Twinning iterative design with community cultural wealth: Toward a locally-grounded, expansive maker culture

By: Angela Calabrese Barton and Edna Tan

Abstract:

Drawing upon critical justice studies and critical ethnographies in two community-centered makerspaces, we build an argument for how designing for expanded iterations that repeatedly draw from community cultural wealth, supported youth-makers and communities in co-creating an expansive, locally-grounded maker culture. Two related-foci are unpacked: First, we examine how youth engage in an "expanded" iterative process across the making cycle -- what this expanded iterative process is, and how it takes shape as youth move from collaborative ideation through to the afterlife of a maker project. Second, by delving into "moments of expanded iterations" we examine how youth articulate ownership of their making: what that means, how and why, and the subsequent generative spaces that resulted.

Keywords: equity | making | iterative design

Article:

1 INTRODUCTION

We build an argument for how designing for "expanded iterations" supports youth in authoring a more rightful presence in STEM-rich making. To do so, we bring a dual focus to this study. First, we examine how youth engage in an iterative process across the making cycle, which engage both technical and cultural dimensions – what this expanded iterative process is, and how it takes shape as youth move from idea conception through the afterlife of a maker project. Second, by delving into moments of "expanded iterations" we examine how new forms of STEM-rich making knowledge and practice are legitimized, shared, and honored as youth gain recognition as powerful community makers.

The idea that iteration is an important principle in design has been well established [1, 2]. In this area of research, iterations generally refer to opportunities to re-think or re-work designs based on technological and social dimensions, within the prototyping process [2]. However, little attention has been paid to either a) how the iterative process involves both pre- and post-design "lives" of maker artifacts, and b) an intentional incorporation of cultural knowledge towards advancing new forms of legitimate maker knowledge and practice. This is the focus of our study.

2 THEORETICAL FRAMING

2.1 Equity in STEM-rich making: Iterative design and legitimate knowledge/practice

For many youth, STEM-rich making remains an elusive goal. They may have access to makerspaces where STEM-rich activities are promoted, but key obstacles remain. Despite being touted as places of democratization to STEM, makerspaces can increase the divide. Those who come in with the "know how" have greater opportunity and spaces for leveraging and improving this know-how than those who do not. Further, engaging in STEM-rich making can be constrained and limited for many youth given the dominant discourse and practice which reflect white, western and masculine ways of knowing and doing [3].

At the same time, the field of making has documented how engaging in STEM-rich making is grounded in experiences in the world, including their families and communities' cultural practices [4]. Central to our concerns is how youth can be supported in developing STEM expertise while also leveraging and deepening cultural knowledge and practice toward powerful STEM-rich making. Without attention to both in the design of making experiences, key equity concerns will not be fully addressed [5].

We focus on STEM-rich making to foreground making projects that require robust science and engineering content knowledge and practice. While there are a wide range of making projects that are not necessarily overtly STEM-oriented, we focus on STEM-rich making because STEM is a domain for whom many youth from historically marginalized communities have been denied equitable access, and because the making movement claims to reduce barriers in access and opportunity in STEM. Further, we focus on community-engaged making to trouble the fast solidifying, mainstream maker culture that re-inscribes white, male, middle class norms. We are interested in an expansive, non-othering maker culture, what that looks like and what that entails. The importance of iteration in STEM-rich making plays an integral role in challenging this normative culture, while also supporting maker learning. This focus on how iteration plays out and its impact on youth is the focus of our work.

2.2 Rightful Presence in STEM-rich making through valuing community cultural wealth

Having a rightful presence in STEM-rich making is central to justice-oriented goals of maker education. Rightful presence in STEM-rich making has two interconnected parts. First, individuals are welcomed as a legitimate, contributing, and fully human member of a maker community because of who they are, and not who they should be. Second, communities work to more fully value the cultural knowledge and practices of newcomers, while seeking to disrupt power-dynamics that inhibit such efforts [6]. Being an outsider in a STEM-rich maker community, as have many youth of color, low-income youth, immigrant youth, and girls in STEM been positioned, means being denied a rightful presence. We suggest that it is important to design for and to support makers in engaging in ways that promote a *rightful presence* in STEM-rich making for all students, but especially those made most vulnerable – indeed, made missing – by the practices of STEM and society [6].

