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# “Sorry, I Was in Teacher Mode Today”: Pivotal Tensions and Contradictory Discourses in Real-World Implementations of School Makerspaces

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## ABSTRACT

This paper examines tensions present in school-based makerspaces. We argue that, as maker education grows, particular attention needs to be paid to social interactions and discourses, in addition to space design, equipment, and curricula. We report the results of observations and interviews conducted in a recently adopted maker program in California, USA. Our analysis focused on behavioral and organizational aspects of the program, composed by credentialed and non-credentialed educators. Considering that discourses can shape practices, we also examined the vocabulary employed by the educators involved in maker programs, revealing tacit and manifest conflicts in the studied schools. We summarized our findings by describing the major tensions that may arise when maker education programs are adopted within a typical K-12 school environment. We conclude with recommendations for designing and implementing school-based maker programs, focusing on tensions that should be identified and leveraged as generative themes to foster culturally situated debates among practitioners.

## CCS CONCEPTS

• **Social and professional topics** → **K-12 education**.

## KEYWORDS

Makerspaces, Constructionism, Culturally-Relevant Pedagogies, Critical Pedagogy, STEM Education, School Reform

## ACM Reference Format:

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## 1 INTRODUCTION

The Maker Movement is often marked by a search for independence and agency [7, 49]. Born within the world of informal education,

with a strong counter-cultural character, making has recently conquered significant terrain in the K-12 education, a system characterized by technocratic control [27], known for formality and structure. Since learning in a classroom involves dynamics and conventions that differ from those materialized by a makerspace, this encounter results in dissonances and, ultimately, in the coexistence of two distinct pedagogies.

In this paper, we investigate how maker education is being repurposed to fit the formal United States school system and the tensions that result from this process. With an emphasis on the individuals that participate in instruction, we analyze how maker programs are making the shift from informal to formal learning environments.

Our analysis builds upon a sequence of interviews, observations and volunteering sessions conducted in four schools within the same district in California, USA. At the time of the study, a maker education program was being implemented in the district and school faculty were invited to make use of new resources and techniques. Our analysis focuses on pedagogical and identity-related tensions between two distinct teams of instructors that share makerspaces — “tinkers” (i.e. maker specialists) and teachers — and discusses how these tensions should be accounted for when designing and implementing maker learning environments in a K-12 school setting.

Drawing from Constructionist, Sociocultural, Critical and Education Reform literatures, we review previous work relevant to understanding the continuous evolution of school-based maker education. Our findings are discussed in the form of tensions and design recommendations, with an emphasis on leveraging tensions as generative themes to reduce potential resistance and increase the chances of success of school-based maker education programs.

## 2 THEORETICAL BACKGROUND

What constitutes maker education has been a theme of intense debate in recent years. Maker education has been consistently described as the “middle space” between Constructionism and Social Constructivism [7, 21], as they combine two different yet complementary epistemologies: knowing as the product of socially situated interactions in a community of practice [32] and knowing as the result of creating and sharing objects [40]. For this study, we conceptualize making as a boundary pedagogy where the borders of formal and informal education are blurred [29, 46].

As maker practices approach schools, researchers have been working to differentiate makerspaces from preexisting school-based labs or shops [21]. In fact, “Maker Education” is a new name for an established and flexible paradigm, present in multiple types of organizations [8], such as libraries [42], museums [46, 55], PK-12

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schools [22, 50], higher-education [28] and youth organizations [45], among many others. One common lesson derived from these studies is that, rather than approaching makerspaces with a “one-size-fits” all model, learning designers should align makerspaces with a range of structures, styles, and contents that match the ethos and structures present in the “target” organization. In PK-12 schools, diverse learning arrangements of maker education seem to be crucial for successful and long-lasting programs, and key for an adequate fit with schools [55].

Insufficient attention, however, has been paid to the cultural models and frictions underlying the adoption of school-based making. Questions orbiting organizational aspects of making remain largely unaddressed and closing this gap seems to be critical for integrating maker education into schools and other organizations [12, 45]. Tan [48] puts forward the idea that schools that start a maker curriculum need to undertake cultural and epistemological changes to what they see as STEM learning. Similarly, Taylor [50] posits that, before integrating making into the classroom, educators need to clearly understand potential points of connection, possibilities and limitations of this paradigm. We view this gradual “buy-in” process as potentially challenging, as multiple tensions and compromises can arise. Investigating this phenomenon more thoroughly can broaden the understanding of how maker education adapts, evolves and becomes a sustainable practice in the school space.

Learning by making involves bringing individuals’ mindsets [13], behaviors and identities [14, 20] to the center of the classroom. Clapp and colleagues [15] argue that character and agency in maker-centered classrooms act together as “a support for can-do spirit that empowers young people to see themselves as agents of change” (p.40). Tomko [51] studied the interplay between different maker identities among students and instructors and the tensions they give birth to. Litts [33] found that identity issues, and not just technical expertise, can either facilitate or be a barrier for makerspace personnel. Blikstein and Worsley [10] and Blikstein [9] (in press) also addressed this topic by analyzing cultural and identity tensions present in the maker sphere. Finally, Marshall and Harron [34] defend that the maker identity, be it in a school or in an informal setting, will be constructed by the broader community and not solely by those directly involved in makerspaces. Since these identity aspects remain fluid in the literature, we decided to pay special attention to them during the research process.

Forming networks of people and organizations within and outside of the school has been documented as a strategy for integrating makerspaces into schools [33, 42, 45]. Research suggests that forming a school-based maker community that goes beyond makerspaces is a crucial step to validate the program, generate integration and further build a maker identity in the school. In the out-of-school level, these networks of support are described as being able to foster inspiration, add new sources of knowledge, impart programmatic and methodological validation and, ultimately, lead to increased culturally-responsiveness.

