# A Card-Sorting Task to Establish Community Values in Designing Makerspaces

Riley Jack Meehan
Dept. of Education
Tufts University
Medford, MA
riley.meehan@tufts.edu

Brian E. Gravel
Dept. of Education
Tufts University
Medford, MA
brian.gravel@tufts.edu

R. Benjamin Shapiro
Dept. of Computer Science
Dept. of Education
Tufts University
ben@cs.tufts.edu

## ABSTRACT
This paper describes preliminary work on the design of a novel interview method for examining how existing values of school communities are integrating into new makerspaces. This new method involves a card-sorting task, similar to those used by information architects to design websites. Our card-sorting task is designed specifically to scaffold rising makers' discussions about their values and commitments for spaces that support tinkering and making. With the increase in excitement around making as a tool to broaden engagement in STEM, literacy, and art, schools designing spaces may adopt externally defined conceptions of making. This design-research method is aimed at refocusing participants' efforts on local definitions of making crafted by members of the existing community. The design and results presented in this paper are preliminary and ongoing, but the motivation is consistent with concerns that have been expressed by many in the emerging field of making: How do we create maker environments that are responsive to the needs and strengths of the existing school community?

## Categories and Subject Descriptors
K.3.1 [**Computers and Education**]: Computer uses in Education – *collaborative learning.*

## General Terms
Design, Experimentation, Human Factors

## Keywords
Makerspaces, Tinkering, Learning, Design, Education, Ethnography

## 1. INTRODUCTION
The maker movement is based around a do-it-yourself culture of innovating, designing, and hands-on creating [4]. The term "making" is deliberately vague as to bring together people from a wide range of do-it-yourself activities including woodworking, electronics, digital fabrication, crafting, sewing, among others. The act of making in all its different forms is not at all new – people have been making things for millennia – but the modern maker movement coincides with the democratization of technologies for small scale fabrication, hence the reinvigoration of making as an available activity that does not require apprenticeship and access to expensive technology. With increasing attention on the maker movement, making and tinkering are positioned as potentially rich intellectual activities and effective in motivating interdisciplinary engagement across STEM, literacy, and the arts [10]. As a result, researchers and educators have begun to consider making in education and educational institutions have begun launching their own in-house makerspaces (i.e. FabLabs@School) [1]. As the maker movement becomes mainstream, school communities are asking for their own spaces; however, the prominent existing examples of makerspaces often prioritize the digital fabrication tools that revitalized making rather than the ideals in which making is rooted.

Inevitably, the question that follows is: How do we make design recommendations that are responsive to school communities' needs? Building on previous research around card-sorting tasks to understand learning and cognition from the 1980s [3, 11], we present a novel methodology for gaining insight into rising makers'priorities and preconceptions of making to inform the design of their own school-based makerspaces.

## 2. BACKGROUND
Across the country, collaborative creative spaces are burgeoning in cities, suburban areas, and even in rural areas. These spaces--communities of people with tools—are often categorized as makerspaces and they are taking root in community centers, museums, libraries, as standalone community spaces. Similarly, formal educational institutions from kindergarten through university programs have begun developing makerspaces. Though these spaces come under many different names, such as fab lab, hackerspace, STEAMspace, or medialab, makerspace appears to be the most common label. For the rising maker, often what comes to mind when considering "makerspaces" is a variety of digital fabrication tools that, with the expiration of certain patents on equipment like 3D printers and laser cutters and the ever-decreasing price of electronics, have made the tools affordable and available to hobbyists for the first time [2]. Given the ubiquity of these tools, it is not surprising that when people think of "makerspace" it is frequently the tools themselves that first come to mind, not the activities (learning, critical thinking or skill development) nor the cultures that are central to these makerspaces. It is 3D printers, CNC mills, laser cutters, microcontrollers, and other affordable tech that have become de rigueur in the maker movement. Consequently, communities looking to start their own makerspaces may look to the preexisting conceptions of makerspaces and the *material*s that exists within them, rather than the *pedagog*y of their creation and culture of implementation.

If these spaces are to be spaces for productive and meaningful engagement, like schools, they must reflect the values and commitments of the community. A large community means many people entering into new spaces, with new activities, and new tools, which presents an alignment issue – what are individual values and commitments for such unknown spaces? And how

does a community of individuals going about the construction and use of a space come to develop shared values?

