and opinions reveal?

Research design

The purpose of this study was to make sense out of the participants’ experiences and opinions of making in school and then interpret these perspectives through the lens of institutionalism. As such, we employed a qualitative approach in order to give voice to participants and identify meaningful overarching themes from their experiences (Creswell, 2015). This research project was an extension of previous work focused on identifying young makers’ educational pathways and their potential intersections with engineering education (Wigner et al., 2016) and utilized data collected through the National Science Foundation grant entitled ‘Might Young makers be the Engineers of the Future?’ (EEC-1329321).

Participants and limitations

All demographic data was given on a prescreening questionnaire and, as such, was based on participant self-identification. The 27 participants of this study varied significantly in age, ethnicity, and gender (see Table 1). While there is undoubtedly more work to do in studying broader and more diverse populations of makers, there were inherent limitations for this study based on the venue in which data was collected. While we would not claim that the population is representative of all makers, the aim of this study was not external generalizability, but rather identification of patterns internal to the population that might illuminate larger trends or raise previously unconsidered issues.

Table 1. Distributions of young maker age (1), ethnicity (2), and gender (3). All demographic data was self-reported.

Young maker age ($n = 17$)	
8–9	6%
10–11	0%
12–13	18%
14–15	24%
16–18	47%
Ethnicity ($n = 27$)	
African	0%
Asian	11%
Hispanic	18%
Indian	19%
Jewish	11%
White	44%
Gender ($n = 27$)	
Male	54%
Female	46%
All demographic data was self-reported.	

Data collection

We gathered data from young makers and parents of young makers who participated in flagship Maker Faires in San Francisco and New York City from 2014 to 2016. Participants were initially asked to take part in a short in-person interview that focused on the artifacts they were showcasing at the festival. In order to maximize variation in the perspectives we captured, participant selection was guided by a purposeful sampling strategy (Patton, 2002) with intentional oversampling of underrepresented populations. Those who agreed to take part in this first interview were then invited to take part in a more in-depth interview that investigated the incidents that led them to identify as makers. The interview protocol used a modified critical incident approach (Flanagan, 1954; Klein et al., 1989) that focused on asking participants about key moments and factors that influenced their thoughts and actions. These critical incident interviews served as the base dataset for this study (see [Appendix](#) for list of questions that were central to the study and their alignment to the research questions).

Interviews were conducted either by phone or with video conference computer software and typically lasted from 45 to 60 minutes. Participants over the age of 18 provided consent, and participants under the age of 18 provided assent as their parents or guardians provided assent. Data was recorded via electronic audio recording devices and transcribed. Pseudonyms were then assigned to all participants using an online name generator. The study was conducted with approval from the Arizona State University IRB.

Data analysis

The data was analyzed by the primary author using a two-cycle coding scheme (Saldana, 2009) that employed both inductive and deductive methods (Boyatzis, 1998). The primary author open-coded all interview transcripts, allowing for codes to emerge organically from the data. Researcher bias was accounted for by keeping careful memos of any theoretical sensitivities (Glaser, 1978) noticed during the coding process, which included learning sciences concepts, educational experiences, and the topic of maker identity (Weiner et al., 2017). The second and third authors provided periodic feedback on the development of the codes and themes, which were also captured via coded memos. In the first cycle, the focus was on making sense of the data

through code organization. Along with open coding, structural codes were also applied to group large passages of the transcripts that “relate[d] to a specific research question used to frame the interview” (Saldaña, 2009, p. 98). This technique was employed mostly for coding and then comparing excerpts that pertained to RQ2. During the first cycle coding, 246 unique text excerpts and 46 researcher memos were coded, resulting in 544 applications of 47 different codes. During second-cycle coding, these 47 first-round codes were collapsed and combined into seven major codes using a pattern coding process (Saldaña, 2009). Finally, the seven major codes were deductively analyzed through the lens of institutional logic theory, resulting in the development of four main themes.

Results

The following schema emerged for organizing the major codes and main thematic findings. In the first section, we describe the two major codes that classify the most common experiences that participants have had with making in school. The second section presents the five codes that emerged when analyzing participants’ views on integrating making into the school day. Last, we present four themes that resulted from assessing the major codes in light of institutional theory, looking specifically for what they tell us about the institutional logics of making and schooling.