Culturally-responsive pedagogies, pioneered by Paulo Freire in the early 60s, has often been appropriated by US scholars without the needed credit to his seminal work [23]. Freire’s idea of generative themes, closeness to students’ lived experience, and dialogical education has been a tacit pillar in the culture of maker education. Later research in this area by US and European scholars upheld

that instructional approaches should be shaped after students’ cultural background and past experiences [25, 30, 31] [3] as a way to promote cultural pluralism [41]. This idea is reinforced by Gloria Ladson-Billings [30] advocacy for pedagogies that lead to academic achievement not *with* but *through* the reflection of communities’ identities. This effort, however, is described in the literature as being marked with risks. First, the idea of merely crafting connections between academic content and cultural knowledge is not enough. Gay [25] posits that, to become truly responsive to students’ cultures and social norms, educators need to first refrain from seeing students and families through a deficit perspective. Second, there is the risk of “essentializing” [47], the trap of reducing cultures to fixed, homogeneous and socially established conceptions, and assuming that all students who are members of a particular group identify with this representation. Hence the need to move away from a “monocultural” making practice [31] by unequivocally appreciating and respecting students’ cultures, passions and identities [6, 23, 24]. Finally, we are keen to the notion of individual and cultural responsiveness advanced by Freire [23], specifically when it comes into being in the form of generative themes. We see these themes as ideas that are not only powerful but also deeply situated within a community of learners and educators.

Despite the relative novelty of school-based maker programs, the implementation of innovative models in schools are not a new phenomenon *per se*. The literature is rife with cases of teacher resistance and power struggles at the school level, which have the potential to thwart the adoption of new pedagogical models [39, 53]. Datnow [18] describes the competing interests, ideologies and informal negotiations of power in schools and districts as the essence of micropolitics in PK-12 education. She illustrates how free, fully informed choice about the adoption of new curricula or pedagogical models is rarely offered to teachers. Likewise, Vossoughi and Bevan [54] forewarn researchers and practitioners about the risks of positioning making over and above the common ethos and practices of school systems. In their own words, “while this reflects the role of making as a critical response to narrow forms of curriculum and pedagogy, we also worry about slipping into pejorative views of schools and teachers in ways that work against the kinds of change researchers are interested in advancing” (p. 38).

Tensions at the school level reflect the long standing dialectics around structure and agency. Common to the Sociology literature, this debate may be summarized as the interplay between autonomy, whether individual or related to organizations, and socially constructed roles and structures [26]. Under this theoretical lens, social interactions between individuals involved in making not only shape their behaviors and identities but also the very essence of what making means for the school. In a similar spirit, Kumpulainen and colleagues [29] describe the interaction between stabilization epistemologies (i.e., knowing by maintaining the status quo) and possibility epistemologies (i.e., knowing and assimilating what is new) when introducing novel approaches of teaching and learning to schools. This constant friction of cultures and ways of knowing may well produce spaces of tension between teacher-centered patterns and student-centered pedagogical models.

Based on both context and theory, we proposed the following research question: **“What dissonances emerge when a maker program is adopted for the first time by a school?”**

### 3 METHODS

#### 3.1 Context of Investigation

This study involved the observation of four schools within the same district in the Bay Area, California, United States, from March to June 2017. The district serves nearly 3,000 students from kindergarten through eighth grade, distributed in seven schools.

The schools in this study are surrounded by colorful technology companies, major research centers and two world-class universities. As one of the tinkers noted "*the school wanted students to be exposed to technology because most of the jobs in the region involve coding, cutting-edge technology and collaborative frameworks*". To respond to this need, a maker education program was implemented in 2015, two years before our study took place. With few exceptions, the majority of tinkers did not possess a formal teacher credential. The program was managed by a senior coordinator responsible for aligning all seven makerspaces with their respective school curriculum. The makerspaces were integrated to the schools' activities in a wide range of ways, from formal and structured classes to informal and less structured activities. In most cases, tinkers and school teachers worked together in the same activity. In other cases, classes did not involve the participation of teachers and were coordinated solely by tinkers.

#### 3.2 Data Collection

Our research adopted a qualitative phenomenological approach [16, 17]. We wanted to dive into the lived experiences of maker instructors while they adapt their programs and mindsets to pre-existing school cultures and instructional identities. Over the course of four months, we collected data from different "flavors" of maker education in schools: from short modules during the school day to longer and more complex after-school sessions. This broad range of applications provided us with a chance to understand different aspects of the conceptual dissonances that arise from the inception of maker programs in school settings. It also allowed us to account not only for classroom activities but also for the community and identity aspects of maker education in the PK-12 realm. A summary of the sequence of methods employed for data collection and analysis is presented in Figure 1.

From March to June 2017, we observed and video-recorded multiple maker sessions in four of the seven participant schools. These sessions involved students of different ages and were either associated with or independent of another curricular subject. During these sessions, we observed not only maker personnel but also a host of teachers of other subjects and faculty members. We were also present in maker staff meetings, which involved tinkers, teacher-tinkers from all seven makerspaces of the studied district, as well as the maker program director. The meetings encompassed topics from general management to curriculum and professional development.

This study also benefited from a call for volunteers that occurred in the first months of 2017. After an initial series of simple classroom observations, our research team directly engaged in the conduction of maker activities, acting as supporters for the instructor. These participant observations allowed for deeper insights into the roles, challenges and discourses of maker-ed personnel. The volunteering sessions often involved simple tasks such as distribution of materials, machine operation and basic safety measures. We refrained from interfering with the curriculum, nature of the tasks and classroom management, so as to avoid any extraneous effects on the data.

