

Parents and Roles in Informal Making Education: Informing and Implications for Making in Museums

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Abstract

Making is becoming a popular activity for young people to get interested in STEM topics. Maker Faire events and extracurricular making clubs support this engagement. Informal science education, particularly through science and technology centers have been adopting making activities for floor programs and some have created maker spaces.

This study explores how museums, and in particular children's museums, incorporate making for young makers and families and how educational learning objectives match up with the attributes of making and values expressed by maker families.

This will be addressed by both qualitative analysis of ongoing interviews with Young Makers and the parents of Young Makers. Emergent thematic analysis is be used to highlight themes relevant to Maker families working together. Additionally, this work will explore the goals and practices of informal science education museum community and establish a baseline and range of making activities and makerspaces in childrens' museums.

There is a trend for museums and science/technology centers to establish Makerspaces. The Pittsburgh Children's Museum has created Makeshop, a makerspace reflecting 7 specific learning practices, for example. Research has shown Makerspaces as sources of multidisciplinary learning, a blending of communities of practice with formal learning, and finally that the depth of learning is in the making. While the research points to the values of making in general, and specifically making in museum makerspaces, there seems to be little research on family making, and how museums can encourage family making. This research hopes to bridge both these gaps by studying the importance of family making and its relevance in children's museums.

Data has been collected over the last 3 years from the New York and Bay Area flagship Maker Faires with sets of interviews with approximately 32 Young Makers and the parents of Young Makers. The particular perspective of Maker families and the associated analysis has not been previously done and this study will allow for me to explore what it means to be a Maker family. Additionally, I will extend this work to have discussions with museum professionals of their informal STEM learning goals and how the hands-on exploration, tinkering and discovery abound in the Maker community could fit the learning goals. Guidelines and best practices across childrens' museums and will create a taxonomy of varying levels of use of making activities.

Introduction

Making is becoming a popular activity for young people to get interested in STEM topics. Maker Faire events and extracurricular making clubs support this engagement. Informal science education, particularly through science and technology centers, have been adopting making activities for floor programs and some have created maker spaces. In our ongoing research into

Young Makers in the Maker Community, the roles of parents to engage in and support such activities has emerged as an interesting part of the informal science and making ecosystem.

In his 2009 address to the National Academy of Sciences, President Obama called for those present to begin inventing new ways to “engage young people in science and engineering... to be makers of things, not just consumer of things”¹. The next year, a report written by the President’s Council of Advisors on Science and Technology (PCAST) stated that research showed students in the United States have a “lack of interest in STEM fields”². Two additional studies that were researching the influence of parents on engineering students echoed this sentiment. Yun cited the number of students dropping out of engineering is increasing³. Andrews and Clark cited that high numbers of “STEM graduates choose to work in non-STEM areas”⁴. All of the above sought to answer the question of retention. The PCAST report provided 7 “highest priority recommendations,” one of which called for the creation of more extracurricular experiences to inspire students. Later, the report recommended encouraging middle schools to partner with a “research organization, college, university, museum...that can bring STEM subjects to life”². Other articles sought to solve the issue through leveraging parent roles on their child’s career choice³⁻⁵.

This paper seeks to expand the research on parent roles to an emerging subculture which encourages participation in informal STEM experiences, namely the Maker Movement. While performing a larger research study on younger makers, themes began to appear defining parent roles in their child’s making. Because there is evidence demonstrating the importance of parents in their child’s decisions to pursue STEM careers, this research provides information to fill an important gap. Therefore, the research question asks:

RQ: What roles do parents serve in supporting their children in Making?

Second, as the PCAST report mentioned, one way to diminish the current deficit in up-and-coming engineers is by providing extra-curricular opportunities for STEM learning. The PCAST report recommended museums as one outlet, and there are already select museums that seek to implement making concepts as part of their content⁶. These factors both point to museums as a possible platform to support parent encouragement of STEM through making. Therefore, the results of this study on parent roles in making are compared to the results of similar studies in the museum world.

