Making Connections: Challenging the Perceived Homogeneity of Making

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Introduction

The Maker Movement, defined by Voight (2014) as "the umbrella term for independent inventors, designers, and tinkerers" and its emphasis on creativity, and innovation, is being increasingly recognized as a potentially transformative pathway to developing interest in engineering (Jordan & Lande, 2013; 2014; Martin, 2015). For over a decade, the exponential growth of the Maker Movement has catalyzed the development of new tools, spaces, programs, and events that allow people to engage in activities and processes that have clear links to STEM learning (Kalil, 2012; Kalil & Garg, 2013), and in particular, engineering-focused skills, knowledge, and ways of thinking (National Academy of Engineering, 2009). Making has been gaining traction across all levels of engineering education, from undergraduate engineering design courses and labs (Wilczynsky, 2015) to the increasing number of *Makerspaces* being built and filled with computers, supplies, and tables for collaboration within K-12 schools (Blikstein & Krannich, 2013). Beyond the classroom, informal learning environments, such as museums, science centers, and libraries, have increasingly embraced these practices (Sheridan, Halverson, et al., 2014) by also setting up Makerspaces, developing and refining Making activities, and sharing Making practices across institutions.

Despite the increasing popularity of Making, common perceptions of "what counts" as Making can often be quite narrow, focused heavily on electronic-based and computational forms of Making while excluding a wide swath of other creative and productive activities. Indeed, while Maker activities and events have been shown to be quite successful at attracting traditional STEM learning audiences – commonly white, male, and middle/upper-middle class – to an expansive range of design-based activities, leaders in the Maker Movement have identified a need to better engage a broader range of participants, especially people of color (Barton, Tan, & Greenfield, in press; Buechley, 2013; Karlin Associates, 2012; Wardrip, Brahms, & Crowley, 2014). As can be the case with other formal STEM learning experiences (e.g., Capobianco, 2007), members of communities of color may not identify with – or even be aware of – the Maker Movement and the Maker Community as it currently exists (Vossoughi, Hooper, & Escude, 2013).

Considering the promise of Making to enfranchise traditionally underrepresented audiences in engineering by providing accessible and relevant engagement with STEM content and practice, the perceived "homogeneity" of Making as being primarily defined as design activity related to the computational, electronic, and 3D-printed hardware arenas becomes increasingly problematic. Indeed, if Making continues to be positioned as a prominent pathway to science and engineering careers, then it is essential for it *not* to become yet another context in which the persistent underrepresentation of women and people of color tends to be reified. A broader definition of Making, one that acknowledges that *all* communities and cultures have been engaged in design and generative practices throughout history and circumstance, could lead to more inclusive, welcoming, and interesting making experiences for all learners.

The Making Connections project seeks to contribute to this conversation around making within the engineering education community by challenging common definitions and perceptions of "what counts" as making. As a partnership between a large Midwestern science and technology

center and several local communities of color, Making Connections explores culturally-embedded making practices and provides a platform to potentially expand and revise what is considered making – and ultimately, who is considered a maker. This paper focuses on two key elements of the research conducted during Making Connections: examining the alignment between the types of making described by project participants and those commonly associated with Making; and the analysis of the maker-style activities developed during the project that draw on these ideas. As such, the goal of this paper is to present one example of how conversations with members from traditionally underrepresented groups can influence and change the types of activities that can be used to engage young people and their families in making.

Background and Theoretical Framework

Recent work in the engineering education community has begun to examine the potential of the Maker Movement for catalyzing the development of early interest and understanding in engineering and design within young learners (see, for example, Honey & Kanter, 2013; Jordan & Lande, 2014; Martin, 2015). While there exist epistemological differences between Making and engineering (Svarovsky, 2011), there are significant overlaps in typical Making activities and engineering design, including designing towards a particular goal, negotiating sets of constraints, and engaging in multiple iterations of a design in order to improve and optimize it. However, Making often includes a greater sense of playfulness, whimsy, and autonomy (Thomas, 2014) than is typically found in traditional engineering design contexts. Often, it is blend of design and personal meaning that is highlighted as one of the most prominent strengths of the Maker Movement for attracting youth; by engaging in creative and design-based activity that matters and is interesting, young Makers can demonstrate high levels of motivation and persistence within a particular activity (Halverson & Sheridan, 2014).

Common Definitions of Making

Despite a rapidly growing body of research, there continues to be an ongoing debate about how to define Making, the central focus and galvanizing activity of the Maker Movement. For example, Lande, Jordan, & Nelson (2013) draw on definitions from other communities that have been associated with Making, such as the "hacker" community, the "hobbyist" community, and the "Tinkering" community in order to represent the multifaceted nature of Making. Martin (2015) also provides a comprehensive review of definitions of making seen in the literature, and proceeds to articulate a "working definition of making as a class of activities focused on designing, building, modifying, and/or repurposing material objects, for playful or useful ends, oriented toward making a ''product'' of some sort that can be used, interacted with, or demonstrated." Honey and Kanter (2013) define making as "build[ing] or adapt[ing] objects by hand, for the simple pleasure of figuring out how things work." Sheridan and colleagues (2014) also provide a definition for Making, describing it as the "creative production in art, science and engineering where people of all ages blend digital and physical technologies to explore ideas, learn technical skills, and create new products."