During these visits to the school sites, we collected artifacts (in physical and digital formats) from the makerspaces, either offered by instructors or students or displayed in the laboratories. These artifacts served as material evidence of students' work and the dominant ethos of each makerspace (e.g. mottoes and phrases on the classroom walls).

After the observation phase, we identified the major themes related to the interplay between instructional identity, maker activities and innovation adoption by the rest of the school community. We further investigated these themes through semi-structured interviews with teachers, tinkers and the maker program director. We refrained from asking questions that directly addressed any concessions made by the maker team to the rest of the school faculty. The reasons for doing so are twofold: first, in our pilot interview, we noticed that a lot of emphasis was put in the time limitations that result from any school schedule, which falls outside of the focus of this study. Second, we understood that, to reach the essence of the phenomenon [17], we needed to extract our data from indirect questions that addressed general aspirations and views about the program, the team and the school as a whole.

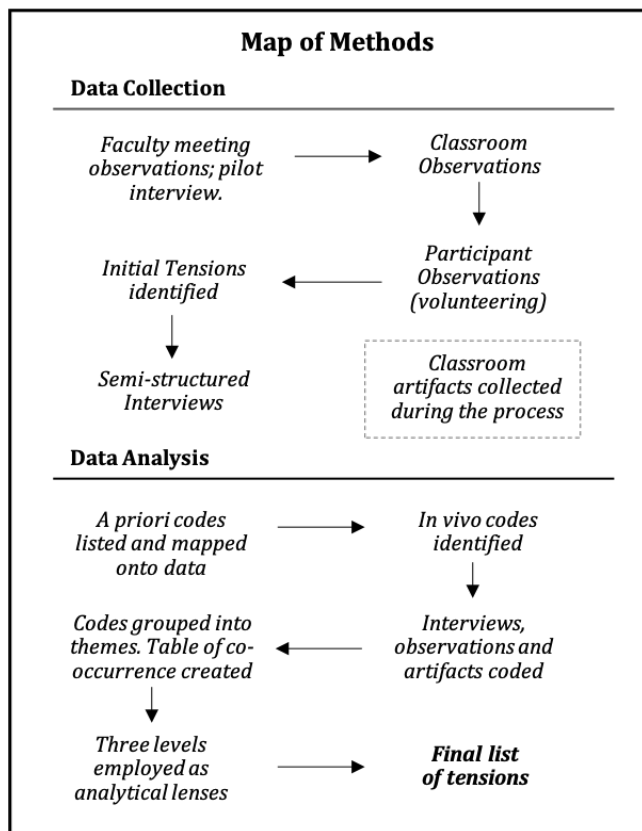


Figure 1: Summary of methods employed in this work.

### 3.3 Data Analysis

Our team analyzed all of the collected data, including audio and video transcripts, observation notes and classroom artifacts. Our first step was to lay-out a preliminary set of *a priori* codes [44], topics drawn from the literature that encompassed ideas central to our work. For example, we mapped educators' framing of students, their families and the surrounding community, identifying deficit, neutral or positive views [25]. Additionally, we actively looked for evidences of positional identities through educators' descriptions of their roles, limits, and views about maker education. These codes were mapped onto our data using the qualitative software Dedoose.

In a second round of analysis, we paid closer attention to the vocabulary employed by educators. We justify this choice by the belief that "the ways discourses are taken up actually can shape the culture of a school" [2]. Some examples of *in vivo* codes [44] include "machine" and "materials" (to reflect numerous mentions to printers, cardboard, etc.), "freedom" (usually employed in relation to tinkers' views about making), and "collaboration" (often used to describe either co-teaching, joint planning or teachers commissioning the makerspace for a given activity), among many others.

These codes were later added to the initial *a priori* ones and organized into groups of concepts. We collectively discussed, treated and merged codes into themes, looking for intersections and compatibilities. One example is "Adult Supervision" and "Activity Structure", two concepts that, although different, point to the amount of scripting and regulation employed in a maker activity. This procedure yielded a list of ideas that could then be compared and contrasted among themselves. We did this by employing tables that display the co-occurrence of codes in the data and by having in mind that tinkers and teachers may experience the same phenomenon in different and even opposite ways. We called the final result "tensions", groups of dissonant ideas that play a key role when implementing constructionist-oriented programs in public schools. Finally, by following phenomenological principles, our team also engaged in intense bracketing [17], filtering our own views and past experiences as K-12 educators from the collected data.

We wanted to account not simply for classroom activities but also for the social roles and views of all instructors directly or indirectly involved in maker curricula. To accomplish this, we drew from Rogoff's [43] ideas of using sociocultural activities as units of analysis and examining learning phenomena through their personal, interpersonal and community levels (Figure 2). This method provided an analytical lens to focus our analysis of each tension. For instance, the "Teacher versus Tinker" tension was analyzed at the personal level, thus involving educators' beliefs and identities but not to actual conflicts at the workplace.

## 4 FINDINGS

During the data analysis phase, we realized that the coded dialogues, artifacts and observations, while being complementary, could be mapped into dichotomous axis. We translated these opposite ideas into what we perceived to be the major tensions that can result from the introduction of maker education into formal school settings (Figure 2). We organized the pairs of concepts into three foci of analysis: personal, interpersonal and community levels [43].