Experiences with making in school

The following codes capture the main ways in which the participants currently engaged in making at school. It is important to point out that, for nearly all the young makers interviewed for this study, most making activities took place outside of school. In general, most took place with other family members or individually, some individuals citing video-streaming platforms like YouTube as their main source of maker knowledge. Several participants had access to community makerspaces, and, of course, all of them were able to attend Maker Faires. Therefore, any making that took place at school was usually complementary to these other outlets.

Major code 1: Extracurricular making

One of the more common ways young makers engaged in making was through school clubs, afterschool programs, and school-based summer camps. Participants *Diana*¹ and *James* both mentioned the importance that the First Robotics Competition played in their development as makers, while *Emma* and *Ella* participated in science clubs that encouraged hands-on experimentation. In the San Francisco Bay Area, there seemed to be more explicitly maker-oriented extracurricular making opportunities. *Hanna* talked at length about a program known as Rocket Science, which provided semi-structured maker challenges that ranged in complexity, from building simple robots to constructing a fully functional go-cart.

For many young maker participants, the content of these activities was not the focus of their responses. In some cases, participants were more interested in discussing how a teacher helped inspire or encourage their interest in making. Another point of focus for some young makers was their role in helping start maker activities in their school. Both observations indicate that, in the minds of young makers, the social elements of community-building and mentorship are closely tied to making.

Major code 2: Maker classes

A small number of participants indicated that making was already a significant element of their or their child’s formal education. *Aaron* was one of two young makers who talked about attending a high school which offered many interrelated maker-oriented classes. Even there, however, it

was not fully institutionalized: “I think it was freshman year they had digital culture class and you got to do a lot of building, just making, it was fun. After that ... something happened. They discontinued it.”

Thoughts on integrating making into the school day

The question “Should making be a part of the school day and if so how?” appeared simple on the surface, but participant responses revealed significant complexity and contradiction. Initial coding structures yielded a “supporters-vs-detractors” scheme; this had to be reformulated several times, eventually leading to the separation of the binary (yes/no) responses from the participants’ further elaborations. Most participants (17) indicated clear support for making in school, with only four explicitly stating that they did not. The remaining responses were conflicted or suggested that there were mixed feelings about the issue.

Interestingly, these divisions were not strongly reflected in the participants’ explanations for their positions. In other words, participants who were “for” and those who were “against” often provided similar explanations or visions of making in school. One reason for this may be the ambiguity of question: what does it mean for “making to be a part of the school day”? As will be discussed further in the thematic findings, this ambiguity was useful in revealing deeply embedded conflicts in the institutional logic of making and schooling.

Major code 3: A separate space

The most common way participants saw making integrated into schools was through the creation of a distinct space on campus in which maker activities could occur. Participants often cited the lack of access to equipment, tools, and materials as being a major barrier to engaging in making: “I think [it] would be nice, because I can’t think of any space that you could just go to make things right now ...” (*Robert*)

Diana pointed out that having a space would not only be useful for engaging with tools and materials, but also with mentors that could help engage students who may not have been encouraged to make:

I think the best model for something like that would be in a maker space, hacker space, fab lab, whatever you want to call it. Just some place where there are a lot of resources, and tools, and mentors for students to create whatever idea they have, because I think that’s the biggest thing that discourages students, especially my age in high school, from pursuing things like this is they don’t have the resources and they don’t have the mentors ...

Blake hoped that his school would open something like a grassroots makerspace, which would not only provide access to the students at his school, but also to other children and adults in the community:

I would like them to maybe open up maybe a room where kids can come in after school or something. I would prefer if somehow possible that it was open to the community and ... get a card like a library card and just get materials or buy them there or use scraps and just building things. Maybe have a whole bunch of LCD blinkers for people to make to learn to solder, bunch of scrap wood for people to learn to drill, a bunch of random sized pieces of cardboard for people to learn to hot glue for grade school kids. Maybe a set of laptops with Scratch for younger kids to learn coding. I just would really love something along those lines. That’s probably my dream for something like this ...

While not all participants saw a makerspace as essential to integrating making into their school, it seemed to be one of the most fully imagined possibilities. The lack of detailed conceptions of maker education will be considered more thoroughly in the themes section.