These broad definitions, and many others found in the Maker literature, seek to balance the need for identifying boundaries around a particular *community of practice* (Lave & Wenger, 1991) – in this case, the Maker community – with the strong desire to be inclusive of all types and forms

of Making. However, articulating these ideas in scholarly journal articles and books does not necessarily mean that members of the Maker community a) know about these definitions, b) buy into these definitions, or b) enact them in daily practice. In other words, although these definitions are rhetorically inclusive, they may not accurately represent the types of activities that the Maker community considers "legitimate" and clearly identifiable as "real Making".

Forms of legitimized Making within the Maker community

One approach to exploring the most centralized and legitimized activities of the Maker community of practice is to examine the types of Making represented in artifacts that are a) developed by the community and b) intended to communicate ideas, messages, and practices to both those who do, and do not, already identify as Makers. Two such artifacts, *MAKE Magazine* and *Maker Faires*, have been studied multiple times (e.g. Brahms & Crowley, 2016; Buechley, 2013; Maker Media, 2014a; 2014b) and yield interesting insights into the core of the Maker community.

MAKE Magazine was launched in 2005 by Dale Dougherty and O'Reilly Media. MAKE Magazine is the flagship publication of the Maker community, with a paid circulation of 125,000. MAKE Magazine has a wide and growing readership, and it has the fueled the explosive growth of the Maker Movement across the world. In addition, MAKE Magazine has synergistic relationships with two other central tenets of the Maker community: the Maker Faire effort and the Makershed.com supply website. Maker Faires are events that bring Makers together, allow them to display their work, and also provide an opportunity for members of the public to engage in Maker activities and demonstrations. Known as "the Greatest Show (and Tell) on Earth", it is estimated that the two signature Maker Faires in the Bay Area and New York City routinely draw over 200,000 attendees annually and feature over 1,500 different Makers (Maker Media, 2017). In addition, over 100 cities around the world host their own Maker Faires or mini-Maker Faires every year. Finally, the Makershed.com supply website features a convenient online hub to find many of the most common components needed to engage in Maker activities. These three endeavors – MAKE Magazine, Maker Faires, and Makershed.com – comprise the areas of the Maker Media Company, which officially formed in 2013. Together, these tools and outlets have created a powerful engine and infrastructure for the Maker Movement, and in so doing, have helped advance perceptions of what counts as Making activity, as well as the accepted identity of the Maker.

As part of her closing keynote to the FabLearn conference, Leah Buechley (2013) presented an analysis of 36 Make Magazine covers, which spanned its first nine years of publication. Across those issues, the five most prevalent themes she found featured on the MAKE magazine covers included: electronics (53%), vehicles (31%), robots (22%), rockets (8%), and music (5%). Generally, the electronics category featured projects that involved 3D printers and Arduino processors; the vehicles category involved remote control cars and pinewood derby models; the robots category involved robotics kits and toys; the rockets category involved rocketry kits as well as DIY rocket activities; and the music category tended to feature homemade instruments or digital mixing of audio files. Finally, across those 36 covers, there have been 40 people pictured; 85% of those people have been men and boys, 15% have been women, and there have been no people of color.

Certainly, the analysis of MAKE Magazine covers is a limited and somewhat superficial portrayal of what Making is and how the Maker community defines itself. Decisions of what gets featured on a cover are often made by a small group of editors at some point during the publishing process. However, in this paper, we argue that regardless of the process involved in choosing a magazine issue cover, the fact that MAKE magazine is one of the central documents and artifacts of the Maker community suggests that what is featured on its covers actually shapes the messages about what types of Making are valued and central to the Maker community. Moreover, data collected during studies conducted at the 2014 Bay Area Maker Faire and the 2014 World Maker Faire in New York City also suggest that the most common topics that attendees "regularly read about, or actively pursue interests" about are *general science, computers and mobile technology, 3D printing, and electronics* (Maker Media, 2014a; 2014b). In addition, these studies also reported that the vast majority of attendees were male, nearly all had at least a college degree and roughly a third had obtained a post graduate degree, and had a median household income over $124,5000 (Maker Media 2014a; 2014b). Thus, considering the central roles held by MAKE Magazine and Maker Faires within the Maker community, it is difficult to imagine that the commonly highlighted themes on the magazine covers and the common interests of Maker Faire attendees do not also significantly contribute to defining the broader discourse of Making.