Another challenge for the integration of making in schools is that, while models of makerspaces exist, a paucity of practical advice is available on how to construct spaces that are responsive to the needs of the community accommodating the space. Frameworks exist for designing constructivist learning environments that are responsive to the priorities of each element in an activity system, but the question of coming to understand those priorities remains difficult to answer. Jonassen & Rohrer-Murphy [7] provide a framework for needs and task analysis based on activity theory [5] that is epistemologically consistent with the beliefs of constructivist learning. The framework provides a place to begin a conversation around aligning the values of a school with the emerging values of a makerspace, but specific tools, guidelines, and recommendations that support a community entering this process have yet to be developed.

In our own work as educators and researchers designing makerspaces in educational settings, the community's interests and priorities have taken central roles informing our design approaches. The focus of this paper is on a novel method for acquiring insight into how individuals organize their priorities and perceptions with respect to making within a school community.

# 3. DESIGN OF A CARD-SORTING TASK

The technique we designed is rooted in the kinds of *card-sorting tasks* that are frequently utilized by information architects and user interface (UI/UX) designers. In the UI field, professionals use card-sorting as an input to the structure of websites or other products. It is generally used as a user-centered design method for improving information findability within a system. UI professionals make use of the card-sorting task when they are looking for patterns in how users would expect to find content or functionality [12]. Some learning scientists have repurposed card-sorting tasks to investigate mental organization of disciplinary knowledge. [3, 11] Like their work, there is much overlap in how the traditional card-sorting task and our novel method are applied; however, the desired outcomes for informing design are ultimately different.

In the traditional (open) card-sorting task, participants are given cards showing various content with no pre-established groupings. They are then asked to sort the cards into groups that they feel make the most sense and describe each group. The focus of our card-sorting task is less on how users are sorting the cards and more on how they *describe* their sorting. The aim of our card-sorting task is to learn two things about a participant's relation to makerspaces: (1) What are the participant's preexisting perspectives on what is valued in making? And (2) When it comes to their own making, what are the participant's interests and how do they prioritize them? These foci illuminate two important distinctions about a participant's perceptions of making. The first (1) is intended to elucidate the externally defined interpretations of makerspaces and what counts as making. The second (2) is aimed at revealing what is most important to the participant as a primary user of a hypothetical space. Since the scope of our research is framed with the schools, the prompts we used attend to learning, though the task can be adjusted with prompts that focus on different commitments by using different prompts. We argue these two pieces of information are essential to designing a space that meets the needs of its individual users and to begin to understand the values that are shared amongst the community members.

There are several ways the participant organize thoughts through this task. The primary ways we anticipated participants to organize their priorities are into the following categories: technocentric, discipline-oriented, ideal-oriented, product/process-orientation.

## 3.1 Anticipated Responses

There are several ways of responding and organizing one's thoughts through this method of data collection. We anticipate the participants to organize their priorities into the following categories: technocentric, discipline-oriented, ideal-oriented, product/process-orientation. These categories are based on Papert's [8] theory on technocentrism and Brahm's [2] work on maker community practices.

**Table 1** *Categories of Anticipated Responses*

| Category | Definition |
|---|---|
| Technocentric | As mentioned previously, we expected some participants to focus on the tools that revitalized making as fundamental to makerspaces. The term technocentric is pulled from Papert's [8] idea of technocentrism, which refers to the tendency to give centrality to a technical object – similar to that of a child's egocentric difficulty understanding anything independent of the self [9]. Participants with technocentric orientations tend to privilege the *stuff* (3D printers, laser cutters, Arduino microcontrollers) when performing the task. |
| Discipline-oriented | Discipline-oriented sorting emphasizes specific educational disciplines over others. Users can either explicitly or implicitly prioritize certain disciplines over others when sorting. The disciplines explicit in the card-sorting task are science, technology, engineering, mathematics, art, and literacy. |
| Ideal-oriented | There are certain ideals that are often associated with "21st Century Learning", STEM, makerspaces, and other new educational initiatives. Many of these ideals have been present in education for centuries, but have gained new excitement in recent years. Ideal-oriented sorting emphasizes ideals such as collaboration, innovation, interdisciplinary learning, sharing, leadership, and entrepreneurship over other categories. |
| Product/process-oriented | The last distinction in sorting strategy is between focusing on the product or process. Tinkering and making often involve a radical emphasis on the process of creating rather than the resulting product of their efforts. Some of the cards were chosen to illuminate where on the product-process spectrum participants situate the activities and their value. |

## 3.2 Cards for the Task

The purpose of including cards in the task is to scaffold a discussion about rising makers' perceptions with respect to making using different ideals, values, objects, and activities across the gamut of making and education.