Literature Review

Making

While there is no one definition for making or a Maker, there has been a great deal of research into the community. One study found that Makers self-identified as solving problems through practice and hands-on activities, differentiating themselves from engineers who solved problems through theory⁷. Furthermore, Makers are interested in sharing their projects and solutions, with the majority participating in collaborative activities⁸. Dale Dougherty, founder of Make Magazine and thought leader in the movement, describes making as a community that learns through “experimental play”⁹. Making provides experience with many different tools,

community building, and leadership¹⁰. The activity has the educational potential to bring “creative, playful, engineering- and design-relevant learning activities...to a wider and more diverse audience”¹¹. Based upon an in depth study on their leadership characteristics, “Makers strongly possess an external organization, and a drive to lead change and produce results”¹². As seen from these articles, making as an activity can lead to an increased knowledge of certain tools relevant in prototyping through production, increased leadership skills, and community building.

Informal Education in Museums

Museums have been identified as another valuable environment to support informal education¹³. Similar to making, museums can provide social and learning settings for their participants. The family visits a museum for social reasons, and the museum’s best aim should be to understand and support this agenda¹⁴. Museum development has expanded to the point that they have become an “important component of education”¹³. Education within a museum can be defined as “observation, perception, satisfying curiosity, making sense out of one’s observation or experiences, incidental learning and, of course, direct efforts to collect or offer information”¹⁵. The article went on to mention hands-on activities as the most attractive type of exhibit to family visitors, defining family as adult/child groups having a “strong and continuing relationship”. Furthermore, the article points out that parents and role models have a “profound” impact on children’s learning. This understanding has since led to several studies on the role of parents in museums. Parents use a variety of strategies from simple encouragement to teaching and expanding upon the exhibits shown¹⁶. Parents also have a harder time developing the children’s experience at the museum, tending to take more passive roles, when the exhibits are less hands-on¹³. Several studies have looked at the different roles parents take in this parent-child interaction. Based upon observation, these roles tend to be organized from more passive to more involved in their child’s learning.

Making and Museums

Both making and museums have served to support informal education. Some research has already been done on the combination of these two mediums. One dissertation set out to study making through the lens of “foundational theories of the learning science” and followed this with a case study into making in the context of a makerspace in the Pittsburgh Children’s Museum, MAKESHOP. The paper highlights issues with museums correctly understanding making, and a general lack of knowledge on how families can learn through making in “informal learning environments”¹⁷. MAKESHOP is an environment held within the Pittsburgh Children’s Museum to encourage “authentic making experiences”⁶. Using a study completed by MAKE magazine, the museum created 7 learning practices to encourage making in their MAKESHOP. They included inquire, tinker, seek and share, hack and repurpose, express intention, develop fluency, and simplify to complexify. The New York Hall of Science has also taken an active role in making, holding one of the three major Maker Faires every year, as well as creating their own makerspace named the Design Lab. This space was able to utilize “design problems to balance deep engagement with deep content” in STEM education¹⁸. The Tinkering Studio in the Exploratorium in San Francisco, California has recorded the largest amount of data: 100 filmed interactions of museum goers making. The studies found 4 dimensions of learning within the

studio: engagement, initiative and intentionality, social scaffolding, and development of understanding. Results of the studies further supported the value of making in equipping museums to create open-ended collaborative discovery, driven by the participants^{19, 20}.

Research Methods

The participants in this study were selected as part of a larger study on young makers. The young makers were chosen based upon stratified, purposeful sampling seeking to find makers 18 years of age and under from diverse backgrounds. Through this process, the larger research group discovered that parents were able to provide key information on their child's making experience. Since this discovery, the team has intentionally interviewed parents of young makers as part of the same study. This paper is based upon the first collection cycle. Twelve parents were interviewed at the 2014 World Maker Faire in New York City, New York.