Shifting the Discourse around Making

Applying Gee's discourse theory (2005) to the Maker community of practice, it seems that *Making*, written with a capital-M and representative of the Making commonly found within the Maker Movement, tends to be associated with only certain forms of generative activity, such as those identified by Buechley (2013) and highlighted by MAKE Magazine. Gee defines "big-D Discourses" as a particular "way of being in the world" that belongs to a specific community – it consists of not only the language of a particular community, but also the "ways of acting, interacting, feeling, believe, valuing, and using various sorts of objects, symbols, tools and technologies – to recognize yourself and others as meaning and meaningful in certain ways." In her analysis of the images on the covers of MAKE Magazine, Buechley (2013) provides us with an initial glimpse into the "big-d Discourse" of Making by exploring what, and who, is highlighted and celebrated over the first nine years of issues: predominantly white men and boys engaging in projects involving electronics, vehicles, and robots. Findings from the Maker Faire attendee studies (Maker Media 2014a; 2014b) also support this narrative.

While these Making activities will definitely appeal to certain audiences, traditionally underrepresented groups may have less access to the types of tools and resources needed to engage in these activities. Moreover, for a variety of reasons, members of traditionally underrepresented groups may also have less interest in engaging in these types of activities, many of which can be associated with hobby and leisure time – and certainly not the daily necessities or realities that can be much more pressing for families with less resources (Vossoughi, Hooper, & Escude, 2013). In contrast, *making*, written with a lowercase-m, can be representative of an incredibly wide range of human endeavors, many of which take place in the everyday contexts of our homes, workplaces, and communities. It is these familiar forms of *making* that a great deal of potential exists for the Maker Movement to be a pathway for groups

commonly disenfranchised by traditional definitions of engineering – and STEM more broadly. By helping young learners and their families make connections between everyday experiences and the roles, practices, and contributions of STEM professionals, making can catalyze the development of early interest and understanding in engineering. However, in order for this potential to be realized, the Discourse around Making described earlier must be shifted to include a broader range of making activities and practices – and in particular, the types of making artifacts and processes that are more familiar and accessible to traditionally underrepresented groups.

Funds of Knowledge as Levers for Change

How, then, can the dominant Discourse of Making be challenged, in order to advance a broader definition of making that values and legitimizes a wider range of making activities? The Making Connections project explored one approach to this question through its research and development activities. A collaboration between staff a science and technology museum (referred to as the "Science Center" in this paper) and a set of community partners, collaborators, and other participants, Making Connections initially sought to better understand the *funds of knowledge* (Gonzalez, Moll, & Amanti, 2005) that members of traditionally underrepresented populations had around making practices and artifacts. The theory of funds of knowledge directly challenges deficit-model thinking about learners, pushing educators to acknowledge and ultimately leverage the abundant "cultural and cognitive resources" within the daily lives of students, particularly those that come from non-dominant backgrounds (Moll, Amanti, Neff, & Gonzalez, 1992). Exploring and engaging funds of knowledge in STEM learning contexts has been shown to empower youth and create more equitable STEM learning environments (e.g. Barton & Tan, 2009; Barton, Tan, & Greenberg, in press; Verdin, Godwin, & Capobianco, 2016).

Once an initial understanding of the funds of knowledge that members of local communities had around making had been formed, the Making Connections team sought to engage in dialog with community partners and collaborators to create set of maker-style activities based on these ideas and practices. These activities ostensibly functioned as a set of *boundary objects* (Wenger, 1998) that incorporated ideas, practices, and artifacts from both the Maker community as well as the communities represented in the project participants. Collaboratively developing and implementing boundary objects can be a complex task, one that necessarily relies on a foundational relationship and trust between members of the different communities involved.

Returning briefly to the theory of communities of practice (Lave & Wenger, 1991), *boundary objects* can be extremely powerful in shifting the shared definitions of what is centralized and legitimized by the community, and can often lead the establishment of new and shifted community boundaries. They can provide opportunities for shared discussion and reflection by different communities, as well as an initial platform for exploring the development of new, shared understandings and practices by different communities. Therefore, based on the theories and prior work described above and building on established relationships with community partners, the Making Connections project began a process to better understand the types of culturally-embedded making familiar to community partners, engage in extended dialog with community partners and collaborators about specific making activities and practices, and then weave the funds of knowledge shared by community partners and collaborators into a series of

activities intended for use during ongoing Science Center programming. As such, this paper focuses specifically on the following research questions:

1) How are the types of familiar making activities identified by project participants aligned (or not) with the types of activities commonly associated with the Maker Movement?

2) How do the types of activities created during Making Connections align with the types of activities commonly associated with the Maker Movement?

3) What funds of knowledge were included in the activities developed as part of Making Connections?

