

Equity-oriented STEM-rich making among youth from historically marginalized communities

Extended Abstract[†]

Angela Calabrese Barton

Michigan State University 305 Erickson
Hall, East Lansing, MI 48823 acb@msu.edu

Edna Tan

University of North Carolina at Greensboro
402 SOE Building NC 27402
e_tan@uncg.edu

ABSTRACT

We investigated the ways in which youth makers from two low-income urban communities engaged in sustained STEM-rich making towards making a difference in their communities. Drawing upon a mobilities of learning framework and four years of ethnographic data across two making spaces (41 youth maker projects), we found that as youth engaged with community across their making efforts, they foregrounded their relationality to communities in their design work, both within activities and across timescales. We also found that engaging making with community opened up new and different opportunities to co-make, as the youth drew on, and expanded their social networks. We discuss how these findings impact understanding of how a more equitable making culture can evolve, and its implications for how youth imagine their social futures in and through making.

CCS Concepts

• Social & Professional Topics → User Characteristics
→ Adolescents • Applied Computing → Education
→ Collaborative Learning

KEYWORDS

Equity, making, community, intersectionality

ACM Reference format:

A. Calabrese Barton. E. Tan., 2017. FABLEARN 2017 Proceedings. In *Proceedings of FABLEARN Conference 2017, Stanford, USA*, 4 pages. <https://doi.org/0000001.0000001>

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from Permissions@acm.org.
FabLearn '17, October 21–22, 2017, Stanford, CA, USA
© 2017 Association for Computing Machinery.
ACM ISBN 978-1-4503-6349-5/17/10...\$15.00
<https://doi.org/10.1145/3141798.3141809>

1 INTRODUCTION

We are concerned with understanding the possibilities for equity-oriented and STEM-rich making for youth from

historically marginalized communities. Given the proliferation of makerpaces across the country, including their growing inclusion in school settings, we seek to contribute new knowledge and practice for transforming the maker culture in ways that are both *equitable* and *consequential* for such youth, expanding the ecology of making and the maker movement. Thus, in this manuscript we report on our investigation into the following research questions:

1. How does community engagement as a part of STEM-rich making impact what, how and why youth choose to make?
2. What are the outcomes of youths' making practices with regards to their communities, and with regards to shaping the making culture in their community making spaces?

2 EQUITY & STEM-RICH MAKING

2.1 Maker Cultures

Inequality and underrepresentation of youth from historically marginalized communities in STEM persist. The maker movement has evoked interest for its potential role in breaking down these barriers to STEM learning and attainment [1]. However, despite growing interest in equity and making, few empirical studies of *sustained youth engagement* in STEM-oriented making exist. There is little empirical evidence describing how youth are supported, over time, in working towards robust STEM-rich making projects or on the outcomes of such making experiences, especially among youth from historically marginalized communities. We focus on STEM-rich making to foreground making projects that require robust science and engineering content knowledge and practice. We recognize that there are a wide range of making projects that are not necessarily overtly STEM-oriented, e.g., cooking, embroidery, although they could be. However, we focus here on STEM-rich making precisely 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.

Making and the maker movement has been rising on a tidal wave. However, there is little evidence that the dominant culture of the maker movement, as described above, has been *broadly shaped* by a diverse audience over a sustained period of time. While there are powerful pockets of making and making spaces that serve families and youth from historically marginalized communities [2,3], the statistics of the movement require caution [4]. As the maker movement has become formalized, the

knowledge and practices of communities of color or of low-income communities have not become central to its discourse. Furthermore, making that youth deem consequential to their lives or how such learning or making is supported is not well understood. Most making resources directed towards children promote the “keychain syndrome” – making experiences that are trivial and without prolonged or sustained meaningful engagement towards more complex projects [5]. The maker movement has placed scant attention on sustained maker learning experiences, despite recent acknowledgement of the importance of sustained engagement in supporting deepening knowledge and practice in engineering design [6]. Even when making projects support authentic engagement on a problem one cares about, there has been limited critical engagement with what constitutes consequentiality in making or for whom. We are interested in this aspect of *relationality* in making. This shift towards relationality is significant from an equity standpoint: Whose voices are valued and who counts as legitimate stakeholders in a community making space impacts how various people are welcomed, positioned and recognized for what they know and can do in a making space as a part of shaping the learning and participation that happens there. Examining how an emergent maker culture is actively shaped in community is a productive way to unpack how youths’ diverse interests and the historicized practices of communities of color are rich and legitimate resources for making.