The data was collected to obtain qualitative information through the use of artifact elicitation interviews²¹. Artifact elicitation, based upon photo elicitation²², relies upon the fact that the participant will be more likely to talk about their creation when it is present. The artifact elicitation interviews were conducted at the fair, where the Makers were asked questions about what they were presenting. Because this study relies on the interviews of the parents of makers, the parents were generally talking about their child's artifact, and not necessarily their own. These interviews were conducted using a microphone and camera, and then later transcribed. The interview questions are discussed in more detail in the results. Next, the participants were offered a \$20.00 Amazon gift card to encourage participation in a secondary and more comprehensive critical incident interview over skype²². These interviews discussed more general questions about the young maker's pathway to making, and the parent's thoughts on that pathway.

Once the data was collected, the interviews were analyzed according to the process of thematic analysis²³. The patterns discovered were written into a central code book. The code book contains themes and subthemes that emerged through completion of the thematic analysis. As a new pattern appeared, the interviews were coded, and recoded, discovering additional themes and sub-themes used to form the full code book. Themes were finalized based upon the frequency of parent responses to the interview questions. These parent role themes can be seen in Table 1.

Results

Table 1 shows the pseudonyms of each Young Maker participant and the different roles each expressed. A "1" serves as a checkmark demonstrating that, during the course of their interview, they mentioned things which were coded to that parent role at least once.

Table 1 Parent Roles Identified in Interviews

| Young Maker Name (pseudonym) | Role(s) Identified in Parent Interview(s) | | | | |
|------------------------------|---|---------|-------------|-------------|---------|
| | Designer | Builder | Facilitator | Cheerleader | Teacher |
| Ryan | | | | | |
| Liam | 1 | 1 | | | |
| Ella | 1 | 1 | | | |
| Diana | 1 | 1 | 1 | 1 | |
| Dylan | | | 1 | 1 | |
| Blake | | 1 | 1 | | |
| Kellie | | | 1 | 1 | |
| Ava | | 1 | | | 1 |
| Anthony | 1 | | | | |
| Drew | 1 | | 1 | | 1 |
| Daniel | | | | 1 | |
| | | | 1 | | 1 |
| Total: | 4 | 5 | 6 | 5 | 3 |

Parents were asked a wide range of questions through the artifact elicitation and critical incident interviews. However, the themes that emerged to form the basis of the parent roles generally came from a smaller subset of the larger set of questions. The types of questions and example of each are shown in Table 2.

Table 2 Question Types and Example Questions

| Type | Specific Example(s) |
|---|---|
| 1) Questions about parent’s involvement in their child’s making | “Were there any parts of the project that you helped him out with?” |
| 2) Questions about the child’s association between school/extracurricular activities and making | “Do they participate in any outside events or competitions and science fairs and things of that nature?” “Yeah, so has he told you any stories about either this school or his previous school, where something he learned in school helped inform what he was doing, as a maker or as a creative artist?” |
| 3) Questions about the location of the child’s making | “OK, great. Where did she learn how to make it?” |
| 4) Questions about parent’s occupation | “Excellent. What do you do for a living? How do you think that helps his hobbies of making?” |
| 5) Questions about who the child makes with | “That’s great. Who does she make with? Does she have a group or a mentor that she usually works with?” |
| 6) Questions about the object being presented | “Awesome, can you tell me a little bit about what you guys made here?” |
| 7) Reason for attending Maker Faire | “What brings you and ... to Maker Faire?” |

Types in Table 2 were arranged top down from those that elicited the most total responses coded as a parent role to those type of questions that elicited the least amount of responses. Type 1 most commonly lead to responses coded as either Designer or Cheerleader. Type 2 inspired answers coded to every type of role. Type 3 led to every role except Designer. Responses to type 4 and 5 questions resulted in Builders or Teachers. Cheerleaders were the only role coded to type 7 questions. A few other questions led to parent role responses, but did not show any commonality to the types listed above, or each other.