Methods

The research questions articulated above are a subset of the larger research endeavors taken up during the Making Connections project. Due to the exploratory nature of the study, a suite of qualitative methods – including focus groups, observations, and interviews – were used to address the questions of the study. A brief overview of the entire project is described below in order to provide a broader context for the breadth of activity and inquiry that took place as part of this work.

Description of Program and Participants

Making Connections was an applied research and development partnership between the Science Center and local families who identified as African American, Latino/a, Hispanic, Dakota, Ojibwe, or Hmong. The overarching goals of the project were:

a) to build lasting relationships between the Science Center and families from traditionally underrepresented groups in STEM,

b) explore culturally-embedded making practices and artifacts, and

c) co-create activities based on these practices and artifacts that engage learners in making.

Making Connections unfolded in three phases: Start-up, Exploration and Development, and Implementation. During the Start-up phase, the Science Center began the project by assembling a cross-institutional team that included staff from community engagement, staff from marketing, program developers, and researchers. Once the internal team was assembled, community partners from each of the targeted underrepresented populations – many of whom had previously established connections or collaborations with the Science Center– were recruited to be part of the project team. A series of initial meetings with the larger project team allowed for the development of shared understanding, vision, and purpose for the effort, as well as the collaborative development of a theory of change for the project overall.

During the Exploration and Development phase, the project team hosted a series of events in order to learn about different types of making and making processes that occurred in different communities. Families from target communities were invited by the community partners to

participate in one of seven ***Listening Sessions***, which were focus groups that were co-led by a specific community partner and a member of the Science Center staff.

Each Listening Session had approximately 8-12 participating families represented. Due to the purposeful invitation process developed by the project team and community partners, participants at given Listening Session typically identified as a member of a particular underrepresented population (e.g., African-American, Latino/a, etc.) but also represented a wide range of socio-economic statuses. Across the seven Listening Sessions, there were approximately 100 total participants, and almost all of the responses recorded in the data were shared by adults in attendance.

Following the Listening Sessions, community partners identified and approached a subset of nine families to continue participation on the project as ***community collaborators***. These collaborators engaged in a series of design workshops with Science Center staff in order to begin the process of co-creating a set of maker-style activities. During these workshops, several activity stations were set up within a classroom at the Science Center, each featuring a different "starter" activity that workshop participants could engage with and explore. Community collaborators were invited to bring their own examples of making activities to share, and other activities from ongoing Science Center programs were also introduced. The goal of the design workshops was to dialog about different making practices and artifacts across contexts in order to catalyze the advancement or generation of ***maker-style activities*** for the final phase of the project.

During the final Implementation phase, the activities developed in the second stage of the project were deployed to Science Center visitors during five Saturday morning Making Connections events. These events happened during normal weekend hours of the Science Center, but often involved members of the Making Connections team standing in the lobby to greet program participants and orient them to the different aspects of the event that were happening throughout the day. The activities developed as part of the project were spread out throughout the Science Center and facilitated by either the project team or Science Center volunteers. In addition, these events functioned as opportunities for data collection with program participants. Community partners and collaborators once again invited families from target communities to attend these events, which occurred approximately once a month over a period of six months.

Data Collection and Analysis

In order to address the specific research questions stated above, three sets of data were collected and analyzed. During the Listening Sessions, ethnographic field notes (Emerson, Fretz, & Shaw, 2011) were generated by members of the Making Connections research team. As the first source of data examined for this paper, these field notes were qualitatively coded for emergent themes (Krathwohl, 2009) and member-checked by the project team and community partners who were present at each of the events. Listening sessions were intentionally not video or audio recorded in order to make the participants – some of whom were undocumented immigrants – as comfortable as possible (Hernandez et al., 2013).

The second source of data used for this paper were semi-structured interviews conducted with community collaborators after the design workshops during the Exploration and Development stage of the project. These interviews, conducted with the most engaged adult from each of the nine families, were audio recorded, transcribed, and also coded for emergent themes by the research team.

Finally, the last source of data used for this paper consisted of the final descriptions and documentation of the maker-style activities that were generated as part of Making Connections. These descriptions were included in a qualitative document analysis (Bowen, 2009) that examined both the topical focus of the activities as well as other emergent themes.

Findings

The findings from each analysis are presented below in three sections, each corresponding to one of the research questions stated above.

Alignment of making activities, Part 1: Listening Sessions and MAKE Magazine

The first research question for this paper asks about the alignment between the types of making activities identified by participants in Making Connections and the types of Making commonly associated by the Maker Movement. Because a comprehensive survey of the Maker community was not possible as part of this work, the categories of Making activities identified in the MAKE Magazine cover analysis by Buechley (2013) was used as a proxy for the commonly represented and highlighted forms of Making within the Maker community. The findings from of her analysis are included in the figures below.

