Equity and the Maker Movement

Integrating children's communities and social networks into making

By Edna Tan, Angela Calabrese Barton, and Kathleen Schenkel

For many children, gaining access to STEM education is an uphill battle. Inequity and underrepresentation of children from marginalized communities persist. Research has pointed not only to an access opportunity gap but also to an identity gap—children from nondominant communities often do not "see" themselves in dominant STEM structures (Authors 2013). The maker movement has evoked interest for its potential role in breaking down barriers to STEM learning and attainment (Martin 2015). Characterized by hands-on working with materials (e.g., cardboard, fabric, wood) and digital components (e.g., 3D printing), making is highly sought after by educators as a productive STEM opportunity for children. However, many making experiences designed for children have been criticized for their trivial, "once-off" nature, without prolonged, meaningful engagement toward more complex projects (Blikstein and Worsley 2016). As makerspaces in and out-of-school are proliferating, few studies exist that investigate how children are supported in working toward robust and personally meaningful STEM making projects, especially for children from historically marginalized communities.

Tips for Classroom Teachers

CAUTION

Children were taught and frequently reminded of basic safety practices that apply during all making sessions, such as wearing safety goggles and the correct way of handling sharp tools (such as wire strippers and wire cutters).

Pedagogical Suggestions

- Invite children to share stories in their everyday lives related to the making/engineering activity. Children could also interview other peers in the school as a way to engage in community ethnography in the school context.
- Remind children to consider both social and technical design aspects during the making process.

Assessment Suggestions

- **Formative assessment:** During both design and making phases, engage children in conversation about how they are addressing specific social (gleaned from community data) and technical (science and engineering content and practices) elements.
- **Summative assessment:** Invite children to present their innovation in a showcase. During the sharing, assess children on the degree to which they attended to both social and technical elements, as well as how well-integrated these elements were in their design.

While working as co-teachers and researchers with upper-elementary children (grades 4–6) in two after-school making programs at local Boys and Girls Clubs, we have found that explicitly recruiting children's rich funds of knowledge anchored in children's existing social networks supported children in sustained, consequential making. Funds of knowledge are all the practices and knowledge children have developed by living their lives (Moll et al. 1992). Taking an *explicitly anti-deficit focus*, which means paying attention to the rich experiences children have and positioning them as capable and competent in STEM, we recognize the children as capable collaborators who possess relevant, community-based knowledge and experiences related to making. Children engaged in weekly making programs at their local Boys and Girls Clubs for a full school year (sustained programming), working on projects that served a need in their community. The making programs are collaborative efforts between the Boys and Girls Clubs and local university science education faculty, funded by both federal and local sources. We consider the children's making as consequential in three ways:

- By integrating their funds of knowledge and fellow community members' expertise, children engaged in positive maker identity work that supported them in seeing themselves as community makers.
- Children drew from both STEM and community knowledge in their making.
- The maker projects were used immediately to solve a community need that children collectively identified with community members.

In this article we highlight the five ways that we have found community ethnography as pedagogy for STEM-rich making to yield powerful outcomes for children.

Ethnography as Pedagogy

Children's funds of knowledge were recruited by engaging them in *community ethnography* (studying cultures from an insider point of view) as a pedagogical approach. Even as the children are informed insiders in their community, equipping them with ethnographic skills (e.g., designing surveys, conducting interviews) helped children and adult mentors appreciate the rich sources of community data that inform the children's making projects. For example, children interviewed peers, families, and community members on safety concerns in the community (e.g., walking alone at night, lack of adequate street lights, bullying) and ideas for ways to solve those problems. They also sought feedback about their project design ideas, both the technical and social dimensions. For example, Samuel's light-up football had to be of a soft material for younger children to be able to use it safely (social). He then had to consider technical dimensions—that is, how to position the rechargeable batteries within the ball to add weight to the ball in the center so that it "feels like a real NFL ball." This contributed to personally meaningful making. It also opened new modes of interaction among adults and children, allowing for greater movement of ideas and resources across settings and time.

The community ethnography process informed the making design process by:

- engaging children in collaboratively brainstorming community salient issues that can be addressed through making. We started with a broad issue, "Safety in the Community" and invited children to brainstorm how they view this issue in their everyday lives.
- introducing ethnographic methods to the children—specifically, how to construct a survey and how to conduct short interviews to gather community insights on problems that matter.
- organizing community meetings by inviting community members (parents, family members, teachers, and other children) to the club to facilitate the children's collection of community data.
- accompanying children into community public spaces (libraries and supermarkets) to survey more community members.
- supporting children in analyzing community data, defining the problem to be solved, and designing possible solutions.
- organizing feedback sessions where local engineering teachers and experts, in addition to peers and staff members at the club, gave children-makers feedback on their making, paying attention to design features.