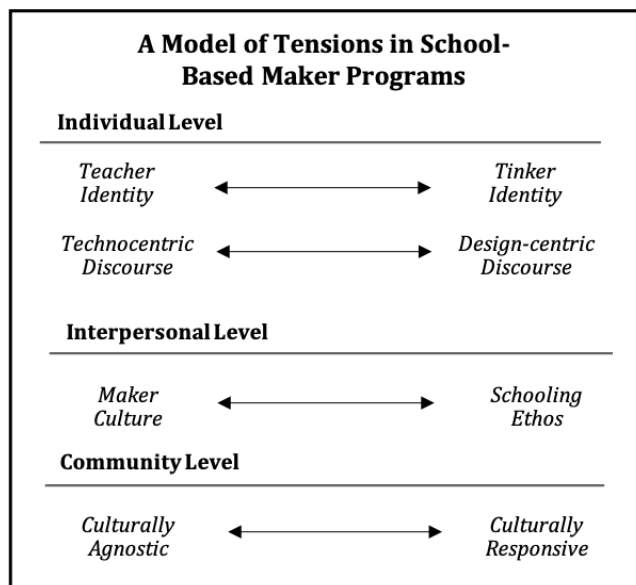


Figure 2: Tensions present in a school-based maker program

In the following section, we summarize the tensions that emerged from the data. It is important to note that, while we named tensions by their extremes, we also observed occurrences that would fall in between these points. Also, even though we will often use short quotes from interviews as examples, they are not decontextualized excerpts, but emerge from the data analysis process, being representative of typical discursive moves identified by our coding.

### 4.1 Teacher Identity versus Tinker Identity

At the individual level, we observed how positional identities [19] play a critical role for instructors involved with makerspaces. During our interviews, tinkers, for instance, seemed worried about being perceived as teachers, and made efforts to differentiate themselves from their credentialed counterparts. Likewise, in our class observations and volunteering sessions, we noticed that the use of authority, especially during moments in which good classroom management was highly needed, were almost exclusively relegated to teachers. In general, tinkers refrained from using their authority as instructors to manage their class, which might relate to their idea of what being an educator means. For instance, after co-teaching a session with a Science teacher, a tinker addressed our team:

*"Well, I hope you liked the session. Sorry if I was too bossy today. I was in 'teacher mode'. You know, I'm not always like a teacher."*

In another interview, we asked a tinker about his role at the school. Once again, the answer revealed a dichotomous positional identity that opposes maker instructors and credentialed teachers:

*"I do mostly projects. I don't teach so many 'educational' things here."*

Similarly, we noticed that teachers often mentioned tinkers as those predominantly responsible for technology-related matters,

whereas their self-concepts usually involved developing more complex pedagogical activities. Although we acknowledge the distinctions between these two roles, as well as potential differences in professional development and technical expertise, our view is that any instructor involved in maker activities is an educator.

The maker program manager maintained that multidisciplinary is a potential solution for sowing these two cultures together:

*"I've been really lucky for having diverse backgrounds on the team. I have two certified teachers (among tinkers) who have a wealth of experience in how to manage the class, structure lessons or do reflections. You know, like those kinds of 'teacherly' questions."*

## 4.2 Technocentric versus Design-centric Discourse

In our classroom observations, we noticed that maker sessions were often focused exclusively on how to operate a machine, employ a technique or utilize a software. However, we also participated in sessions where technology was no more than a background, with design ideation frameworks foregrounded by the instructor. We initially abstained from framing this as a tension, as we understand that maker curricula is normally prone to variability and needs to include more than one type of knowledge.

However, by paying close attention to the discourse of tinkers, we found conflicting views about the materialization of maker philosophies. When questioned about the core of their activities, tinkers frequently responded referencing exclusively equipment or materials and rarely mentioning longer-term learning goals. For instance, when asked about what they would recommend for starting a new maker program in another district, tinkers responded:

*"Definitely having a good source of cardboard. That's huge in makerspaces. Anything with circuitry. Vinyl cutters, building structures... computers and iPads are really good for stop-motion. I think that's the must haves if I were to start a makerspace."*

At the same time, other members of the maker team described their work with expressions more closely related to values and processes, leaving tangible aspects of making outside of the narrative.

*"My third grader are working on a prototype through Design Thinking. The goal is to ensure that they understand concepts in the cognitive and practical realm."*

*"(My work) is an outlet for students that don't thrive in classroom. You learn more by teaching them that failure is emphatic and to make what you learn from it."*

## 4.3 Maker Culture versus Schooling Ethos

One tension that became evident since the beginning of our work was the opposition between a highly supervised learning process and non-directed exploration. Once again, our research team refrained from judging any pair of incongruent activities for its face value, as we recognize that free craft and adult guidance can jointly compose a coherent teaching strategy. Instead, we focused on educators' discourses — especially their ideologies about making and justifications for particular choices in class — to frame this tension.

In four months, we observed both excessively prescriptive and "anything goes" types of projects. Even though we acknowledge that activity structure is usually planned to be age-responsive, and that our data come from both elementary and middle schools, we witnessed very different approaches to the implementation of maker projects for similar age-groups. On the more structured side, we observed sessions in which the instructor revealed all the steps needed to reach the end of the project. We also observed instances when no distinguishable objective or idea was introduced, and students were free to roam and explore materials and machines. Along similar lines, we observed diverse levels of adult supervision, ranging from a lack to an excess of guidance of students' projects. In some cases, we noted instructors took an active role, sometimes walking through the entire activity with students. We also observed tinkers and teachers assuming an inactive role, not directly supporting or even scaffolding support to students.

These dissonant practices seem to be rooted in conflicting discourses. We noticed that tinkers usually mentioned free craft and exploration as a positive approach to making:

*"I think I should have less of an emphasis on trying to teach them how stuff works and just get them kind of playing with stuff and figure out how it works as you're actually playing with it, you know?"*

*"(I prefer to) leave some projects open ended so that you don't end up with a bunch of the same all around the class. Diversity and the uniqueness is really good."*

A tension between different cultures became more evident when we asked tinkers about collaboration with credentialed teachers.