During the each of the Listening Sessions conducted as part of the study, participants were asked to respond to the question "What have you made lately?" Across the field notes for the seven Listening Sessions, 111 examples of making activities were recorded by the note takers. The five emergent categories found in responses to this question included: Art/Crafts (26%), Cooking/Food Production (26%), Repairs/Renovations (16%), and Activities/Toys for Youth (16%), and Clothing/Accessories (9%).

Responses coded as Art/Crafts ranged from expressive paintings and drawings to craft projects that involved traditional techniques such as intricate beading or paper crafting. In addition to several mentions of cooking as making, participants also described a range of gardening methods (such as using a grow lamps) to produce their own food. Responses associated with repairs and renovations related primarily to cars and houses. Sewing clothing and knitting accessories such as hats were also examples that were identified by participants as examples of making. Interestingly, several participants also mentioned creating games or activities for kids and youth, in order to engage them in productive play – and at least in one instance, "keep them from getting stuck in front of a screen".

In addition to the emergent themes, Buechley's (2013) themes from the MAKE Magazine covers were also explored within the participant responses. Only 3% of responses were associated with electronics, 5% were associated with vehicles, and 3% were associated with music. No responses were associated with robots or rockets. Figure 1 below provides the

comparison of theme frequencies across both the Making Connections Listening Sessions and the MAKE Magazine covers.

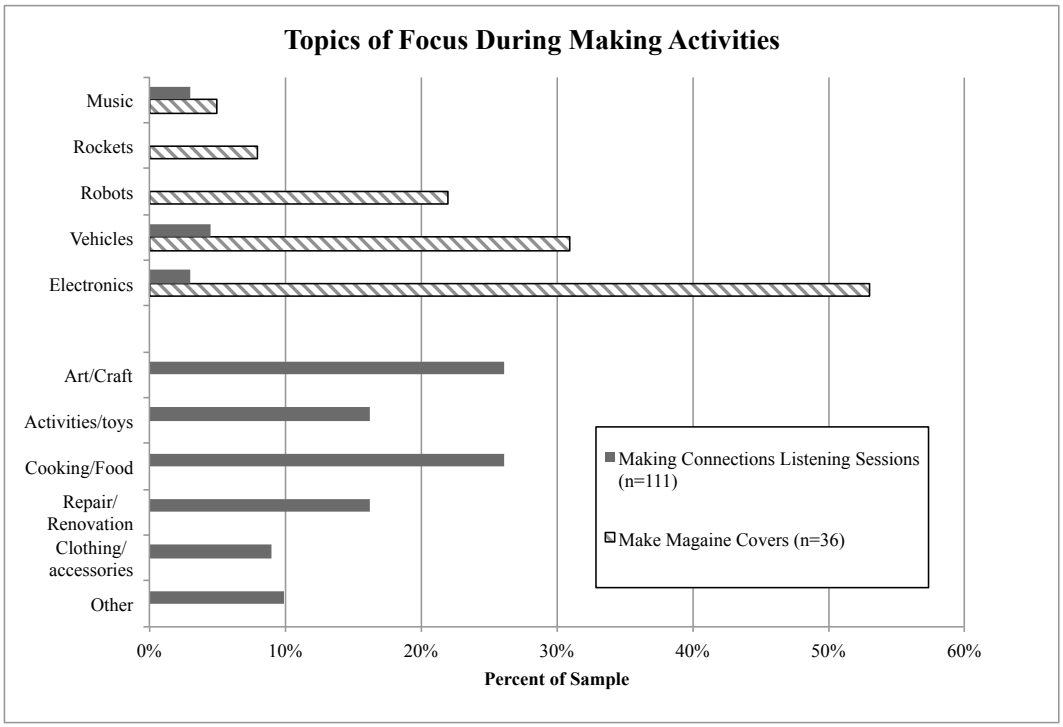

Figure 1. Analysis of making activities described in Listening Sessions.

As seen in Figure 1, little alignment between the types of making identified by Making Connections participants and the types of Making observed by Buechley (2013) in the first nine years of MAKE Magazine covers. The three areas where overlap was present were music, vehicles, and electronics. Responses from Listening Session participants related to making music involved playing music and creating instruments. Responses from participants related to vehicles were focused on tinkering with cars for the purposes of repair and customization. Responses from participants related to electronics were connected to repairing and modifying existing electronics such as speakers.

Alignment of making activities, Part 2: Making Connections activities and MAKE Magazine

The second research question for this paper asks about the alignment between the types of making activities developed as part of the Making Connections project and the categories of Making activities identified in the analysis by Buechley (2013). The findings from the document analysis of the final list and description of activities are seen in Figure 2 below.