Major code 4: A separate elective

Several participants also noted their interest in having classes offered at their schools that focused on making. *Ella* mentioned this several times throughout her interview; when asked directly, she replied emphatically: “Definitely. Yes please. Oh my God so much. I wish that was a class... I really wish there was a making class in school.” While the public school she attended did offer some classes that she saw as related to making, such as Computer-Aided Design (CAD) and robotics, they had mathematics prerequisite requirements which she did not meet. To *Ella*, a “true” maker class would be specifically for self-directed exploration and expression. As she put it, a maker class would be “like study hall but significantly better.” Yet, not all participants made the distinction. Both parents and young makers often talked about robotics, engineering, and other hands-on STEM-oriented electives synonymously with making.

Major code 5: Not integrated at all

Several participants were strongly against the idea that making should occur during formal class time. This view was held almost exclusively by young makers and not the parent participants. *Dylan* expressed a view shared by others when he said, “I don’t think it really needs to be part of the school day because not everyone’s interested in it but, like, I think it’s a good after school thing that you could work on your own time...” The opinion that personal interest is a central dimension of making and that it should not be forced upon anyone is notable, given the implicit message it sends about school.

Major code 6: Interdisciplinary/curricular integration

A small number of participants suggested that making could enhance existing classes and should be considered as a way of approaching a variety of disciplines. Responses in this category framed making as being more than just a set of technical skills or social practices, but instead conceived of more broadly as an approach to learning. *Madhav* put it succinctly: “In any kind of subject, making can ... explain things and to help people understand.” *Alyssa* also described making as applicable to a wide range of courses from history to mathematics, suggesting that “the effect of creation in education helps information stick more than just memorizing. Because you’re thinking... conceptually about things.”

Some parents also voiced support for interdisciplinary integration, such as *Sunil* who questioned the value of separating making from the rest of school: “I don’t know why there need to be separate makerspaces. They should have making part of the regular curriculum where they spend time on some project which is in a way helping them create hands on, applying that knowledge of their book in more hands-on way [sic].”

Major code 7: Complex and uncertain positions

While some participants had clear conceptions of how they would or would not like to see making integrated into school, many others expressed muddled ideas or conflicted sentiments about the question. *James* touched on a few issues, including the educational value of making and how it relates to traditional disciplines, eventually considering the possibility of interdisciplinary integration:

Some people say they’re not creative and stuff like that, but I think experimenting with your creativity is a very important part of development. Even making it a separate class, or a branch off engineering, or even if it’s what you do for one marking period of pre-engineering class... I like pre-engineering, but of course you still get assignments. You have to make a bridge or something like that... Even if you don’t physically make it, but if you’re given ... for example, the stock market, a million dollars to create a product or something like that.

Some young makers suggested that making should be integrated into school weekly, as opposed to daily. *Emma* voiced a common perspective about not forcing other students to engage

in making if they do not want to, though she tentatively considered how it could be used in some structured classes:

I'm not sure about school days but definitely sort of a school week ... there will always be some kids in any class that think "I hate this, it's not what I want to do," but I think that there will also be some kids who are really interested in it. Definitely having the opportunities to get involved in making. I think that all schools should have at least an afterschool option to do something like that and maybe include it in some other class's curriculum. It'd be great if some schools, or even most schools had a class option like once a week where you could be making, where you could make stuff and it could be structured or it could just be you could have a study hall where you could make something.

Even *Dylan*, who stated that making had no place in school, later qualified this position: "I think that making itself should be separate, but I think some concepts from making, such as the skills you get out of it, like researching some stuff, should be better taught in school."

Main themes

In order to make meaning from the data, institutional logic theory was utilized as a lens through which the major codes were analyzed. The emergent themes point to significant conflicts between the logics of making and schooling. While the existence of such divides may not be a surprise, participant responses highlighted how institutional logics unknowingly determine what elements of schooling can be challenged or questioned and what kinds of alternative educational models can be envisioned.