*"On the third time the teachers came in and said we should we do something different. I think it's too directive. It kind of takes something away (from the task)."*

*"Yeah, I think (we should be) giving them a lot of freedom. He (the Math teacher) is very regimented. He's very interested in, you know, them to be good at math. (...) Like passing some tests, just getting high scores."*

*"(Teachers) weren't so interested in collaborating. They were just focused on their own stuff."*

These dissonant ideas pointed to conflicting views about the purpose of a makerspace in a school. We found views that ranged from a focus on technological fluency (i.e. maker activities should teach technology above all things) to an orientation towards the school curriculum (i.e. making should directly reflect the curriculum of other subjects). The following tinkers' quotes reveal how attaining harmony between practices and viewpoints may be challenging:

*"I look at their their scope and sequence to come up with maker activities that match what they are doing."*

*"I had an emphasis for a certain amount of time on trying to teach the kids certain concepts or content that relates to a 'normal school curriculum'."*

Finally, we also noticed how this tension is materialized within a classroom activity. In more than one episode, we observed students and instructors debating about what counted or not as "work". The passage below, taken from a third-grade class observation, illustrates how these conflicting ethos generate subtle but significant tensions in the makerspace (all names are fictional):

*Jenny* – I finished my work. Now I want to play with something else!

*Maria* – But you can't play with something else.

(Jenny starts playing with play-doh.)

*Richard* – What are you doing? You are not supposed to play. You are supposed to work.

In the end, the tinker instructed the child not to play with what she wanted but to repeat the same activity until the end of the class.

#### 4.4 Agnostic versus Culturally Responsive

One question within our study was if and how school-based making relates to and responds to the local culture where it's inserted. This tension became evident through observations of students' work in maker activities and through the analysis of instructors' discourses around students' background. We found directly opposite views and classroom practices related to culture responsiveness, ranging from agnosticism (i.e. maker activities do not need to include traces of local culture by design, since they will emerge naturally from the student) to traces of cultural sensibility (i.e. making activities can and should be structured around students' interests and cultural standards).

In one after-school session, while a tinker explained how to make a scribbler robot, students drew Mexican flags and "Cinco de Mayo" motifs on the tables (Figure 3). On that day, the local community – populated mainly by Latinos – was celebrating this traditional Mexican holiday, and streets were taken by colorful clothes and *sombreros*. It surprised us that the instructor made no mention of this significant date during the entire 90-minute session, nor acknowledged the students' doodles on the table. When questioned about the fact, the instructor responded that this was not part of the designed activity. We found this to be a tension not at the interpersonal level (e.g. between educators) but at the community level, between the maker program (as part of the school) and its surrounding community.

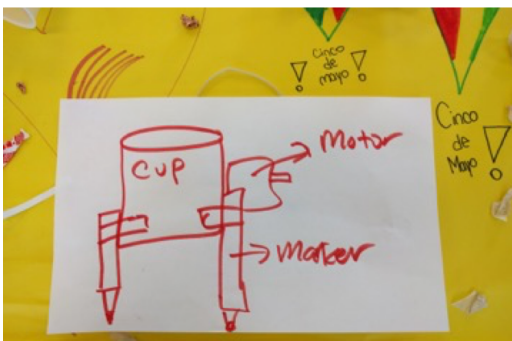


Figure 3: Cinco de Mayo doodles and the scribbler robot.

We also noticed tensions between publicized beliefs (i.e. mottoes, website text, etc.) and the actual discourse of educators involved in maker practices. While communication materials (not reproduced here for anonymity reasons) mentioned ideas such as “inclusiveness”, “empowerment” and “equity”, our interviews with maker educators revealed a deficit perspective when framing students and

the local community. When asked about the challenges of implementing a maker curriculum in the school, one tinker declared:

*"If we were in [rich area - blinded for anonymity] the likelihood that kids would clean up and manage materials would be bigger, just because of the nature of the situation. Whereas with these kids there's a certain lack of stewardship of materials. Some of them live (with) more than one family in a house. The idea of stealing is like 'something that I take is kind of normal'. So, that was a challenge. How do you get kids that don't have that understanding to teach them that."*

Along similar lines, despite the will to adapt instruction to local demands, another educator declared:

*"Most of the available maker activities end up not working well here, so we need to adapt. They work best in schools in higher income communities."*

We view these deficit framings as evidences of an underlying tension between institutional and individual discourses, as well as between the program itself and the local community, thus echoing some of Gay's [25] main concerns around cultural responsiveness.

## 5 TENSIONS AS GENERATIVE THEMES

This section discusses ways to leverage the identified tensions to facilitate the design and adoption of school-based maker programs. Our choice for working with ideas in opposition has two reasons. First, we see these particular tensions at the school level as manifestations of the duality of structures at a macro, societal level [26]. This view implies that the interplay between opposites is a natural force in any system and can be leveraged without giving primacy to one side over another. Secondly, we believe that these tensions, some latent and others plainly manifest, can be intentionally transformed into “generative themes” [4, 11, 23], concrete representations of individuals' lived realities about which people are willing to take some action [4]. In Freire's own words, generative themes “contain the possibility of unfolding into as many themes, which in their turn call for new tasks to be fulfilled” (p. 74). Believing that discourses can fundamentally influence school practice [2], our recommendation is for school leaders to not only acknowledge tensions them but to actively promote transparent and purposeful debates with the school community.

Leveraging tensions as generative themes for educators merits careful consideration. Freire proposed that, to be truly generative and conducive to learning, themes should be of great relevance and recognized importance – cultural or political – to a particular group of individuals [23]. More importantly, even if proposed by a single individual, the final meaning of a theme should be dialogically agreed upon by the community. Hence, we view the notion of scripted, “flash-card-like” generative themes as fragile and limited. The following topics are not meant to be exhaustive or construed as “boxed” conversations [6]. Instead, they should offer seeds for dialogue. We propose that schools design their own generative themes, resonant with and situated in their community of educators.