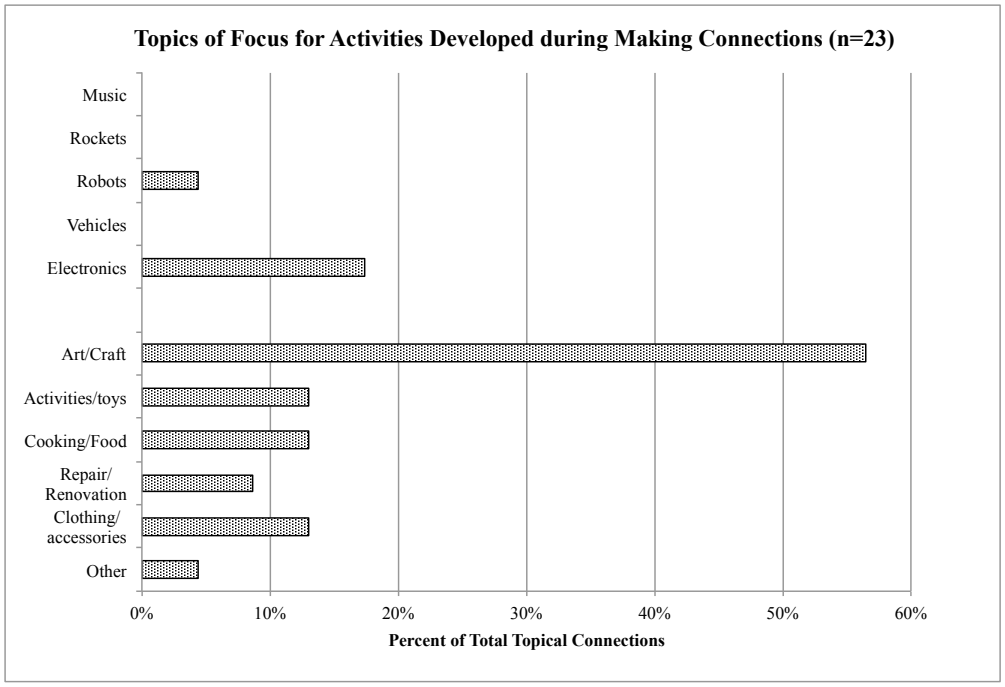

Figure 2. Analysis of making activities developed as part of Making Connections.

In total, 23 activities were developed as part of the project. These ranged from creating "DIY cookie cutters" by cutting, bending, and pop-riveting strips of aluminum, to working with different colors of duct tape to create woven patterns, to using cardboard, markers, and tape to create functional shoes and sandals. (For a more comprehensive description of several activities and how to implement them, please visit the online guides at https://snapguide.com/learning-technologies/.)

A few of the activities were revised versions of prior activities used during Science Center programming, such as programming the LEGO RCX robotic system. This robotics activity accounted for the only connection to robotics within the set of 23 activities. The connections to electronics were found in activities such as sewable circuits using conductive thread and LEDs, stop-motion animation using paper-cut outs, and creating a set of DIY speakers out of a paper cup, tape, wire, and a magnet.

Funds of Knowledge included in activities developed as part of Making Connections

The third research question for this paper asks about what funds of knowledge were included in the activities developed as a part of Making Connections. To begin, it is important to clarify the different types of funds of knowledge that emerged from the conversations with community partners, collaborators, and Listening Session participants.

Types of familiar and interesting making activities. Certainly, the categories presented in the above that emerged from the Listening Sessions could be considered as a type of fund of knowledge, highlighting the different making activities most familiar and interesting to members of the different target populations. These categories are listed in the first column of Table 1.

Making practices and processes. In addition to the funds of knowledge identified during the Listening Sessions, interviews and interactions during design workshops with community collaborators provided additional ideas about common making practices and specific cultural artifacts that could potentially be incorporated into Making Connections activities. During their interviews (n=8), community collaborators were asked to talk about the making processes and practices in which they engaged. Four common themes emerged from their responses, which can also be found in Table 1 below:

- Being messy: Messiness was a popular attribute that participants mentioned when they reflected on what Making looks like in their home. People described it positively, such as in one example, "If there's an activity going on where people are encouraging 'come on, do it! Get messy!' I think I do it more."

- Thrift: Attention to costs was a very common theme across several of the interviews. One participant described a craft project as a way to "reduce, reuse, recycle" materials which would have been thrown away. Another participant mentioned that the budget usually determines how loose or structured his process for making or fixing household items will be: "If it's simple tools and materials then I just dig in. But if there's a greater cost and going to the store, I gotta plan it out."

- Taking things apart: Participants talked about taking things apart during their making processes, such as "When I was a kid I had an old radio, just a clock radio, and I took that apart to see how it worked, back when I was younger when I had time. That really interested me." Many shared the same kinds of childhood memories, and even discussed being okay "when you put it back together and you're either missing a part or have too many."

- Making wrong or unexpected turns: Finally, the theme of making wrong or unexpected turns during the design process was quite common. One said "mistakes turn out to be genius ideas," and a different participant said "Sometimes I plan it in advance but when I finish it's something completely different than what I thought in the beginning."