Theme 1: Imagining integrated maker education is difficult

Despite enthusiasm for bringing making into school, participant responses suggest that envisioning integrated maker education is difficult. Some evidence for this conclusion lies in the vague or conflicted answers participants gave when asked to specifically describe what institutionalized making would look like in practice (see the Code 7 section for several examples). One parent said that he "hadn't really thought about" how it would be implemented, despite being strongly supportive of interdisciplinary integration (*Max*, Parent). Another parent, *Lindsay*, deflected the central question and instead chose to talk more theoretically about the educational value of making:

I absolutely do [think making should be part of the school day]. I think it helps with critical thinking skills. Like, that's number one to me. It helps with just being allowed to experiment with things. Being allowed to be free with things and do what you personally want to do with them. Manipulating things in your own way, testing things out ... I think it's really important ... for life. I think it's the most important thing you can have in school, besides learning to read and do math.

While *Lindsay* indicates that making promotes the development of important abilities, like critical thinking, experimentation, and agency, she speaks about them vaguely with respect to school. Moreover, it is difficult to parse how *Lindsay* views the learning outcomes of making compared to those traditionally prioritized in school. The final sentence presents a dramatic example of institutional logic "flipping." Faced with the conflicting norms of two different institutions, *Lindsay* moves between them and avoids having to wrestle with any underlying incongruencies.

It could be argued that most of the participants' suggestions for integration do not constitute true institutionalization of making in school. Electives can easily be changed or eliminated, technology can be scrapped, and makerspaces can be refitted for other purposes. Recommendations for more systemic changes to course structures, grading systems, or degree requirements never emerged in the data. The limitations of the participants' visions illustrate just how deeply the logic of schooling is engrained in their imaginations.

Theme 2: Only the technical elements of making are valued in school

Throughout their interviews, respondents often mentioned the qualities of making that pointed to its educational value. The most frequently mentioned kinds of characteristics could be classified as “soft skills,” such as self-directed learning, resilience, persistence, creativity, experimentation, and critical thinking. Several parents also commented on how making helped develop a stronger sense of self-efficacy and agency through the completion of complex projects. At the same time, few participants saw the inclusion of these traits as currently – or even potentially – a focus of school. When the topic of maker classes was raised, most participants appealed to the ways that making intersected with STEM concepts and skills. The notion of a class that intentionally encompassed both the technical and social-emotion dimensions of making almost never came up.

Sunil said that one of the most valuable things about making was that it had “given [his son] confidence to take any project and run with it.” Yet, when asked how making could help his son in school, he said “[*Madhav*] knows a lot more about the electronics and science concepts, and that will help further when other kids are not learning the same way. Definitely it will help him get better scores.” This is another example of logic flipping between schooling and making (see quote from *Lindsay* in Theme 1), indicating that *Sunil* did not resolve institutional logic conflicts, perhaps because he did not see resolution as a possibility. The value of a formalized version of maker education *must* relate to the mastery of scientific concepts and success on standardized tests because other learning outcomes, like the development of self-confidence, creativity, or agency, are not legitimated by school.

Theme 3: Making is fun, personal, relaxing; schooling is obligatory and stressful

Many young makers argued that making should remain extracurricular since it is fundamentally rooted in personal interest. Participants saw the institution of schooling as having little to do with what they want to do or learn – and they accept this. *Dylan* said it clearly: “I understand why everything is there in school and it’s not really meant for you to appreciate all of it.”

Participants also suggested that making could not be integral to school because they did not want it to be imposed on other students who may not want to make things:

I would definitely love it if making was part of my everyday life, but I do understand that some people, making isn’t their thing or they’re not that kind of person. I don’t think anyone should be forced into it, but I think a lot of people would probably benefit from making ... (*Robert*)

Although institutions often represent constraint (DiMaggio & Powell, 1983), in this instance making is actually being excluded on principle because it is unconstrained. In other words, school is interpreted as specifically pertaining to activities that are mandatory for all students. This interpretation casts making as kind of an anti-institution, defined by personal interest and individual choice.

Relatedly, participants described making as a relief from high stakes testing and Advanced Placement (AP) course work. Words like “stressful,” “busy,” and “anxious” were used to categorize school, while making was frequently described as “relaxing.” *Blake* repeatedly referred to a student lounge as being a model for a possible makerspace on his campus: “... we have a lounge we’ve created for students because a lot of students were complaining about the extreme stress because it’s actually possible to take three or four AP courses during junior and senior years.”