### 5.1 Theme 1: The good, the bad and the maker

Our analysis suggests two contrasting identities within faculty involved with making. On one side, tinkers performed an almost archetypal role of creative inventors and risk-takers, sometimes relegating “teacherly” functions to teachers. As a matter of fact, classroom observations revealed a consistent association between tinker-identity and lack of authority, as well as teacher-identity and an orientation towards command and control in maker activities. We also perceived that – perhaps due to a lack of classroom management skills – tinkers tried to exert power through super-structured and over-prescribed activities. This often limited student autonomy and also seemed to obstruct the learning of underlying concepts behind tasks and activities.

A closer look into educators’ discourses showed that their identities are indeed positional and relative to the school microcosm [19]. Teachers often mentioned tinkers as those predominantly responsible for technology-related matters, whereas their self descriptions usually involved developing more complex pedagogical activities. Likewise, tinkers often presented a tool-centric [35, 37] discourse around teaching and learning, resembling what Papert described as the “fallacy of referring all questions to the technology” [38]. This might be explained not only by social constructions around teachers and makers but also by the fact that most tinkers do not hold an official teaching credential. Although we acknowledge the natural distinctions between these roles, this tension is potentially harmful as it creates an atmosphere of “good-guy versus bad-guy”, encouraging pejorative views of teachers [54] and potentially affecting micropolitics at the school [18]. Promoting debates that start at but are not limited to formal roles and job descriptions seems to be necessary for any school-based maker program’s coming-of-age.

### 5.2 Theme 2: Boundary spaces, boundary laws

The dissonance of identities identified by our study may well be a product of the boundary nature of maker programs. On multiple occasions, we detected competing ideologies about the role of making among school faculty. These conflicts emerged not only through instructors’ words but in their actual approach to making. While tinkers wanted to provide more space for free exploration, they declared not knowing how much students were learning from the activity. At the same time, credentialed teachers were concerned with the long duration of projects and their apparent disconnection from curricular standards. We also view students’ discussion around play and work – especially the assertion that “You are not supposed to play, you are supposed to work” – as an internalization of “Schooling” values, an evident contrast with the program’s ethos of agency, independence and fun [49].

The silent schism between Schooling and Making seems to run parallel to the long-established dialectic between structure and agency [26, 29] and confirms the theory that a complete buy-in of making will only be achieved when schools finally promote epistemological adaptations to what educators see as STEM learning [48, 50]. By examining this tension, however, we do not suggest a school should choose one ethos over the other. In reality, we propose that the boundary laws and representations around making should be leveraged as a generative theme to positively affect school’s pedagogical practices.

### 5.3 Theme 3: Finding the right tone

Learning is a socioculturally situated phenomenon that happens across settings. Outside of the classroom, children learn from various knowledge brokers [1, 12], who impart not only technical or content related information but also other forms of literacy. We view communities as a powerful fuel for the maker endeavor, capable of answering the “making for what” question [36, 54]. If maker education is set to fulfill its original promises [35], it ought to be concerned about its role in a world with growing social challenges. In our study, however, we found neither concrete evidence of connections with the surrounding neighborhood nor indications of local residents being leveraged as knowledge brokers.

In his *Pedagogy of the Oppressed*, Paulo Freire [23] warned against a type of education that disregards students’ cultures and interests. In fact, maker programs should bring neighborhoods’ cultures to the center of activities by asking students what is most relevant to their lives [6]. The lab can then become an instrument for the development of students’ agency and identity, not as self-centered, hedonist makers [49] but as members of a community of practice [5]. Schools’ main challenge will be finding the right tone. While being agnostic to the local culture is certainly not the way to go, culture responsiveness should not be limited to festivals and folk-related motifs. Most importantly, our view of culturally responsive pedagogy starts with developing the right framing of students and communities and rejecting any form of deficit view. We recommend that educators first recognize their views and, ultimately, debate it, so that the school finds its own way to respond to and connect with the extramural world [9].

## 6 STUDY LIMITATIONS

While this study provides insights into sociocultural components of school-based making, it is limited in both nature and scope. While our results are not necessarily generalizable, they add valuable insights for the research community, with a special attention to the individuals involved in making.

## 7 CONCLUSION

We set out to examine the dissonances that emerge while maker education adapts to formal learning systems. Our study of practices, identities and discourses revealed several tensions in a recently implemented school-based maker program. We proposed leveraging these tensions as generative themes to foster discussion around the design of Constructionist interventions. We see themes not as “boxed” conversations but as seeds to be dialogically negotiated and adapted to school communities.

This study views tensions not as conflicts but as potential bridges, and “objects to think with” [52]. By crossing them, maker programs can go beyond the doors of the lab and influence the pedagogical paradigm of the entire school.