The idea of rightful presence emerged from critical justice studies of borderland and refugee communities in welcoming host countries [8]. Most host countries have legislation in place which describe and formalize the rights (or lack thereof) of immigrants and refugees. These are "institutional rights." However, how such rights are enacted in-practice do not always fully account for the injustices individuals experience in place or time. For example, a place can legislate access to public commons and services, but atmospheric walls (immaterial walls with material effects) of whiteness, masculinity, and class privilege can, in-practice, mediate access [9]. While being welcomed as guests in a new place provides forms of access and opportunity otherwise unavailable, it also sets up power dynamics. Hosts may be benevolent and caring in welcoming newcomers. However, by merely extending a static set of institutional rights to newcomers, hosts consign newcomers permanently as "guests" with attenuated agency [9].

Rightful presence asserts that legitimately being welcomed in a community requires the guest/host powered relationship to change. Hosting shifts from having the power to dictate norms for others, to having the responsibility to make sense of and value the cultural knowledge and experiences of newcomers as powerful contributions to society. It also involves the responsibility to acknowledge the injustices newcomers have experienced historically and in their new lives, as they seek to build a new present and future in their new home.

Youth of color from lower-income backgrounds and refugee youth are not the typical poster-children of the mainstream maker movement [5]. They are positioned as peripheral, and therefore "guests" of making spaces. Explicitly soliciting for and accruing community cultural wealth [9] as integral to maker iterative design, is one way to rightful presence in STEM-rich making. Seeking relevant, community cultural wealth to inform youths' iterative making design is epistemological in nature: What are the sources of knowledge that matter to making, whose knowledge counts and why? Explicitly soliciting for and leveraging the rich aspects of community cultural wealth, including aspirational, familial, social and resistance capital [9], to inform iterative design-decisions that in turn translate these forms of community capital into specific forms of making knowledge and practices, can lead to both a robust and more equitable making process.

3 METHODS & CONTEXT

3.1 Community Centered Making

Our study takes place in four makerspaces, three of which are located in community centers (two in North Carolina and one in Michigan) and one of which is located in a science center (located in Michigan). All four have a community-engaged focus and seek to serve a diverse youth population, with attention on youth of color and youth from low-income communities. All four makerspaces are located in mid-sized cities facing some degree of economic depression. In our overlapping researcher-educator roles, we have collaborated with all four makerspaces to establish these making paces and the programs within them, with the primary goals of supporting youth in sustained engagement in STEM, while also learning about making in culturally sustaining ways. We sought to engage youth iteratively and generatively in making space activities and in community ethnography as one approach to embedding local knowledge and practice into making and engineering design.

3.2 Longitudinal Critical Ethnography

Our study was carried out as a longitudinal critical ethnography over a two-year period. Critical ethnography is grounded in the idea that researchers can use the tools of ethnography to conduct empirical research in an unjust world in ways that examine and transform inequalities from multiple perspectives [10]. Critical ethnography is an approach that politicizes the interaction between actors and the social structures through which they act, grounded in the belief that these relationships are never neutral. Data were generated between 2016-2018 academic years, from 90-180 minute, weekly community making sessions with youth. Data include artifacts, weekly youth conversation groups, and video analysis capturing youth interaction with STEM and community experts at various stages in their design process. Data analysis involved multiple stages and levels of coding based on procedures for open coding and method of constant comparison.

4 FINDINGS

We present three illustrative cases from partner sites to make sense of how iterations unfold over time and space. We use these cases to both delve into key moments of in project iterations, and what these moments meant for youth maker learning and development.

4.1 Case 1: Massaging Slipper

Consider Su'Zanne, a 6th grade African American girl. While in the maker program, her brother had designed the Timmy, a lighted, heated boot that would keep the foot warm in the winter, an important topic because their makerspace is located in a cold climate and many youth have limited access to quality boots. A prototype of his design is displayed on a cabinet, visible as people enter the making space. When new people enter the room, Su'Zanne has brought them over to the boot, saying, "my brother made that" and explaining what the boot is for and how it works.

On a day when other youth in her making space were working on finishing an e-textiles project, Su'Zanne spent the day making a massaging slipper, which she continued to iterate over several sessions. She initially traced and cut a sole on thick butcher paper and covered the newly cut sole with hot glue in a criss-cross pattern. She tried several different patterns with input from several interested peers and her mentor until one "felt really good" on the foot. She then re-made this pattern on a cardboard sole so that it would be more durable, and attached double-ply butcher paper for the slipper sleeve.

Su'Zanne then re-made the slipper using the inner sole from her brother's boot as he had suggested to her that her slipper should be more durable if it were to have a vibrating function. She also needed a place to install (and hide) the mini-motors and batteries.