On occasion, conflicting obligations between making and schooling caused additional stress. When opportunities to attend a robotics competition or the White House Maker Faire arose, *Diana* described school administrators as being extremely inflexible in excusing her absences. Additionally, the workload in her final years of the International Baccalaureate (IB) program was extreme, preventing her from participating in the robotics club that she enjoyed. *Anjali*, her mother, repeatedly mentioned that she was torn about keeping *Diana* in the school, but overall supported the decision. Interestingly, *Diana* was the only participant who suggested that making

could be compulsory: “I think making for a lot of people who aren’t necessarily naturally inclined, you have to motivate them. I think in terms of just the education system, a lot of that would be adding resources, adding mentors, or making a tech elective, like I said, a mandatory part of the diploma.”

Theme 4: Making should stay in a “bubble”

... for robotics, there’s the pre-engineering room, which is basically ... it’s the bubble from the rest of the school. That’s where we can be ourselves, we can build, we can have fun. (*James*)

The above quote succinctly captures the final theme of the study: many participants viewed making as something that should not be fully integrated into school, but instead remain as an element at the periphery. Rationale for such a position emerged in two ways. First, making currently has no legitimate place in schooling and it is hard to imagine how it would secure one. Second, formal integration would eliminate making’s central qualities of being enjoyable and learner driven. This harkens back to Papert’s analogy about the “body” of school protecting itself from the “foreign organism” of computers (Papert, 1993); however, in this case, the participants seem to think that a maker education “infection” might harm both the host and the invader.

Discussion

The experiences and opinions of young makers and their parents suggest that the gap between the institutional logics of grassroots making and schooling may be currently too great to bridge. One possible reason for these sentiments is that neither grassroots makers nor educators have confronted the conflicting elements of these institutions head-on. This is understandable since it is the nature of institutions to go unnoticed (Meyer & Rowan, 1977). Yet, a more explicit picture of the two logics might help educators appreciate the distance they need to traverse and provide some concrete guideposts for going from one to the other.

To that end, we submit the first iteration of a comparative assessment of the conflicting educational characteristics of making and schooling (see Table 2). This chart is by no means comprehensive and demands further elaboration and confirmation from future research. Yet, it may be a helpful initial step for keeping educators focused on the deeper issues at work when attempting

Table 2. A proposed comparative model of the characteristic institutional logics of making and schooling.

Conflicting institutional logics of making and schooling ^a		
	Making	Schooling
Learning goals	Self-determined, variable, unplanned	Externally determined, fixed, planned
Learning trajectories	Ad hoc, iterative, inquiry-driven	Thematic, linear, content-driven
Modes of evaluation	Internal (personal judgement), social (peer review), artifact function	External (expert judgement), standardized (testing), promotion to next level/unit
Objects of assessment	Working prototypes, projects, performances	Tests, problems, assignments, conduct
Motivational goals	Fun, expressing creativity, problem-solving	Attaining academic credit, legitimating further schooling
Types of knowledge gained	Practical, technical, socio-emotional	General, abstract, rational
Motivational affect	Curiosity, inspiration, desire to accomplish	Commitment, responsibility, fear of failure
Resulting affect	Relaxing, productive stress (eustress)	Anxiety-provoking, destructive stress (distress)
Default factors for content differentiation	Interest, proficiency based on application of related content	Age, proficiency based on educator/ test assessment
Role of educator	Facilitator, guide, partner	Distributor, expert, authority
Personal outcomes	Personal accomplishment, community service	Academic achievement, long-term success

This chart presents a synthesis derived from the findings of this study as well as theoretical and empirical literature on student experiences in school (Galloway et al., 2007; Pope, 2003; Sawyer, 2014; Tyack & Cuban, 1995).

to translate making into school. Teachers and administrators may be more empowered to leave behind the old “grammar of schooling” (Tyack & Cuban, 1995, p. 85) when it is easier to see how such grammar diverges from the language used in more authentic learning environments. This claim is modestly strengthened by the results of a recent pilot study, in which pre-service STEM teachers increased their usage of student-centered language when crafting a maker-oriented lesson plan (Weiner et al., 2020).