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## REFERENCES

- [1] Thomas Akiva, Stacy Kehoe, and Christian D Schunn. 2017. Are we ready for citywide learning? Examining the nature of within- and between-program pathways in a community-wide learning initiative. *Journal of Community Psychology* 45, 3 (2017), 413–425.
- [2] Gary Anderson and Angus Mungall. 2015. Discourse analysis and the study of educational leadership. *International Journal of Educational Management* 29, 7 (2015), 807–818.
- [3] James Banks, Marilyn Cochran-Smith, Luis Moll, Anna Richert, Kenneth Zeichner, Pamela LePage, Linda Darling-Hammond, Helen Duffy, and Morva McDonald. 2004. Teaching Diverse Learners. In *Preparing Teachers for a Changing World: What Teachers Should Learn and Be Able to Do. (Chapter 7)*, Linda Darling-Hammond and John Bransford (Eds.). Jossey-Bass, San Francisco, CA.
- [4] Dave Beck and Rod Purcell. 2013. Developing generative themes for community action. In *Working with Young People (2nd Ed.)*, Sheila Curran, Roger Harrison, and Donald Mackinnon (Eds.). SAGE, Thousand Oaks, California.
- [5] Alexander Berman, Brittany Garcia, Beth Nam, Sharon Chu, and Francis Quek. 2016. Toward a Making Community of Practice: The Social Aspects of Elementary Classroom-Based Making. In *Proceedings of the 6th Annual Conference on Creativity and Fabrication in Education*. ACM, New York, NY, 9–16.
- [6] Paulo Blikstein. 2008. Travels in troy with freire: Technology as an Agent of Emancipation. In *Social Justice Education for Teachers: Paulo Freire and the possible dream*.
- [7] Paulo Blikstein. 2013. Digital Fabrication and ‘Making’ in Education: The Democratization of Invention. In *FabLabs: Of Machines, Makers and Inventors*.
- [8] Paulo Blikstein. 2019. Beyond Mindsets, Cultures, Brands, and Clichés: A Possible Future for Equitable Maker Education. In *Meaningful Making Vol 2: Projects and Inspirations for fab labs and makerspaces*, Paulo Blikstein, Sylvia L. Martinez, Heather A. Pang, and Kevin Jarret (Eds.). CMK, Los Angeles, USA, XVIII–XXI.
- [9] Paulo Blikstein. 2019. (Forthcoming) Cultural Making: Emancipatory Practices in Culturally-Aware Maker Education. In *Constructionism in Context: The Art, Theory, and Practice of Learning Designs*, Nathan Holbert, Mathew Berland, and Yasmin Kafai (Eds.). MIT Press, Cambridge, MA.
- [10] Paulo Blikstein and Marcelo Worsley. 2016. Children are Not hackers: Building a Culture of Powerful Ideas, Deep Learning, and Equity in the Maker Movement. In *Makeology*, Kylie Peppler, Erica Halverson, and Yasmin Kafai (Eds.). Routledge.
- [11] David Cavallo, Paulo Blikstein, Arnan Sipitakiat, A Basu, A Camargo, Roseli de Deus Lopes, and A Cavallo. 2004. The City that We Want: Generative Themes, Constructionist Technologies and School/Social Change.. In *IEEE International Conference on Advanced Learning Technologies*. IEEE, 1034–1038.
- [12] Dixie Ching, Rafi Santo, Christopher Hoadley, and Kylie Peppler. 2016. Not just a blip in someone’s life: integrating brokering practices into out-of-school programming as a means of supporting and expanding youth futures. *On the Horizon* 24, 3 (2016), 296–312.
- [13] Sharon Lynn Chu, Francis Quek, Sourabh Bhangaonkar, Amy Boettcher Ging, and Kumar Sridharamurthy. 2015. Making the Maker: A Means-to-an-Ends approach to nurturing the Maker mindset in elementary-aged children. *International Journal of Child-Computer Interaction* 5 (2015), 11–19.
- [14] Sharon Lynn Chu, Rebecca Schlegel, Francis Quek, Andrew Christy, and Kaiyuan Chen. 2017. ‘I Make, Therefore I Am’: The Effects of Curriculum-Aligned Making on Children’s Self-Identity. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. ACM, New York, NY, 109–120.
- [15] Edward P. Clapp, Jessica Ross, Jennifer O. Ryan, and Shari Tishman. [n. d.]. *Maker-centered learning: empowering young people to shape their worlds*. Jossey-Bass, San Francisco, CA.
- [16] John W Creswell. 2016. *30 essential skills for the qualitative researcher*. SAGE Publications, Inc., Thousand Oaks, CA.
- [17] John W. Creswell. 2018. *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. SAGE, Los Angeles, CA.
- [18] Amanda Datnow. 2000. Power and Politics in the Adoption of School Reform Models. *Educational Evaluation and Policy Analysis* 22, 4 (2000), 357–374.
- [19] Bronwyn Davies and Rom Harré. 1990. Positioning: The discursive construction of selves. *Journal for the Theory of Social Behaviour* 20, 1 (1990), 43–63.
- [20] Don Davis and Lee L. Mason. 2017. A Behavioral Phenomenological Inquiry of Maker Identity. *Behavior Analysis: Research and Practice* 17, 2 (2017), 174–196. <http://doi.apa.org/getdoi.cfm?doi=10.1037/bar0000060>
- [21] Tonia A. Dousay. 2017. Defining and differentiating the makerspace. *Educational Technology* (2017), 69–74.
- [22] Laura Fleming. 2015. *Worlds of Making: Best Practices for Establishing a Makerspace for Your School*. Corwin Press.
- [23] Paulo Freire. 1996. *Pedagogy of the Oppressed*. Continuum, New York, NY.
- [24] Paulo Freire. 1998. *Teachers As Cultural Workers: Letters to Those Who Dare Teach*. Westview Press, Boulder, CO.
- [25] Geneva Gay. 2010. *Culturally Responsive Teaching: Theory, Research, and Practice*. (2nd ed. ed.). Teachers College Press, New York.
- [26] Anthony Giddens. 1984. *The constitution of society: Outline of the theory of structuration*. Polity Press, Cambridge, Cambridgeshire.