There are two categories of cards used for the two different parts of the task. The first category is comprised of cards with images and titles on them. The individual cards are broken down into

disciplines (science, technology, math, art, etc.); soft skills (leadership, collaboration, project documentation, entrepreneurship, etc.); motivations (personally meaningful projects, projects meaningful to the community, individuality, functional products, etc.), digital fabrication technologies (3D printing, laser cutting, microcontrollers, etc.), and personas (novices and experts). The second set of cards contains short descriptions of different activities or projects one might come across in makerspaces located in educational settings such as "3D DESIGN ACTIVITY: Learn to design digital models and print them out." Outlined below is the protocol for performing both parts of the card-sorting task.

## 3.3 Task Protocol

Preparation for our card-sorting exercise follows the same guidelines as other card-sorting tasks [3, 11, 12]:

1. Selecting content
2. Selecting participants
3. Preparing cards

Content selection was mentioned above in Section 3.2, the remaining steps of the task protocol are as follows:

### *3.3.1 Selecting participants*

Interviews are conducted in two formats: (1) with individuals and (2) with groups made up of those with shared interest in a specific makerspace in a known community. In our initial trials reported here, the interviews were held individually. The benefit to interviewing a participant individually is that they are less likely to be affected by the responses of other participants and more willing to speak exactly what s/he honestly believes. The downside is they are less likely to think aloud, thus it is important that the interviewer prompt them to describe why they make each of their decisions.

When considering whom to interview, participants who will be most frequent users of the space should be the primary focus. In the case of a school, teachers and students are key participants.

### *3.3.2 Preparing the cards*

When designing the exercise, a list of activities, ideals, values, objects, skills, and disciplines of making and makerspaces was generated. This collection is intended to run the spectrum of making activities from the arts to robotics. One important note is that while we try to gather ideas from a broad variety of making, we focused on the Gershenfeld [6] "bits and atoms" version of making, rather than Papert's variety that would include any "product [that] can be shown, discussed, examined, probed, and admired" from a sand castle to a theory of the universe, for the scope of the preliminary interviews we remain focused on bits and atoms [8].

As far as number of cards is concerned, in our preliminary trials with the task we found that around 20-40 cards per sorting task were suitable; more than that many can be time consuming and tiresome, especially when asking participants to explain their choices.

### *3.3.3 Execution*

Before beginning the task, it is explained to the participant that they will be performing two very simple exercises that will give useful insight into how they think about making in education in order to design a space that is valuable to their community.

The first task: The researcher places a stack of cards in front of the participant that represents different ideals, values, objects, skills, and disciplines. They should be asked to try to sort the cards in a manner that is representative of their priorities within a makerspace. It is important that they know the goal is not to sort the cards into different categories based on likeness. As mentioned, the cards are different disciplines, soft skills, motivations, digital fabrication technologies, and personas and can be sorted as such, but the participant should try to sort them with a focus on their interests.

During the exercise, the facilitator's main jobs are to observe, listen, and prompt. In order to avoid interrupting the natural flow of the participant's sorting process, the facilitator should take notes on a small notepad about particular questions that may be worth raising after initial sorting has completed.

Once the participant has finished sorting the cards, they should be prompted to explain their categories and decisions for sorting the cards accordingly. This is where the most useful information lies. Though different participants may sort cards dissimilarly, they may be implying very similar values and it is through explication of their deliberations and decisions that these values are illuminated.

The second task: After completing the first task, the facilitator may ask them to complete a second, similar card-sorting task. This task is done with cards that have different activities that may occur at educational makerspaces. They should again sort the cards based on how they would prioritize them with respect to making. One example of a useful way to frame the question is, "If you wanted to educate students to be makers, which of these activities are examples of activities that may achieve that? You may think they are all useful activities though differently useful, if so, sort them accordingly." The goal here, like in the first activity, is to gain insight into what the participant is valuing with regards to making. This second part may serve as a useful supplement particularly with teachers as it starts to get at the application of some of the items that appear in the first card-sorting task in an educational setting.