Conclusion

The findings of the study leave maker education efforts in a strange place. Over the last century, major social and technological changes have taken place in the areas of health care, finance, transportation, communication, and even government function. Yet, it has been said that a 19th-century teacher would have no problem operating in a 21st-century classroom (Dintersmith, 2018; Papert, 1993). Moreover, the importation of new technologies has repeatedly been hailed as a way to address a myriad of perceived ailments within the system and heralded as the incarnation of educational progress (Winner, 2009). As schools make investments in tools, materials, and spaces inspired by the maker movement, we’re poised to see history repeat itself.

Yet, the voices of young makers and their parents suggest a different route for reform, one that leverages the enthusiasm and passion of students, honors their interests, and allows them to have a say in their own education. If maker education is to fully capitalize on its roots in a social movement, then it will be critical for educators to integrate elements of community, agency, and exploration. Since these qualities of grassroots making conflict with the deeply engrained logics of schooling, teachers and administrators may be more inclined to adopt the 3D-printers and laser cutters, while leaving out the rest.

Note

1. Proper names are italicized to indicate that they are participant’s pseudonyms.

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References

- American Society for Engineering Education. (2016). Envisioning the future of the maker movement [Summit Report]. <https://www.asee.org/documents/papers-and-publications/papers/maker-summit-report.pdf>
- American Society for Engineering Education. (2017). *Advancing the maker movement: Making and makerspaces at engineering and engineering technology schools and departments and outside the engineering academic maker community*. <https://aeir.asee.org/advancing-the-maker-movement/>
- Anzivino, L., & Wilkinson, K. (2016). Libraries and tinkering spaces. *Young Adult Library Services*, 14(4), 20–23.
- Bean, J., & Rosner, D. (2014). Making: Movement or brand? *Interactions*, 21(1), 26–27. <https://doi.org/10.1145/2541669>
- Blikstein, P. (2013). Digital fabrication and "making" in education: The democratization of invention. In J. Walter-Herrmann & C. Büching (Eds.), *FabLab: Of machines, makers and inventors* (pp. 1–21). Transcript-Verlag.
- Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. Sage.
- Committee on STEM Education. (2018). *Charting a course for success: America's strategy for STEM education* (p. 48.). National Science & Technology Council. <https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf>.
- Creswell, J. W. (2015). *30 essential skills for the qualitative researcher*. SAGE Publications, Inc.
- Cuban, L. (2001). *Oversold and underused*. Harvard University Press.
- Cuban, L. (2013). *Inside the black box of classroom practice: Change without reform in American education*. Harvard Education Press.
- DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, 48(2), 147–160. <https://doi.org/10.2307/2095101>
- Dintersmith, T. (2018). *What school could be: Insights and inspiration from teachers across America*. Princeton University Press.
- Dixit, M. (2016, August 9). 5 fantastic inventions by kids under 17 that will blow your mind. *India Today*. <https://www.indiatoday.in/lifestyle/people/story/maker-faire-delhi-young-innovators-technology-science-robots-lifest-334155-2016-08-09>