2.2 Mobilities of Learning & Intersectionality

We ground our work in a mobilities of learning framework, anchored in expansive and connected learning principles [7]. We then layer on an explicit focus on the intersectionalities of race, class and gender, across this framework. There are three dimensions that tie to our study in making contexts: 1) Historicity – emphasizing that making always takes place in particular spaces and times influenced by institutional, societal and individual histories; 2) Remixing, that of resources, relationships and tools for nontraditional outcomes and forging new norms; 3) Identity work – who people are and who they can be, when they are making. Making is a dynamic multi-practice, involving the processes of re-authoring and re-mixing practices from a wide range of experiences. Connections and interests forged through making and as youth move resources/practices are shaped by one’s own historical geographies [8]. We are interested in how the shifting nature of STEM, making, and community places are always under negotiation as different individuals reproduce and resist the narratives at play, giving rise to new routines, ideas, and ways of being.

3 METHODS

3.1 Community Centered Making

In both MI and NC, the making space programs are housed in Boys and Girls Clubs (BGC), which are community-based clubs serving low-income families, with a focus on youth development, homework help, and sports for youth from low-income backgrounds. Both clubs serve low-income, predominantly multi-generational African American communities. Both are also located in mid-sized cities facing some degree of economic depression. In our overlapping researcher-educator roles, we have collaborated with BGC staff

to establish these making spaces 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 four-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 [9]. Critical ethnography provided an approach with which to “politicize” 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 from 2013 to 2017 from 41 youth team projects, including 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 [10].

4 FINDINGS & DISCUSSION

4.1 Relationality and making towards responding to and making visible historicized injustice

Across projects, youth identified problems that were linked to their community’s unique history and context and used community data to justify the urgency of projects. Many youth explored problem spaces that drew from their historicized experiences growing up amidst systemic racism and poverty, and the violence (symbolic and physical) they experienced because of it. Youth noted a prominent lack of access to a wide range of resources by members of their community, such as a lack of access to books and toys, videos made by people who look like them, or fashionable and functional clothing. All sustained maker projects (n=41) reflected these experiences in ways which intersected with other lived experiences, including lack of childhood (n=10), geography/climate (n=9), urban infrastructure (n=8), health/disability (n=8), bullying (n=7), sexism (n=5), healthy peer representation (n=5), education (n=5), caregiver responsibilities (n=4), signaling distress (n=4), policy brutality (n=1), and privacy (n=1).

Some youth makers addressed concerns tied to growing up poor in a place, calling attention to intersecting sociopolitical and geographical histories. Several youth addressed concerns about getting hurt in the *dark* because their interview and observational data showed that “where we live it gets dark really early in winter” and “lots of our streetlights don’t work.” Those projects, for example, would “keep my peers and younger children safe when playing football outdoors” (Samuel’s light-up football), or “help kids or our peers play with scooters outdoors in the late afternoon or evening when it is dark” (Jennifer and Emily’s light-up scooter). Alana wanted to assuage fears, noting that beyond increasing visibility and keeping one dry, her light-up umbrella prototype might help “people in my community feel

safe on the streets in the rain and at night.” Tamzin drew on her homeless shelter experience and peer interviews to design a light-up, alarmed cautious hat that youth could wear at a shelter, with a carefully embroidered heart design to “make it more attractive. In her interviews, she discussed how homeless youth are made fun of for “looking ghetto.” We see how she addressed the stigmatization of homeless youth alongside the concerns for physical safety. Samuel and Fall’s Little Free Library design addressed concerns about living in a library desert. They observed younger children sneaking into their making club to use materials, and they talked to 75 club-attending youth about whether they had a library card. Fall explained: “It is hard for our parents to take us to the library. Lots of kids do not have library cards, either. If we get a book, we can’t return it on time, and then that costs money, and we can’t check out another book.”

As they delved into the project over two years, Samuel and Fall began to see that the problem went beyond geographical access: libraries themselves were prohibitive by design. Most youth did not have transportation to a library, or could not produce the needed documentation to acquire a card. Other peers who had been to the library before could not check out books anymore because they owed late fines they could not pay. Both youth also noted that STEM books were important for both learning to read and learning STEM. That Fall had been labeled a “struggling reader” in school further punctuates this point. These concerns were therefore intersecting for the youth. As youth moved their projects across different spaces through community engagement, they expanded scales of criticality and connectivity in their work by engaging with the ideas of others. This emergent cultural knowledge and practices became platforms for seeing patterns of injustice within their community systemically, and for community development.

These projects challenged the youths’ mentors to re-consider their own criticality and connectivity. As one mentor said, “I had not considered the multiple layers of challenges in book access. I noticed at least 6 concerns raised by the youth: the location and hours of libraries, the need for proof of residency to get a library card, the cost of overdue books, whether one feels welcomed in a library, and access to things other than books, like maker kits. The library desert is just the tip of the iceberg.”