Thematic Analysis: Parent Roles

By emergent thematic analysis of the interviews, parents were separated into the following roles: Designer, Builder, Facilitator, Cheerleader, and Teacher. As can be seen in table 1, often the same parent took multiple roles. Sometimes, this made identifying a single role within a particular quoted instance of parent assistance more challenging. Therefore, sometimes a single quote would highlight multiple roles. For example, the following longer narrative highlights multiple roles: “I’ll bring something home to experiment and see what it will be able to use for in the classroom, she tends to pick it up and monkey with it when I’m not around so she’s been big into 3-D printing. She helps figure those things out. My son, when I brought home some stuff to connect a scratch to a black-face programming language, he got into those things” (*Ava’s parent*). This quote has aspects of the interviewee identifying as a Builder and Teacher. Therefore, the roles that emerged were chosen by seeking to best qualify the different aspects of what a particular parent was trying to accomplish while working with their child’s making. The roles are explained in more detail in the following section, along with example quotes of each type from the interviews.

Designer

In this role, the parent took a more artistic role in participating with the child’s making. Some parents referred to their participation in their child’s making by helping to design the project, or using art to assist with their child’s making. For example, when one parent was asked if they considered themselves a Maker, they said, “I don’t actually do the instructions for the 3D printer... I design things more than anything else” (*Ella’s parent*). When another parent was asked about the support they gave during projects, the parent answered “Just the art part of it” (*Anthony’s parent*).

Builder

Parents that took more of a hands-on role in their child’s making process, speaking specifically about physically assisting the making, filled the role of builder. These parents completed actions such as wiring, soldering, or simply providing extra hands to help complete the child’s making by a set deadline. When asked about the location of their child’s making, one parent responded, “She basically did it all at home. My husband and she wired, set it up and took a lot of time off from school failing attendances but we managed to get it done” (*Diana’s parent*). In this example, the “husband” is taking the role of builder. Another interviewee provided a good example of a Builder, specifically isolating differing roles in the making process. The parent noted, “his father sort of did a lot of the idea development... And then I came in a little bit later

and worked on the build” (*Liam’s parent*). Quotes such as this one served to highlight that roles were evident to the interviewees as well, supporting this paper’s observations of distinguishable roles in the making process.

Facilitator

Facilitators supported their child’s making by providing rides, chaperones, or other time commitments, while not necessarily providing anything directly to the project the child was working on. One sub-group within this theme was facilitator-financer. There were several examples of parents specifically supporting their child through their personal finances, and this role was noted within this sub-group. One parent said that they helped their child’s hobbies of making by becoming “more like the event organizer, the networker that tries to build the support network around him. I’m the background person to try and actualize what he wants to accomplish” (*Dylan’s parent*). An example of an answer coded as facilitator-financer is as follows: “We help finance some of the programs. We obviously pay for some of them. Then we spend a lot of money on electronics and other things, so that he’s able to do it” (Blake’s parent).

Cheerleader

This role was the least involved of the parent’s roles. The Cheerleader generally did not always have a complete understanding of their child’s project, but were supportive emotionally of the child through the child’s exploration and project completion. When one parent was speaking to the importance of letting their child choose their own path, she said, “Yeah. She’s done it herself and ... but she is ... I don’t want to sound like a parent who doesn’t do anything but I feel she actually knows better. I guess I overall guide her, support her and lifting ... suppose if something looks drastically wrong, I’m there but I think the choices have been hers” (*Diana’s parent*). Making can be an extremely rigorous activity, and another parent “support him [their child] in general and get him where he needs to be, feed him, make him go to sleep, these kinds of things and just set limits when we need to” (*Daniel’s parent*). This quote also highlights another example of the fluidity of the parent roles. While “get him where he needs to be” would be more along the lines of a Facilitator, the other actions relate to Cheerleader due to their focus on their child’s general well-being.