- Dougherty, D. (2012). The Maker Movement. *Innovations: Technology, Governance, Globalization*, 7(3), 11–14. https://doi.org/10.1162/INOV_a_00135
- Flanagan, J. C. (1954). The critical incident technique. *Psychological Bulletin*, 51(4), 327–358. <https://doi.org/10.1037/h0061470>
- Fyfe, S. (2018, August 23). Makerspaces a growing trend, but will they deliver? *ECampus News*. <https://www.ecampusnews.com/2018/08/23/makerspaces-a-growing-trend-but-will-they-deliver/>
- Galloway, M., Pope, D., & Osberg, J. (2007). Stressed-out students-SOS: Youth perspectives on changing school climates. In D. Thiessen & A. Cook-Sather (Eds.), *International handbook of student experience in elementary and secondary school* (pp. 611–634). Springer. https://doi.org/10.1007/1-4020-3367-2_24
- Gershensfeld, N. (2012). How to make almost anything: The digital fabrication revolution. *Foreign Affairs*, 91(6), 43–57.
- Glaser, B. G. (1978). *Theoretical sensitivity: Advances in the methodology of grounded theory*. Sociology Press.
- Goodbody, W. (2019, May 5). Young coders showcasing inventions in Dublin. *Radio Television Ireland*. <https://www.rte.ie/news/2019/0505/1047594-coolest-projects/>
- Greenwood, R., Díaz, A. M., Li, S. X., & Lorente, J. C. (2009). The multiplicity of institutional logics and the heterogeneity of organizational responses. *Organization Science*, 21(2), 521–539. <https://doi.org/10.1287/orsc.1090.0453>
- Harackiewicz, J. M., Smith, J. L., & Priniski, S. J. (2016). Interest matters: The importance of promoting interest in education. *Policy Insights from the Behavioral and Brain Sciences*, 3(2), 220–227. <https://doi.org/10.1177/2372732216655542>
- Honey, M., & Kanter, D. (Eds.). (2013). *Design, make, play: Growing the next generation of STEM innovators*. Routledge.
- Jepperson, R. L. (1991). Institutions, institutional effects, and institutionalism. In W. Powell & P. DiMaggio (Eds.), *The new institutionalism in organizational analysis* (pp. 143–163). University of Chicago Press.
- Kalil, T. (2015, January 12). A new resource for bringing making into education. *Whitehouse.Gov*. <https://www.whitehouse.gov/blog/2015/01/12/new-resource-bringing-making-education>
- Kim, Y., Edouard, K., Alderfer, K., & Smith, B. K. (2018). *Making culture: A national study of education makerspaces*. Drexel University.
- Klein, G., Calderwood, R., & Macgregor, D. (1989). Critical decision method for eliciting knowledge. *IEEE Transactions on Systems, Man, and Cybernetics*, 19(3), 462–472. <https://doi.org/10.1109/21.31053>
- Lawrence, T., Suddaby, R., & Leca, B. (2011). Institutional work: Refocusing institutional studies of organization. *Journal of Management Inquiry*, 20(1), 52–58. <https://doi.org/10.1177/1056492610387222>
- Lou, N., Peek, K. (2016, February 23). By the numbers: The rise of the makerspace. *Popular Science*. <http://www.popsoci.com/rise-makerspace-by-numbers>
- Maker Ed. (n.d.). *About Maker Ed. Maker education initiative*. <http://makered.org/about-us/who-we-are/>
- Martinez, S. L., & Stager, G. S. (2013). *Invent to learn: Making, tinkering, and engineering in the classroom* (1st ed.). Constructing Modern Knowledge Press.
- Mathewson, T. G. (2019, March 27). *Intrinsic motivation is key to student achievement – But schools kill it. The Hechinger Report*. <https://hechingerreport.org/intrinsic-motivation-is-key-to-student-achievement-but-schools-kill-it/>
- Meyer, J. W., & Rowan, B. (1977). Institutionalized organizations: Formal structure as myth and ceremony. *American Journal of Sociology*, 83(2), 340–363. <https://doi.org/10.1086/226550>
- Meyer, H.-D., & Rowan, B. (2006). *New institutionalism in education*. State University of New York Press. <http://ebookcentral.proquest.com/lib/asulib-ebooks/detail.action?docID=3407448>
- National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas* (pp. 437–441). National Academies Press. <https://doi.org/10.17226/13165>
- National Research Council. (2013). Appendix I: Engineering design in the next generation science standards. In *Next generation science standards: For states, by states*. The National Academies Press. <https://doi.org/10.17226/18290>
- Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. Basic Books.
- Papert, S. (1993). The children's machine. *Technology Review*, 96(5), 28.
- Patton, M. Q. (2002). *Qualitative research and evaluation methods*. Sage Publications.
- Pope, D. C. (2003). *“Doing school”: How we are creating a generation of stressed-out, materialistic, and miseducated students*. Yale University Press.
- Powell, W. W., & DiMaggio, P. (1991). *The new institutionalism in organizational analysis*. University of Chicago Press.
- Quinn, H., & Bell, P. (2013). How designing, making, and playing relate to the learning goals of K-12 science education. In M. Honey & D. Kanter (Eds.), *Design, make, play: Growing the next generation of STEM innovators* (pp. 17–33). Routledge.
- Rainwater, B. (2016, March 8). How the Maker movement is revitalizing industry in American cities. *Fast company*. <https://www.fastcompany.com/3057349/how-the-maker-movement-is-revitalizing-industry-in-american-cities>