Across design processes, youth and mentors began to see problems they faced as bigger than themselves, opening up new ways to talk about and make that challenged systemic injustice. Ethnographic tools, employed as part of the making process, such as dialogic and structured interviews with community members and member checking, supported youth in making sense of the problems they cared about. It assisted them in recognizing those problems as part of broader, entrenched challenges that their community members had struggled with or negotiated over time. These tools also expanded spaces for mentors to share our own experiences with the problems youth identified, which assisted adult-youth collaboration to better understand the ways in which problems were entangled in systemic oppression experienced by their community.

Critical community dialogue was essential, for example, in supporting one group of youth to understand problems of homelessness with more complexity and nuance than is easily reached without such person-to-person interaction. The Donator app group had initially approached the problem space of homelessness as a one-dimensional issue. Well-intentioned, some group members had a limited understanding of actual

peoples’ stories, concerns, and tensions. Interviews with a mentor who had experienced homelessness herself, and also with housing campaign organizers and homeless shelter directors helped Donator app designers Zani and Kandy develop a more multifaceted, tangible, and human understanding of what it means to be homeless. They began to discuss the issue in terms of housing rights at national, state, city, and individual levels, and they explored how they could leverage their own experiences with both housing resources and digital technologies to engineer a potential solution. They connected what they learned from interviews and research to a simulation game they played on their phones, inspiring their design of an app that would allow users to experience homelessness through the lives of individuals. The girls transformed their own knowledge of their problem space and then expanded outward to educate and empower other community members as fellow housing rights allies.

One aspect of expanding scales of criticality is in how the youth began to both see the problems they were trying to solve as tied to different but intersecting scales of injustice. As youth moved their projects across spaces through their different forms of engagement with community, they began to make connections among economic, racial, gender and environmental justice.

Across the cases, youth viewed their design work as tackling multiple, related problems. Most youth, however, did not begin their design work with these intersecting ideas at the forefront. Their participation in surveying community members supported them in noticing which concerns were most salient, where and when, and for whom. While these connections were not made solely through these surveys, the approach created the space for new questions to be opened and new discourses to be legitimized, among both youth and mentors.

4.2 Engaging making with community: Co-making and expanding social networks

Engaging in making with community centralized what we refer to as co-making, including the co-production of design problems and solutions with a wide range of stakeholders across setting and time. First, engaging in on-going dialog with community opened up avenues of collaboratively informed exploration no one could fully anticipate. This meant that adults in these settings needed to become co-learners alongside youth to effectively support them. As one mentor stated, “there were times when I just did not know how to help the youth, and we had to seek out input together from others in the community. I think this really shifted the power as we needed each other and the community members to figure out how to move on the project.” While STEM educators may hold deep knowledge of some practices and ideas needed for the youths’ engineering/making designs to be successful, we did not always have the same level of knowledge of community or specialized applications to help youth solve particular problems.

While co-making looked vastly different across the range of projects, we highlight the motion sensor-activated baby gate project as one example. Designers Peter and Kalvin wished to help elderly, wheel-chair bound baby-sitters. Both boys had extensive experience with babysitting responsibilities and Peter knew of elderly caregivers, who had difficulty manipulating tension baby gates. They set out to design a motion-sensor

motorized baby gate, hacked from a simple tension baby gate. While we, as science educators, could explain the science behind tension, we had no experience in redesigning a tensioned baby gate into a motorized one. We enlisted help from a range of experts, including Peter's carpentry expert father, who shared advice on how to take apart a tension baby gate using particular tools, and a local maker-educator on easy-to-use sound sensors. Finally, we spent extensive testing time with Peter and Calvin, trying out mechanisms with different-sized motors, fishing line, Lego blocks, and wheels, before a prototype with moving panels on wheels was completed after 6 months of work.

Second, engaging in ongoing dialog with community created ongoing and snowballing moments for a wide range of others to contribute to design. For example, the Timmy, a heated work boot, began as a concept led by two boys but ultimately involved 12 others in its design. Maken's emphasized their design's polyvocality of concerns: "The Timmy is for people that can't afford shoes, people that don't have boots for winter . . . We will have a website where we sell boots for free for homeless people. Our product is useful for winter and for people that have cold feet, or just want to look cool."