Teacher

The teacher takes a purely instructional role in their child’s making experiences. Parents who follow this role either teach their child skills to support their making, or else provide examples of ways they further their child’s process of learning new skills. In one example, a father supported his child’s making by “coach[ing]” his son and said, “I taught him the different things you can make and taught him soldering and the basic electronics” (*Drew’s parent*). Another parent was a teacher by profession, and intentionally created learning opportunities for his children. Referring to himself, he said, “Dad will intentionally leave something out for them to play with...there would be a 3-D printer I would leave out for them to go and play with” (*Ava’s parent*). As the Maker community self-identifies with hands-on learning experiences, these teaching moments could become building or designing moments. Therefore, Teachers set themselves apart by highlighting their specific intent in the teaching part of the process, as opposed to Builders or

Designers who highlighted their contribution as assistance in those areas. Once again, the fluidity of the making process served to blur the lines between the roles.

Discussion

While each role is unique, they all serve to support their child's making activities. The diversity of roles demonstrates an important aspect of making. There are many different ways to support children as they begin making. In the review of making and museums, it revealed the majority of museums seeking to support the Maker movement have chosen to support it through a place, or a set of tools using physical hardware and/or knowledgeable facilitators. The study completed at the Exploratorium hints at the difficulties this causes in terms of understanding the larger impact on the museum patrons, stating that "we have no repeat visitors and no information on how they used the museum before or after their tinkering experiences"¹⁹. Following the same vein, they have no information on the families and the impact of making outside the museum. If museums seek to impact the students drastically, especially as the PCAST report called for, then they must seek to have an impact outside their own walls.

To attain this impact, Falk and Dierking found that an integral part of turning the museum visit into a learning experience lay in the individual's motivations for entering the museum. Individuals who quoted entertainment and education as their motivations learned the most from their museum visiting experience. Furthermore, these two factors were together, rather than one or the other, the main motivation for all those asked about their reasoning behind going to a museum²⁴. Museum goers share these in common with those who participate in the Maker community. As mentioned above, making focuses on the playing with the experiment, not just building something, but enjoying the process. One young maker exhibited this combination well. When asked why he makes he responded, "I just thought it'd be fun" and then later expressed the need to learn "more about how to wire motors because most of our stuff before hasn't really involved motors" (*Liam's parent*). His enjoyment initially drove entrance into the activity, but education and enjoyment drives his progress deeper into making.

While the motivators behind making and attending museums are similar, their impact, especially in a temporal sense, is much different. Currently museums, at most, influence their patrons only while they are open. However, if they can leverage making as an activity that goes beyond the walls of their museum, then they begin to fill the PCAST call. The roles of parents can be the bridge necessary to more firmly connect these two informal-learning experiences. Unlike a space or museum facilitator, parents spend close to 24 hours a day with their child. Therefore, a parent trained by the museum in the roles available to fill in their child's making, can take these lessons home after the museum has closed for the night. The agenda of the museum and the making community are similar with regards to STEM subjects, and the parents can support this agenda in both realms. This partnership has already begun to form as "the museum, as a sight of making, is becoming an embedded resource of the family's contextualized learning"¹⁷. Therefore, this paper seeks to look at the roles parents currently take in their children's museum going experience, and how those roles compare to those found in this study.