When she finished her prototype, she covered the entire slipper in fabric so that it would look "beautiful." She had gotten this idea from one her mentors who had suggested using fabric for the sleeve instead of butcher paper or carboard. She stated that it was important for her slipper to

look beautiful because she made it for the homeless people in her city. She felt that not only did their "feet hurt a lot" from having to "stand" and "walk" all day long in looking for money and food, but also that they deserved to feel good about their clothes and shoes. She reported on a YouTube video she had seen about how "some dude" gave a homeless person a drink, but that "the drink was bad." The video showed the homeless person drinking the bad drink and spitting it out amidst laughter. She felt that this treatment was wrong. Her prototype is displayed on a table next to the entry way of the makerspace, where it, too, can be easily seen by those entering the room.

This case illustrates how Su'Zanne leveraged upon her brother's boot project (the "afterlife" of the boot) to not only be inspired to make something that is helpful to others, but also the boot parts (the sole) and her brother's expertise in making it (getting ideas form him on how to make it more comfortable and durable). It also shows how Su'Zanne went through several iterations on this project so that it would serve an important social need in her community, that is, helping homeless people. With various forms of input from her peers, her mentors, her brother and the internet, she developed a comfortable criss-cross pattern, a way to make her slipper vibrate, and durable sole, and beautiful look.

4.2 Case 2: Geodesic Play Dome

The geodesic playdome, made out of 50 separate pieces of cardboard, was a play-structure constructed over six months, as the original makers and new friends observed how it was being used in their community club. The original makers, Ariel and Sharon, were driven to build a play-structure in response to community feedback highlighting the lack of toys for kids at their club. Both girls had also observed that their club has a lack of play structures specifically for the younger children, which they deemed a serious problem because "kids need to *move*!"

Building the initial dome was not an easy. The girls had to work through challenging technical problems, such as how to make the proper size triangles that would fit together for a secure dome, what materials they might use to construct the dome that were both affordable and durable, and where to have windows and doors so that the building was safe for little kids. They tried different kinds of cutting tools that would work best with cardboard, and for lefthanded Ariel. The two makers added solar-powered LED lights, with the solar panels on the outside of the dome and the LED output lights on the inside, "so kids can see because it's quite dark."

As the dome became a part of everyday life at their community center, Ariel, Sharon and other youth-makers (Sasha, Ginny and Talie) began to notice several important things. First they noticed that some of the younger children liked to take short naps in the dome. They also noticed that the children's naps were interrupted by people peeking through the windows, or because they themselves were uncomfortable or cold. This led them to consider re-working the dome so that it had curtains for the window and doors ("for privacy and nobody be peeping in on you if you are taking a nap in there"). Using fabric and hot glue, Sasha, Ginny and Talie measured and cut put curtains which they then glued onto the window and door of the dome. They then decided that a "rug" was necessary so that it will be "soft and cozy" inside the dome, since they had observed some of the smaller kids actually napping in the dome. Because they could not find a rug at the club, they made do with the largest piece of fabric from their making space supplies,

that covered the required surface area. Finally, on observing the prominent location of the dome right by lobby next to the entrance of the club, Sharon, Steven and Tricia decided that the dome needed to be further spruced up by galaxy-color spray paints. The geodesic playdome has sat in a corner in the club lobby, utilized by many younger club children.

4.3 Case 3: #StopRacism

In a Community Making Space hangs a light-up sign which reads #StopRacism. The sign, made out of heavy poster board, double plied with hot glue, is painted gold so that it would be bright and noticeable, with black lettering. Around the sign are 40 white LED lights, each punched through the poster board, and connected by a hidden parallel circuit. The circuit is powered by both a set of batteries and a hand crank generator. Nila the youth-maker had indicated, before moving away to Texas with her mother, that the next step was to re-make the sign on wood so that it would be more durable, and powered by a solar panel and batteries so that it could be placed outdoors on the street by her school.

Nila made this sign over four months. She wanted to make something that would address the heightening racism she felt in her city "because of the Orange Duck." Nila also worried that racism was creeping into all aspects of life. She recounted an event that had gotten national prominence: "Like the two black guys who were arrested at that Starbucks in Philadelphia? They just like showed up for a business meeting and they didn't want to buy coffee right away. The manager called the police and the police arrested them for what? For nothing. For being black and at Starbucks."