Table 1 summarizes the cases of children engaging in community ethnography in their making process. The children presented their projects to peers and parents at showcases held in the community club. It is important to note that even as the children and community members identified some serious issues they were grappling with, their stance was not one of resignation but of agency—what can we do to make our communities better and stronger? As one child articulated, "We love our neighborhood … we want it to be even better."

Why Does This Matter in Terms of Outcomes?

First, the tools of community ethnography (interviews, observation, and open-ended surveys) opened up powerful modes of interaction among adults and children makers, allowing for greater access to ideas and resources, while expanding social networks.

When children and making men-

TABLE 1.

Summary of children's maker projects.

Children, age	Project	Community ethnography insights	Design features as a result of community ethnography
Samuel, 10	Light-up football for children ages 6+ to play with in neighborhood with no street lights	• Lack of streetlights • Lack of play • Gang activity • Long winter, short days	• Soft Nerf material • Tube lights • Nested rechargeable batteries in body of ball • Weighted "properly" • Waterproof
Tonya, 10	"Cautious hat" to keep children safe and fashionable	• Frequent homelessness among children at club and school • Appearance-related bullying due to homelessness • Fear for personal safety at homeless shelters • Limited income	• Double-layered beanie hat to hide circuitry between layers • Embroidered pattern for fashion, with LED light in middle of pattern • Alarm that can be activated by a button • Powered by solar panels and rechargeable batteries
Jennifer & Emily, 11	Light-up scooter to keep children who commute on scooters safe in the winter when it gets dark early	• Lack of transportation • Long winter, short days • Lack of fun • Limited income • Most popular scooter model • Speed at which children like to ride their scooters	• Prototyped on most popular scooter model • Solar panel for cost-efficient power source • Rechargeable batteries • Specific kinds of lights • How and where the circuit should be on the scooter
Sasha & Talia, 10	Cardboard dollhouse with lights and furniture for younger peers at the Boys and Girls club	• Lack of toys for younger peers in community • Dollhouse a common theme among younger female peers	• Three-story cardboard dollhouse with cardboard furniture and scrap fabric for curtains and rugs • Paper circuits with LED lights for lighting
Ariel, 10	Light-up umbrella to keep people safe on wintry sidewalks in the dark	• Lack of streetlights • Short winter days • Abundant rain and snow in the winter months • Low-income community	• Using a recycled umbrella that another peer repaired, built a light-up system with LED tube lights along the handle and spokes of the umbrella, powered by a hand-crank generator

tors engaged in conversation around problem definition and solution design, children were encouraged to present as many perspectives as they deemed significant, informed by community data. Mentors were mindful in these brainstorm sessions to attend to inclusivity and broadening perspectives of what the making process might entail. In so doing, adult mentors supported children's development of ownership, supporting their autonomy and their perspectives, in framing the community safety problem space for themselves.

For example, fifth graders Jennifer and Emily prototyped a solar panel–powered light-up scooter (Figure 1) to solve the problem children in their neighborhood faced: a lack of transportation. Some families did not own cars, parents who worked needed cars, and the bus system was unreliable and expensive. After analyzing survey data that highlighted their community's concerns about safety, Jennifer and Emily asked their maker mentors to walk through their neighborhood with them to collect observational data about children's scooter use. They noticed where there were safe sidewalks for riding and identified locations of streetlights. They interviewed children at the club about their initial ideas. They noticed that people of varying ages used scooters. Through interviews, Jennifer and Emily also noted that when it gets dark, especially during the short winter days, children were unable to use their scooters to get around because of inadequate street lighting. All this community ethnography data and conversations helped Emily and Jennifer design a solar-powered light system that could be attached to their neighborhood's most popular model of scooter.

With help from maker program mentors, the girls worked hard to experiment the optimum positioning of the circuitry, to not impede movement or comfort (handlebars must be free enough for hands but still be lit up). Throughout the design process, mentors (none of whom were scooter riders) were mindful to let Jennifer and Emily lead the activities as the children addressed their concerns (e.g., how many hours of light and therefore power requirements would be required in the winter, as related to frequency of scooter use).

Second, the problems the children hoped to solve through engineering design in their makerspaces reflected both personal and community concerns or needs that were deeply linked to their community's unique history and context.