Parent Roles Hierarchy of Support

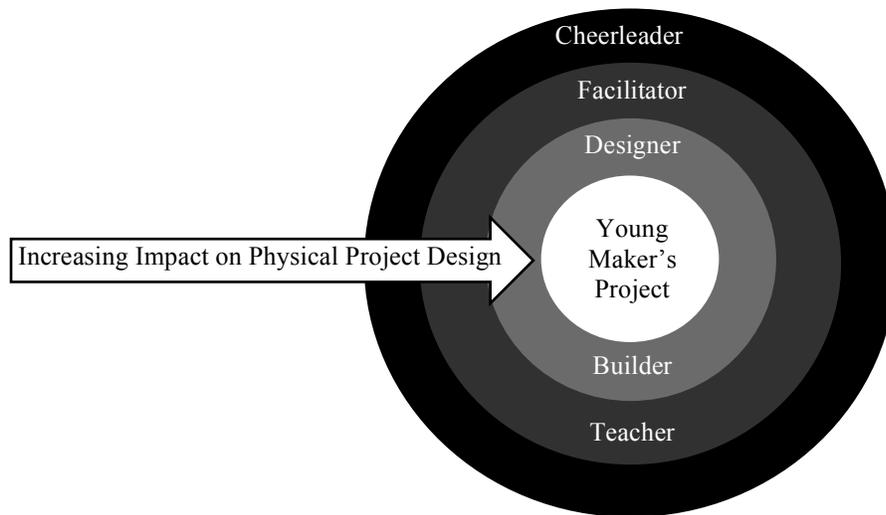


Figure 1. Hierarchy of Parental Impact

An additional pattern that emerged out of the data was a hierarchy of parent impact on their children's projects. Figure 1 gives a visual example of this concept. As the roles move away from the young maker's project, the roles begin to have less of an impact on the final, physical manifestation of the project. For example, imagine Tommy the young maker was designing a new pen. If his parents were designers, they would have assisted with the aesthetics or technical design of the pen. If a builder assisted with the project, they would have directly touched the object alongside Tommy by putting the physical pieces together. The next ring back in Figure 1 signifies one level of impact farther away. While the facilitator may have provided resources to build the pen, or given rides to a pen design seminar, they would not have actually influenced the final manifestation of the project in any direct way. A similar pattern emerged with the teachers who provided intellectual capital, such as a knowledge of pen design techniques, but did not influence the final manifestation of the project in any hands-on way. Finally, the Cheerleader was 2 levels of impact back from the project, helping with the general needs of the child as opposed to specific aspects of the project. It is important to note in the context of the following section of this paper that this hierarchy did not relate to the *amount* of assistance provided. Rather, it corresponds to the impact the assistance given had on the physical manifestation of the young maker's finalized project.

Comparative Review of Parent Roles in Museums and Making

There is a lack of research specifically focused on the roles parents take in their child's museum experience. Many articles highlight the importance of parents to their child's education in informal and formal settings^{3,5,13-16}. However, the specific roles they take on were more difficult to find in the literature. Brahm found a similar conclusion commenting that the study of roles in informal learning environments for family learning is "in its infancy"¹⁷. Brahm, as well as two additional studies, defined general roles parents take in their child's informal learning process at

museums. Table 3 provides a list of roles discovered under each study in which they were identified. As the number of roles varied from study to study, they do not align perfectly.

Table 3 Parent Roles Across Studies

| “Making the most of family visits: Some observations...” ¹³ | “Parent Beliefs about Teaching and Learning...” ¹⁶ | “Making as a learning process: Identifying...” ¹⁷ | This Study |
|--|---|--|-------------|
| Caretaker | Observation | Technical Advisor | Designer |
| Supporter | Encouragement | | Builder |
| Helper | | | |
| Initiator | Direction | Technical Support | Facilitator |
| Assistant | | | |
| Partner | Describing | Technical Facilitator | Cheerleader |
| Leader | | | |
| Demonstrator | Explaining | | Teacher |

The first column from the left comes from a study completed over 12 one hour periods studying parent-child interactions in the context of hands-on activities in a museum. The second and third columns are interesting because their research space is contained in the same physical museum. The second column asked parents about the level of interaction they had with their children, from which 5 levels of participation emerged. Column 3 lists the results from a study that defined roles in a similar fashion to this one, defining them based upon data from questions not explicitly about roles. They were also completed in different areas of the museum. The data for column 2 was collected in an area that was not explicitly focused on making, while column 3 was. Lastly, column 4 contains the results of the thematic analysis completed within this study.