Specific cultural artifacts. Finally, interactions with community partners and collaborators during project meetings and design workshops generated discussions that were focused on specific cultural artifacts made by members of the different target populations. For example, a community collaborator from the local Hmong community talked about her knowledge of ***Story Cloth Embroidering*** that was she was familiar with when she was growing up. While she could describe the finished pieces in detail and also some of her experiences observing the process, she herself did not actually have much experience engaging in the activity. Another culturally embedded making activity from the Hmong community that was discussed during the project was the ***Sepak Takraw Ball***, which is a ball typically made out of rattan and used in different games throughout Southeast Asia. Brought forth by a member of the Science Center program development team who was also a member of the Hmong Community, the Takraw Ball could potentially be created using everyday materials such as paper. Additional examples of cultural artifacts shared by project participants included ***Chancay Dolls*** from the Peruvian community and ***Sand Paintings*** from the Native American community. These examples are also listed in Table 1 below.

Table 1. Funds of Knowledge included in activities developed as part of Making Connections.

Familiar and interesting types of making activities	Common themes from descriptions of making processes	Examples of cultural artifacts shared by members of a specific community
- Art/Craft - Activities/toys - Cooking/food - Repair/renovation - Clothing/accessories	- Being messy - Thrift - Taking things apart - Making wrong or unexpected turns	- *Story Cloth Embroidery* (Hmong Community) - *Sepak Takraw Ball* (Hmong Community) - *Chancay* Dolls (Peruvian Community) - *Sand Painting* (Native American Community)

Drawing on these different types of funds of knowledge shared by participants, the project team began to create, develop, and refine a set of activities to be used during the set of Making Connections Saturday morning events at the Science Center. Figure 3 below illustrates how the different types of funds of knowledge were connected to the final activities produced and showcased during the events.

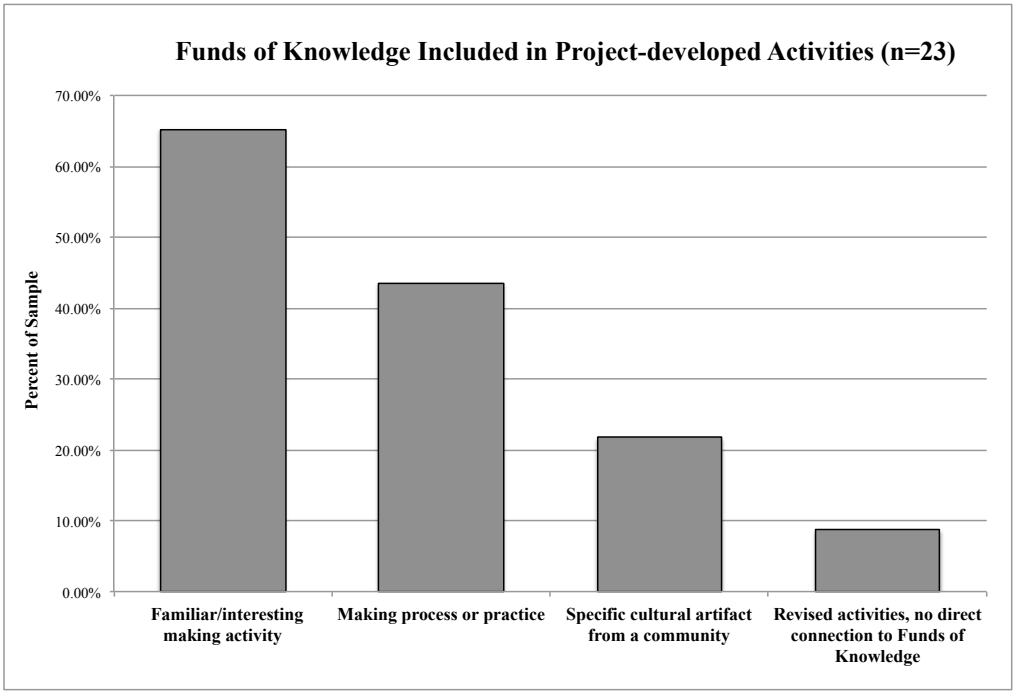

Figure 3. Distribution of participant funds of knowledge across activities developed

The most common type of funds of knowledge drawn upon in the activities were the familiar/interesting making activity categories from the Listening Sessions. Across the activities, 15 of 23 (65%) were directly connected to a category that emerged from the Listening Sessions. Ten of the activities (43%) were directly connected to one of the common making processes or practices that emerged from the interactions with community partners and

collaborators. Finally, five activities (21%) were connected in some way to a specific cultural artifact shared by project participant or team member. Two activities (9%), both of which existed before the project and were refined for use during the Saturday events, did not make direct connections to the funds of knowledge identified in Making Connections. However, the facilitation of those activities was retooled based on the overall product development that happened on the project.