While the project was led by Maken and Tel, daily discussions of their work during basketball games with friends led to six additional middle school boys offering help in various stages of design. In addition, two different engineering undergraduate students assisted in the particularly challenging aspect of figuring out which heating elements could be powered with a single rechargeable battery, and is safe and robust enough to sit in a shoe. Maken and Tel also involved adults in their community by seeking input on what kind of boot might be most fashionable and comfortable. Furthermore, they described the inspiration of their design as coming from seeing one of their teachers in an ankle cast and her concern over a cold foot in the cold/harsh winter.

Our study expands how the field frames a culture of sustained making [5] by highlighting that when youth have opportunities to engage as community ethnographers as a part of their making work, they are compelled to be responsive to basic questions of social justice and equity as a part of – not apart from – the technical and social dimensions of their making work: "Who is their making project for? Whose knowledge counts in their making project? Who takes part in defining the problem, data collection, interpretation, and analysis? Who owns their making project, and to what end? How youth makers are taught to examine and incorporate these concerns, as part of making, shapes not only their development as makers, but also how their making work may potentially impact both the individual and society. This intersecting approach reframes making both in terms of process and outcome. This culture supports the deliberate departure from pre-designed making activities redolent of the "keychain" syndrome so as to best support making projects that authentically contribute to the improvement of conditions for youth. This culture supported deeper engagement in STEM knowledge and practice, when community needs demanded more robust designs.

The youth's making culture was also geared towards relationality. This is important because it requires maker educators to consider how youth sought to transform the relations among the youth makers, the content/practice of making, and their making peers, mentors and community towards who they are and want to be and towards the

possibilities for their making work. The problems addressed were emergent of their locations and histories, rather than the interest of any given individual. The design approach leveraged within these two making spaces foregrounded community voices and co-ownership, offering youth opportunities to build relationality into their making culture. Community engagement helped youth to see and understand their own relationality; that is, how youth are related to the issue they are investigating, to other youth involved in the project, to community members, adult mentors, and the broader systems of power which shape their experiences in the world as young people of color growing up in lower-income communities. This view has a disruptive dimension that focuses on challenging historicized inequalities as a part of making. By engaging with community as part of their making practices, the youth placed new attention on making as a process not just of producing new artifacts, but also of co-constructing *new spaces for imagining new social futures*.

5 CONCLUSIONS

Through community-grounded making work, youth demanded widening of boundaries for making in dialectical relationships with the lived experiences of community youth makers. The landscape, population and practices of a community makerspace are reshaped as a result. Who youth makers are, what issues they care about, who other stakeholders could be with whom youth-makers can collaborate, what resources and approaches are sanctioned are renegotiated in ways that foster equitable and consequential making for the youth. Equity in STEM-rich making is possible when co-created in locally-centered, community makerspaces where youth can be empowered to collaboratively frame problems and design solutions to authentically address injustices in their everyday lives.

ACKNOWLEDGMENTS

This work was supported by the National Science Foundation.

REFERENCES

- [1] Martin, L. (2015) "The Promise of the Maker Movement for Education," *Journal of Pre-College Engineering Education Research (J-PEER)*: Vol. 5: Iss. 1, Article 4 <http://dx.doi.org/10.7771/2157-9288.1099>
- [2] Peppler, K., & Bender, S. (2013). Maker movement spreads innovation one project at a time. *Phi Delta Kappan*, 95(3), 22-27.
- [3] 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..
- [4] Brahm, L. & Crowley, K. (2016). Learning to make in museums. The role of maker educators. In K. Peppler, E. Halvorsen., & Y. Kafai (Eds.) *Makeology: Makerspaces as Learning Environments* Vol 1., 15-29.
- [5] Blikstein, P. & Worsley, (2016). Children are not hackers. Building a culture of powerful ideas, deep learning and equity in the maker movement. In K. Peppler, E. Halvorsen., & Y. Kafai (Eds.) *Makeology: Makerspaces as Learning Environments* Vol 1., 64-80.
- [6] American Society for Engineering education (2016). *Envisioning the Future of the Maker Movement: Summit Report*. Retrieved from <https://www.asee.org/documents/papers-and-publications/papers/maker-summit-report.pdf>
- [7] Engeström, Y., & Sannino, A. (2010). Studies of expansive learning: Foundations, findings, future challenges. *Educational Research Review*, 5, 1-24.
- [8] Haan, M., Leander, K., Unlusoy, A., & Prinsen, F. (2014). Challenging ideals of connected learning. *Learning, Media and Technology*. 39:4, 507-535, DOI:10.1080/17439884.2014.96425
- [9] Trueba, H.T. (1999). *Latinos unidos: From cultural diversity to the politics of solidarity*. Lanham, MD: Rowman & Littlefield.
- [10] Strauss, A., & Corbin, J. (1998). *Basics of qualitative research* (2nd Ed). Thousand Oaks, CA: Sage.