Some defined problems included "keeping my peers and younger children safe when playing football outdoors in our community" and "helping kids make friends" (Samuel's light-up football), "helping people stay safe in the dark and rain" (Ariel's light-up umbrella) and "helping kids or our peers use scooters outdoors in the late afternoon or evening" (Jennifer & Emily's light-up scooter).

Furthermore, the children identified problems linked to broader, sustained problems that their community members (including themselves) had struggled with over time, creating opportunities for them to develop ownership with their STEM-rich projects while also opening up space for critical reflection on *systematic injustices*, large-scale inequities that impact particular groups of the population. For example, problems youth identified to address include: decay-

FIGURE 1.

Jennifer and Emily's solar-powered, light-up scooter.

PHOTOS COURTESY OF THE AUTHORS

FIGURE 2.

Samuel's football.

ing infrastructure (e.g., limited street lighting), police brutality (e.g., need for protection), economic concerns (e.g., the high number of homeless people and poor families), geography (e.g., harsh weather conditions and short days) and children's concerns (e.g., fostering positive peer relationships/friendships, bullying).

Samuel's light-up football (Figure 2) featured a softer, Nerf ball with LED tube lights stretched along the concave edges of the ball, powered by rechargeable batteries housed in the center of the ball. The design-features of his ball were informed by interviews and feedback sessions with community members, including peers at the boys and girls club, a local professional football player, his mother, younger cousins who play football, and science educators who visited the club during feedback sessions. Community ethnography supported Samuel in attending to both technical and social aspects of his football design. Having access to healthy recreational activities (social) and staying safe while playing football in the dark (social and technical) due to lack of streetlights are both essential. Therefore, technically, his football had to have specific lights that illuminated the shape and location of the ball, while maintaining smooth contours (for ease of catching and throwing) and staying cool (limited heat given off from lights). The making experience was meaningful to Samuel. As he reflected, "[Making this football] is helping me become an engineer. I want to be an engineer when I grow up."

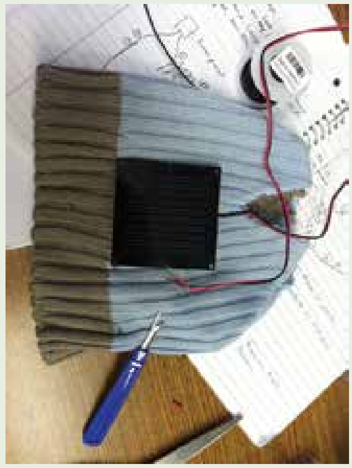
Third, as children moved their projects across spaces through engaging in dialogue with community members, they had new opportunities to deepen their STEM knowledge as community input helped refine the projects. The children also expanded their social networks by engaging with the ideas of others.

As community concerns initiated more complex design conditions, the youth had to turn to science to consider the best ways to both maximize trade-offs and optimize their designs.

For example, Tonya, a fourth grader, designed a "cautious hat" (Figure 3) for children who might find themselves in homeless shelters quartered with strangers. Tonya's conversations with peers revealed that many periodically encountered homelessness. Tonya and her peers discussed the need for the hat to be stylish so that homeless children will not be bullied for their appearance. Her beanie hat featured a hidden circuit with a solar panel, diode, and rechargeable batteries sewn into the hat to power an alarm and a decorative LED light.

FIGURE 3.

Tonya's hat.



Fourth, robust STEM knowledge learned and applied not in isolation but in an integrated fashion as they became necessary for the children to progress in their making.

The STEM knowledge the youth learned and became competent in during the making process included basic circuitry, energy transformation, efficiency of energy transformations, calculating power requirements for outputs, and alternative green energy sources such as solar panels and hand-crank generators.

Principles to Apply in Multiple Settings

Three pedagogical principles emerge from our work with children and making. Community ethnography as pedagogy (1) emphasizes children as experts of their own communities' concerns and how these concerns connect to STEM; (2) situates knowledge production within local contexts in inclusive and empowering ways, and (3) contributes to improvement of conditions for children in the here and now while supporting children in seeing themselves as community makers. We found that actively bringing in community wisdom through ethnographic activities as described, dedicating time to conversations with children during the making process, and providing access to sustained making (both time and space) all supported children's robust making.

For the maker movement to truly attend to equity concerns, we need to consider that who can make and who cannot and whose knowledge matters and whose does not are all a part of making itself. We suggest that community ethnography is a productive way to support children in robust and meaningful making while leveraging and honoring children's everyday experiences and their communities. ■

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