### *3.3.4 Wild Card*

For both tasks, we include a blank "wild card." This card should be given to the participant at the end of each task as an opportunity to add anything to the pile that they may have thought was missing from the original deck. If they decide to designate the wild card as something specific, they should be asked to sort it into their existing scheme and explicate their choice. If a participant expresses that the deck is lacking a particular card before the task is over, the facilitator may offer the wild card early.

# 4. PRELIMINARY RESULTS

While we have yet to finish conducting interviews with faculty and staff at our research sites, preliminary interviews with five makerspace summer interns did show notable results. The five participants were interns who designed and built a makerspace from an empty room and ran summer workshops for K-8 students, which they planned and conducted. At the end of their internship, interns prepared case studies of student thinking in the space. The interns were interviewed at the beginning and end of their 10-week internship.

As anticipated, many rising makers seem to emphasize particular digital fabrication technologies like 3D printers and microcontrollers. Most of these participants tended to explain their choice to prioritize certain technologies as useful tools to facilitate making, noting that before the advent of personal digital

fabrication tools, it was difficult to design functional, aesthetically pleasing prototypes. Prioritization of functional products in pre-interviews indicated a focus on the product rather than the process, which one participant actually noted in his post-interview saying, "I think before it was all about making a product, … but now it's more about, you know, how is this good for learning and what changes when you want to care more about what the kid is learning through the process rather than what they've done when they're done."

Another notable result was the participants' shift towards multidisciplinary learning in their post-interviews. In pre-interviews, 4 of 5 participants emphasized the discipline in which they were majoring (programming for the computer scientist, human factors for the engineering psychologist, etc.) In post-interviews, all five participants expressed emphasis on a multidisciplinary space as opposed to prioritizing one discipline.

Additionally, we discovered that the presence of the cards themselves were enough to produce constructive discussions of their values around making, irrespective of a final sort. The card-sorting acted as an entry point to the ultimate goal of having participants explicate their ideas around making. Some of the most insightful interviews arose when participants expressed they were having trouble sorting cards. It may have been that these participants were having trouble sorting the cards because they were dealing with the complexities and interrelatedness of the many different items so asking them to prioritize them was seemingly impossible at the time. Instead of sorting them, they went through the cards, identifying those they thought of as most important to making. Their explanations surrounding their difficulties in sorting the cards, were a rich source of insight into their beliefs and the contrasts between the different elements on the cards.

## 5. LIMITATIONS AND FUTURE WORK

We recognize and want to acknowledge the seemingly apparent disconnect between our goals and the design of our task. In the interviews reported in this study, participants sorted individually, were not directly part of the community building the makerspace, and neither the procedure, nor the analysis remained on the individual and were never brought back to the community level.

We designed our initial trials to be conducted individually with the intent of later analyzing and synthesizing their values to gain insight into the community's values as a whole – a poll on making values of sorts; however, synthesizing individuals' responses requires analyses and interpretation by an individual or individuals that may not represent the community, which gives rise to bias towards the individual(s). To preempt that, in our most recent trials, we have conducted interviews of entire groups that are divided into pairs, who upon finishing the task share their sorting and conversations with the group. We have seen promising results with this method in (1) participants naturally eliciting justification for their sorting methods around values and understandings of makerspaces and (2) creating an activity that generates community discussion about where they see value in a makerspace and how it can meet their existing commitments. These recent group interviews show promise for the task as both a design-research tool and professional development tool and we intend to continue refining as such.

## 6. CONCLUSION

Although this study is in its preliminary stages and requires some further analysis, if the initial results are any indications, this novel card-sorting task can provide useful insight into the interests and priorities of the educational communities in which makerspaces are being implemented. The rise of the maker movement has cued the concept of a makerspace in many communities, schools included, but the ambiguity of the term leads to great variation in their goals. This may be a worthy method for identifying such goals so that they reflect the values and commitments of the community ultimately lending them to more productive, meaningful engagement.

In introducing our card-sorting task method, we are not suggesting the ideal way to gather this information, nor are we critiquing any existing approaches. Rather, we are attempting to present another method that can be used to help us get closer to designing makerspaces that are responsive to needs of the communities that they serve.

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