Discussion

An important overarching goal of the Making Connections project was to challenge the perceived homogeneity of Making by exploring culturally embedded making activities and practices and then incorporating those ideas into activities that would be used with public audiences. In examining the data collected across the project as well as the final list of activities developed, this work contributes to the ongoing scholarly conversations (Vossoughi et. al, 2013; Barton et al., in press) around "what counts" as making, what is included and valued in current definitions of making, and who engages in making. Emergent themes from these data suggest a lack of alignment with the types of Making that has been commonly portrayed as Making within the Maker community. Left unaddressed and unacknowledged, this lack of alignment becomes increasingly problematic as Making continues to be positioned as having real potential to provide pathways to science and engineering careers for young learners (Jordan & Lande, 2014; Lee, 2015).

Using Gee's theory on D/discourses (2005), it is possible that the branding of Making by MAKE Magazine has resulted in a limited and narrow definition of making focused heavily on electronics, rockets, and robots. The findings presented here begin to push back on this definition, suggesting that study participants connected the creative, innovative, and generative processes found within their own communities to the idea of making. Indeed, if the community of practice around Making is to become more welcoming and inclusive of traditionally underrepresented populations in STEM, then a wider range of activities and pursuits must be legitimized, valued, and highlighted by the current leaders and influencers within the Maker community.

Of course, moving the needle from the branded definition of Making to the more inclusive and wider definition of making is a difficult, complex, and ongoing task. The Making Connections project approached this work by creating maker-style activities that incorporated interests, processes, and artifacts shared by project participants, as evidenced by the findings of the activity analysis described above. By weaving together the *funds of knowledge* (Gonzalez et al., 2005) identified in the data and the types of interaction and activity commonly found in makerspaces and Making experiences, these activities essentially act as *boundary objects* (Lave & Wenger, 1991; Wenger, 1998) that can begin to help expand and redefine our perceptions of making to include activities rooted in a wider range of communities and cultures. However, creating a set of boundary objects is merely the first step in changing the conversation around Making. Moving these types of activities more towards the center of the broader Maker community – and thus accepting and including them in the list of "canonical" Maker activities, particularly those that are identified as connecting to STEM learning – will require ongoing conversation, relationship-building, and collaborative effort.

Certainly, this study has several limitations. Making Connections was an exploratory study that unfolded at one Science Center in the Midwest that is surrounded by a particular set of communities. Participants for the study were recruited from specific traditionally underrepresented groups, but of course, their experiences before, during, and after the project should not be taken as representative for all other members of their communities. The findings reported here are highly contextualized, and several aspects of the project would be potentially difficult to replicate in other settings (such as other science museums or cities). In addition, it is beyond the scope of the current project to actually measure changes in the perceptions of Making that might occur after engaging with the activities developed by Making Connections; certainly, examining these outcomes and processes would be of value to the effort to redefine Making. Finally, Buechley's (2013) analysis of MAKE Magazine covers is not ideal as a proxy for the types of Making most centrally accepted and highlighted in the Maker community; certainly, an actual survey of Makers would provide a more comprehensive picture of "what counts" as Making for the Maker Community.

Despite these limitations, these findings still have several potential implications for a range of engineering education audiences. First and foremost, pre-college engineering educators who are considering adding a maker/making element to the educational experiences they design for young learners can use this work to begin thinking about how to broaden their scope of maker projects and activities, moving beyond 3D printers, Arduinos, and other commonly seen types of Making. Secondly, engineering educators who engage in community-based projects can draw on some of the collaboration techniques described here, particularly around the identification and inclusion of funds of knowledge from local community members into specific engineering and design focused activities. Lastly, this work seeks to contribute to the growing body of research around making within the engineering education community, extending the scholarly conversation by exploring and highlighting a wider range of culturally-embedded making practices and examples that have the potential to inform additional studies and projects.

Future work for Making Connections includes further exploration of the organizational change that happened at the Science Center as a result of this work, the additional decisions that happened when developing the final set of activities for the project, and the respectful but sometimes difficult conversations within and between project team members, community partners, and collaborators about how to appropriately honor and highlight cultural traditions without crossing over into the practices of cultural appropriation. In addition, further inquiry is warranted into how, if at all, engagement with Making Connections activities can impact perceptions of Making, STEM engagement, and the development of specific engineering interests and understanding. Additionally, the role of these activities as boundary objects can be further explored with Makers across the country as well as with afterschool STEM programs that are not necessarily identified as being Maker-focused. Finally, a broader survey of the Maker community that more clearly identify central and shared understandings and practices about "what counts" as Making would also be a fruitful future endeavor. Through these broader lines of inquiry, the Making Connections team seeks to make contributions to several intellectual communities interested in broadening participation in STEM for underrepresented groups through the use of Making.

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This material is based upon work supported by the National Science Foundation under Grant No. 1323584. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.