The first two studies based their role choices upon the amount of parent-child interaction they gathered took place. While the third and fourth studies were influenced by the level of parent interaction, they tended to focus more on the type of interaction. For example, the first column noted that the first four roles from top to bottom were more “passive” while the bottom four were more “active”¹³. In a similar vein, the second study noted that parents were assigned their role type “reflecting the highest level of mediation”¹⁶. In contrast, the third study described the parents as “learning partners...yet flexible in their role relative to the child’s learning intentions”¹⁷. The third study then went on to explain how all the roles involved some type of active participation with their child. Similarly, in the role study in this paper, all the roles, perhaps with the exception of Cheerleader, were active in different ways. This difference in coding styles can provide interesting insight into the way museums look at parent participation versus the way making facilitates parent participation. The results of the first study discovered that two thirds of their parents took passive roles, while only one third was active. While active parent participation was desired, the study could not find a way to facilitate such activism. Making could be a solution to this problem.

This difference reflects a difference of approach, and is highlighted even more clearly when viewing the parent interactions of the last two studies through the lens of the first two studies. For example, the role of assistant in the first study is described as providing an “extra pair of hands”¹³. Builders from this study often served as this, such as the example of a dad helping his

daughter with the physical building of her project. However, this role was also filled by Facilitators. One mother commented, “I have to constantly take her out or do something” (*Diana’s parent*). While not physically working on the projects, Facilitators provide extra help through the form of rides to places, facilitating making interactions that would not otherwise happen. Leaders led their project, allowing some participation from their children¹³. In the second study, parents at the highest level of interaction mediated the child’s learning by explaining the concepts and how they connected to other areas of life¹⁶. Similarly, several of the roles discovered in this study were different examples of the tendencies of parents leading the project, or the education of their child. Teachers led their children into different learning areas. In one example, a parent described himself as a “coach” (*Drew’s parent*) while another “intentionally leave[s] something out” (*Ava’s parent*) so his children could learn about it through play. However, Designers often led their side of the projects, encouraging their child’s creativity, and Builders became leaders when the child was less knowledgeable on the concept. Just like the third study, while the parents consistently took an active role, their roles were fluid as the needs of their child prescribed.

Conclusion

Acknowledging the importance of parents in the STEM education of their children, the roles of parents in the STEM related activity of making were explored in more detail. Based upon the thematic analysis, five different roles appeared in the findings: Designer, Builder, Facilitator, Cheerleader, and Teacher. Compared to three previous studies, these roles demonstrated that parents actively engage with their children through the making process. Furthermore, the results of this study agreed with the results of the third study in Table 3 that parents in making tend to have active, but fluid, roles in their child’s making process. As can be seen in Table 1, most parents described serving several different roles in their child’s making process. Therefore, making seems to encourage active parent-child interactions, and supports parents changing their roles as the child needs to support their child’s learning. These interactions manifest themselves through a hierarchy of impact on their child’s final project design. If museums are seeking to encourage parent-child interaction, making seems to naturally accomplish this. Furthermore, as it is an activity that supports STEM concepts, it solves the issues posed in the introduction.

Future Work

This study was completed with the interviews of 12 parents. In order to form more informed conclusions, more interviews are necessary to see if the conclusions of this paper are representative of the greater Maker Movement. In addition, parent roles only encompass one part of making. While there is significant research on making implementation through the use of maker spaces, there is not much implementation outside of this single tool. Museums are often quoted as places of user-driven learning. Making also supports this type of informal learning. Based upon the results of this and future studies, guidelines and best practices across children’s museums need to be formed. These guidelines and best practices should include types of activities that use the strengths of the museums and combine those with the strengths of the parents. These could include parent focused content in museums to assist with the parent-child interactions in making, such as seminars for parents on new ways to make with their children.

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