- [27] Erica Rosenfeld Halverson and Kimberly Sheridan. 2014. The Maker Movement in Education. *Harvard Educational Review* 84, 4 (2014), 495–504.
- [28] Kyungwon Koh and June Abbas. 2015. Competencies for Information Professionals in Learning Labs and Makerspaces. *Journal of Education for Library and Information Science Online* 56, 2 (2015), 114–129.
- [29] Kristiina Kumpulainen, Anu Kajamaa, and Antti Rajala. 2018. Understanding educational change: Agency-structure dynamics in a novel design and making environment. *Digital Education Review* 33 (2018), 26–38.
- [30] Gloria Ladson-Billings. 1995. But that’s just good teaching! the case for culturally relevant pedagogy. *Theory Into Practice* 34, 3 (1995), 159–165.
- [31] Gloria Ladson-Billings. 1999. Preparing Teachers for Diversity. In *Teaching as the learning profession: Handbook of policy and practice (Chapter 4)*, Linda Darling-Hammond and Gary Sykes (Eds.). Jossey-Bass, San Francisco, CA.
- [32] Jean Lave and Etienne Wenger. 1991. *Situated Learning: Legitimate Peripheral Participation*. Cambridge University Press, Cambridge.
- [33] Breanne K Litts. 2015. Resources, facilitation, and partnerships: three design considerations for youth makerspaces. In *Proceedings of the 14th International Conference on Interaction Design and Children*. ACM.
- [34] Jill A Marshall and Jason R Harron. 2018. Making Learners: A Framework for Evaluating Making in STEM Education. *The Interdisciplinary Journal of Problem-Based Learning: Tinkering in Technology-Rich Design Contexts* 12, 2 (2018), 3.
- [35] Lee Martin. 2015. The Promise of the Maker Movement for Education. *Journal of Pre-College Engineering Education Research (J-PEER)* 5, 1 (2015), 4.
- [36] Atelia Melaville, Amy C. Berg, and Martin J. Blank. 2006. *Community-Based Learning: Engaging Students for Success and Citizenship*. Technical Report.
- [37] Seymour Papert. 1987. Computer Criticism vs. Technocentric Thinking. *Educational Researcher* 16, 1 (1987), 22.
- [38] Seymour Papert. 1988. A critique of technocentrism in thinking about the school of the future. In *Children in the information age: Opportunities for creativity, innovation and new activities*. Papert88. CritiqueTechnocentrism.
- [39] Seymour Papert. 1997. Why School Reform Is Impossible. *The Journal of the Learning Sciences* 6, 4 (1997), 417–427.
- [40] Seymour Papert and Idit Harel. 1991. Situating Constructionism. *Constructionism* 36, 2 (1991), 1–11.
- [41] Django Paris. 2012. Culturally Sustaining Pedagogy: A Needed Change in Stance, Terminology, and Practice. *Educational Researcher* 41, 3 (2012), 93–97.
- [42] Kylie Peppler, Erica Halverson, and Yasmin Kafai (Eds.). 2016. *Makeology. Makerspaces as learners environments (Vol. 1)*. Routledge, New York.
- [43] Barbara Rogoff, Karen Topping, Jacquelyn Baker-Sennett, and Pilar Lacasa. 2002. Mutual contributions of individuals, partners, and institutions: Planning to remember in Girl Scout cookie sales. *Social Development* 11, 2 (2002), 266–289.
- [44] Johnny Saldaña. 2014. *The Coding Manual for Qualitative Researchers*. SAGE.
- [45] Rafi Santo, Kylie Peppler, Dixie Ching, and Christopher Hoadley. 2015. Maybe a maker space? Organizational learning about maker education within a regional out-of-school network. In *Makerspace Expansive Learning Fablearn Submission*.
- [46] Kimberly Sheridan, Erica Rosenfeld Halverson, Breanne Litts, Lisa Brahms, Lynette Jacobs-Priebe, and Trevor Owens. 2014. Learning in the Making: A Comparative Case Study of Three Makerspaces. *Harvard Educational Review* 84, 4 (2014), 505–531.
- [47] Christine E Sleeter. 2012. Confronting the Marginalization of Culturally Responsive Pedagogy. *Urban Education* 47, 3 (2012), 562–584.
- [48] Michael Tan. 2018. When Makerspaces Meet School: Negotiating Tensions Between Instruction and Construction. *Journal of Science Education and Technology* (2018), 1–15.
- [49] Joshua G. Tanenbaum, Amanda M. Williams, Audrey Desjardins, and Karen Tanenbaum. 2013. Democratizing technology: pleasure, utility and expressiveness in DIY and maker practice. In *In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI’13)*. ACM, 2603–2612.
- [50] Bart Taylor. 2016. Evaluating the Benefit of the Maker Movement in K-12 STEM Education. *Electronic International Journal of Education, Arts, and Science (EIJEAS)* 2 (2016).
- [51] Megan Tomko, Julie Linsey, and Robert Nagel. 2017. A Qualitative Approach to Studying the Interplay Between Expertise, Creative, and Learning in University Makerspaces. In *ASME 2017 International Design Engineering Technical Conference and Computers and Information in Engineering*.
- [52] Sherry Turkle (Ed.). 2007. *Evocative Objects: Things we Think With*. MIT Press, Cambridge, MA.
- [53] David B Tyack and L Cuban. 1995. *Tinkering toward utopia: a century of public school reform*. Harvard University Press, Cambridge, MA.
- [54] Shirin Vossoughi and Bronwyn Bevan. 2014. Making and Tinkering: A Review of the Literature. *National Research Council Committee on Out of School Time STEM* (2014), 1–55.
- [55] Peter Samuelson Wardrip and Lisa Brahms. 2016. Taking making to school: A model for integrating making into classrooms. In *Makeology*, Kylie Peppler, Erica Halverson, and Yasmin Kafai (Eds.). Vol. 1. Routledge, 97–106.