Nila conducted surveys with over 30 peers at her club, and all of them indicated that they had experienced racism on a fairly frequent basis. She noted that the majority of youth respondents, the majority of whom are African American youth, experienced racism at school, on the bus, and walking through their city. In conducting research on how to help stop racism, by interviewing adults in her community center and also reading about it on-line, she thought one approach would be to promote dialogue on racism. Putting up a sign to increase awareness of the problem, she felt, may at least get more people talking about racism in their city.

Nila went through several iterations, each on requiring her to dig into both technical and social dimensions of her design. Her first iteration was a sign on a single ply of poster board, and a single string of lights. However, her peers indicated that the sign would not catch anyone's attention and she needed a hash tag to show that the "stop racism" was a much bigger conversation and a resource for ideas. At the same time, her mentor asked her where she wanted to place the sign, opening up questions on the sign's durability.

She then went through additional iterations to address these concerns. First, she added a second ply of poster board, however, this did not solve the problem raised by her peers. Nila then decided to make a new sign, this time reading #StopRacism. She also decided that she wanted lights around the entire sign to make it more visible. In further talking about her sign with her peers, and looking at the survey data, she decided her sign needed to be outdoors, on a street where the youth experienced a great deal of racism. At the same time, though, she struggled to

get the lights to light up with copper tape, despite having soldered the connections, she completely replaced her circuit with standard wire.

Nila had one more idea for revising her prototype: to remake the sign on wood to ensure its durability in all kinds of weather. However, before Nila could make these changes, she moved with her mom to another state. Her poster board sign currently hangs in the maker space. Youth who attend the makerspace periodically turn the sign on when they feel racism was particularly affecting their day. The sign has become a symbol of their group needing to stop and affirm each other for who they are. They also moved the sign to a central spot and turned it on when they hosted an electric art workshop for younger kids.

This vignette illustrates how Nila went through many iterations so that it would serve a social need in her community, that is, helping to stop racism. With various forms of input from peers, mentors, her mother and the internet, she developed an approach – more than a sign – to engage her community in dialog on racism. While Nila had to move away, her sign continues to be used by peers, and as an exemplar during electric art workshop with others.

4.4 Looking Across Cases

Looking at the "moments of expanded iterations" across the cases, there are *three compelling elements* that have implications for designing for equitable and consequential making experiences for youth. First, youth were able to locate broader injustices within their making space discourse, suggesting that youth drew from multiple epistemologies, some grounded in community cultural wealth, others in making and STEM. Su'Zanne drew from familial capital (brother's project), aspirational capital (serving the homeless in a practical way), social capital (help from allies like maker mentors) and resistance capital (recognizing injustices nested in the state of homelessness). The geodesic dome youth-makers also drew from aspirational and resistance capital in their desire to make a play structure for younger peers because of the unjust lack of play infrastructure at the community club. They too, drew on social capital in garnering support from maker mentors.

Second, iteratively engaging in design-making work in tandem with mining relevant community wealth afforded further design and making experiences to both the original designers and other youth-makers. In both cases, ownership of the made artefacts expanded to more members of the youth-making community. In Nila's case, the sign was turned on when youth felt that racism needed to be foregrounded in group discussions, and also served as reminder of how powerful electric art could be. Third, the afterlife of made objects are significant in impacting the emergent maker culture through influencing the processes of making. In the next section, we discuss how twinning iterative design with community cultural wealth could foster more equitable and consequential making experiences for youth in communities.

5 DISCUSSION

Our findings suggest that "expanding iterations" are critical to legitimizing knowledge and practices toward rightful presence. We use the phrase expanding iterations to call attention to how the iterative process in making involves much more than the prototypical technical

iterations in the actual design. While important, layered into these iterations are iterative cycles of engagement with social and cultural context, mining and building on community cultural wealth relevant to the making projects. Such community wealth were translated into maker-relevant knowledge and practices during the iterative design process, as youth sought to make in ways that mattered in their communities, even when such contexts posed problems not typically taken up in normative STEM programs.

Also layered into these iterations were the iterations involving the "afterlife" of a project, as such projects gained shared ownership within a community. How is a project being used, by whom, and with what impacts? Such iterations expanded the ways in which cultural knowledge/practice became more legitimized in and hybridized as a part of STEM-rich making, re-shaping whose cultural knowledge had capital.

5 CONCLUSIONS

Reconceptualizing "iterative maker design" to intentionally recruit a range of relevant community cultural wealth in dialogue with technical design fine-tuning is a productive way forward in legitimizing relevant epistemological anchors that already exist in communities. Such an approach is one way toward positioning youth of color as rightful members of making.

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