- Resnick, M. (2012, July 1). Reviving Papert's dream. *Educational Technology: The Magazine for Managers of Change in Education*, 52(4), 42–46. <https://www.media.mit.edu/publications/reviving-paperts-dream/>
- Rowan, B. (2006). The school improvement industry in the United States: Why educational change is both pervasive and ineffectual. In H.-D. Meyer & B. Rowan (Eds.), *New institutionalism in education* (pp. 67–85). State University of New York Press.
- Saldaña, J. (2009). *The coding manual for qualitative researchers*. Sage Publications.
- Sawyer, R. K. (Ed.). (2014). *The Cambridge handbook of the learning sciences* (2nd ed.). Cambridge University Press.
- Selznick, P. (1996). Institutionalism “Old” and “New.” *Administrative Science Quarterly*, 41(2), 270. <https://doi.org/10.2307/2393719>
- Sheridan, K., Halverson, E. R., Litts, B., Brahms, L., Jacobs-Priebe, L., & Owens, T. (2014). Learning in the making: A comparative case study of three makerspaces. *Harvard Educational Review*, 84(4), 505–531. <https://doi.org/10.17763/haer.84.4.brr34733723j648u>
- Smithsonian Lemelson Center. (2018, August 23). *About the Spark!Lab National Network*. Lemelson Center for the Study of Invention and Innovation. <http://invention.si.edu/about-sparklab-national-network>
- Sonoma State University. (2017, June 15). Expanding “Maker” programs. *SSU News*. <http://news.sonoma.edu/article/expanding-maker-programs>
- Tyack, D. B., & Cuban, L. (1995). *Tinkering toward Utopia*. Harvard University Press.
- van Holm, E. J. (2017). Makerspaces and local economic development. *Economic Development Quarterly*, 31(2), 164–173. <https://doi.org/10.1177/0891242417690604>
- Vossoughi, S., Hooper, P. K., & Escudé, M. (2016). Making through the lens of culture and power: Toward transformative visions for educational equity. *Harvard Educational Review*, 86(2), 206–232. <https://doi.org/10.17763/0017-8055.86.2.206>
- Wagner, T., & Dintersmith, T. (2016). *Most likely to succeed: Preparing our kids for the innovation era* (Reprint). Scribner.
- Weiner, S., Lande, M., Jordan, S. (2017). *Making identities: Understanding the factors that lead young adults to identify with the Maker Movement* [Paper presentation]. Proceedings of the American Society for Engineering Education (ASEE) Annual Conference & Exposition, Columbus, OH.
- Weiner, S., Lande, M., & Jordan, S. S. (2020). Designing (and) making teachers: Using design to investigate the impact of maker-based education training on pre-service STEM teachers. *International Journal of Engineering Education*, 36(2), 702–711.
- Wigner, A., Lande, M., Jordan, S. S. (2016, June 26). *How can maker skills fit in with accreditation demands for undergraduate engineering programs?* [Paper presentation]. Proceedings of the American Society for Engineering Education (ASEE) Annual Conference & Exposition, New Orleans, LA.
- Winner, L. (2009). Information technology and educational amnesia. *Policy Futures in Education*, 7(6), 587–591. <https://doi.org/10.2304/pfie.2009.7.6.587>

Appendix: Table of interview protocol questions with relevance to this study

Topic	Question from interview protocol	Alignment to research questions
Formal Education	How have your experiences in school prepared you for the Making you are doing now?	RQ1
	(probe) Have you learned anything in school that has helped you with the Making you are doing now?	RQ1
	(probe) What knowledge did you learn in school that has helped you with your Making?	RQ1
	(probe) What skills did you learn in school that has helped you with your Making?	RQ1
	Are there any classes [subjects] you wish you had in school?	RQ3
	(probe) What would you hope to learn from this?	RQ3
	Are there any activities you wish you could do more of while at school?	RQ2/3
	(probe) What about them seems like they would be useful?	RQ2/3
	Are there any activities you wish you could do less of while at school?	RQ3
	Are there any activities you do afterschool that relate to the Making you are doing now?	RQ1
Informal Education	(probe) What knowledge did you learn in the activity that has helped you with your Making?	RQ1
	(probe) What skills did you learn in the activity that has helped you with your Making?	RQ1
Maker Integration	Do you think Making should be a part of your school day?	RQ2
	(probe) If so, how?	RQ2/3