Echoes of diversity: using maker activities to support children's learning *and empowerment*

Foad Hamidi
Karla Saenz
Melanie Baljko

Pontifícia Universidade Católica do Rio de Janeiro
Foad Hamidi
foadhamidi@umbc.edu
Postdoctoral Research Associate, Department
of Information Systems

Dr. Foad Hamidi is a Postdoctoral Research Associate at the Univeristy of Maryland, Baltimore County. He is interested in using digital media to facilitate creative and learning processes in intercultural settings for children and adults. He is also interested in the participatory design and evaluation of tangible and embedded systems.

Universidad Iberoamericana Mexico City, Mexico
Karla Saenz
karla.saenz@uia.mx
Instructor, Department of Design, Science, Arte and Technology

Karla Saenz is a designer, artist and educator who is interested in creating opportunities for creative expression for children and adults. She is the co-director of Kopalli Arte Público.

York University, Toronto, Canada
Melanie Baljko
mb@cse.yorku.ca
Lassonde School of Engineering

Dr. Melanie Baljko is an Associate Professor in Electrical Engineering and Computer Science at York University in Toronto and also a member of the graduate programs in Science and Technology Studies and Critical Disability Studies. She leads a research lab and a critical technology practice that focuses on assistive and enabling technologies, on technologies that mediate learning and communication, and on their ecosystems of production and use.

Abstract

Interactive digital media are emerging as new tools for learning and self-expression for children. The development of easy-to-use and affordable electronic hardware and software is making it possible to engage children in low-income settings in personally meaningful digital design projects. We describe a two-day interdisciplinary workshop in Oaxaca, Mexico, where we used a maker process to create interactive digital artifacts with 16 children. We incorporated local folk art traditions in the projects that consisted of a series of alebrijes habitats and a sonic mural installation. We explored the possibility of supporting psychological empowerment and learning through digital making for the children.

Keywords: design, interaction, children, Maker Movement, learning.

Resumen

Los medios digitales interactivos se están convirtiendo en nuevas herramientas para el aprendizaje y la autoexpresión de los niños. El desarrollo de hardware y software electrónicos asequibles en costo y uso, hace posible la participación de niños y niñas de escasos recursos, en proyectos de diseño digital personalmente significativos. Se describe en el siguiente articulo un taller interdisciplinario de dos días impartido en Oaxaca, México, donde fue usado un proceso creativo para crear artefactos digitales interactivos con la participación de 16 niños. Fueron incorporadas las tradiciones locales de arte popular en los proyectos que consistieron en una serie de alebrijes, sus hábitats imaginarios y una instalación mural sónica. Exploramos la posibilidad de apoyar el empoderamiento psicológico y el aprendizaje a través de la creación digital para niños y niñas.

Palabras clave: diseño, interacción, niños, Maker Movement, aprendizaje.

Introduction

The emergence of affordable and easy-to-use digital components is opening up novel possibilities for engaging children in learning and problem solving activities. The Maker Movement (or Do-It-Yourself (DIY) Movement) refers loosely to the body of amateur and professional designers who use novel (e.g., 3D printing) and traditional (e.g., glassblowing) fabrication methods to engage directly with every stage of the creation of their customized, small-batch designs (Anderson, 2012). Interest in making has motivated the development of technological tools and processes that aim to decrease barriers to digital design: the barrier of cost through increased availability of low-cost software and hardware, and the barrier of knowledge through the proliferation of more user-friendly, less-specialist interfaces and on-line shared tutorials and knowledge (Lindtner et al., 2014). At the heart of the Maker Movement is a set of values that include inventiveness, resourcefulness and the sharing of knowledge and expertise (Anderson, 2012). The potential of making for learning (Blikstein, 2013), empowerment (Katterfeldt et al, 2009) and inclusion (Hurst and Tobias, 2011) are increasingly being recognized. There is a need to explore the possibilities of adapting and developing maker tools and processes in new contexts, specifically in the developing world.

Many grassroots organizations are using making for learning and self-expression with children. Examples include Maker Junior (http://makerjunior.com), Maker Kids (http://www.makerkids.com) and the Plug-in Studio (http://pluginstudio.net/). An interesting potential of engaging in maker practices is their ability to induce or strengthen feelings of wellbeing and empowerment. Using a series of case studies, Marshall et al. (2014) have shown that participating in maker processes contributes to both hedonic wellbeing (i.e., identified by the presence of positive affect and absence of negative affect) and eudemonic wellbeing (i.e., identified by the feeling by engagement in meaningful and purposeful activities). In another study, Katterfield et al. (2009) have used computational textiles that combine low-tech craft materials with computational components as a way to encourage women to design personally meaningful projects. They found that the participants became more confident in their skills and gained a stronger sense of agency and self-efficacy through creating unique working prototypes.

Given these results, we are interested in exploring the potential of the maker approach for supporting empowerment, and specifically psychological or agency-based empowerment in children. Rappaport (1987) defined empowerment as a process in which people, organizations and communities gain mastery over issues of concern to them. We focus on psychological or agency-based empowerment, which is empowerment at the individual level of analysis (Zimmerman, 1990a) and integrates perceptions of personal control, a proactive approach to life, and a critical understanding of the sociopolitical environment (Zimmerman, 2000).

Empowerment and specifically psychological empowerment are inherently difficult to measure (Zimmerman, 1995). However, Diener and Biswas-Diener (2005) have argued that PE is necessary for external conditions of empowerment to be effective, motivating research into processes that can support and measure it. In the case of children, Bandura et al. (2001) found that children's perceived self-efficacy (i.e., their belief that they can produce desired effects by their actions), rather than their actual academic achievement is the key determinant of their preferred choice of work life and perceived occupational self-efficacy.

Making Digital Artifacts with Children in Oaxaca

We conducted a series of maker workshops for children to explore the possibility of using digital technology as a tool for teaching hands-on problem-solving, creative collaboration and for raising children's awareness of their immediate environment. During the workshops, the children collaborated with each other to create functional interactive artifacts that represented information about the environment. Through engaging in these hands-on activities, they experienced the

potential of technology as a tool for problem-solving and realized their agency and self-efficacy through using technology to address the needs of their projects. In this sense, we aimed to explore the possibility of using maker processes in support of psychological empowerment.

A key aspect of our approach was the incorporation of local cultural elements in the workshops, in order to make the projects more familiar and relevant to the children. Mexico is rich in folk art and handicraft traditions. Specifically, Oaxaca State is well known for its rich folk art traditions and culture. As we will describe later, we incorporated some of these elements into the projects. In these workshops, we used the theme of bio-diversity to explore the inter-relationship of different entities in an ecosystem of objects created by the children.

We are a multidisciplinary multinational team of Mexican and Canadian designers and researchers with backgrounds in public art, participatory design and community engagement. For the past two years, we have co-conducted a series of workshops with the dual themes of art and technology with children who are in economically and socially marginalized in Oaxaca City, Mexico. The workshops we are describing in this paper are a second series of workshops we have conducted in Oaxaca. For a description of the first series of workshops please see Hamidi et al. (2014). Our workshop facilitation team in Oaxaca consisted of the first and second authors of this paper, as well as, 7 final-year undergraduate university students (majoring in a variety of degrees including architecture, graphic design, industrial design, art history and communication studies) and a technical support volunteer.

Setting, Participants and Material

The workshops were conducted through the Kopalli organization, which is a non-governmental organization (NGO) that has worked with the children for several years. The workshops were held in a large room at the center, with a large garden next to it where children could take breaks between different workshop activities. A separate small room provided a quiet space where facilitators could have discussions or do preparations. The child

participants consisted of 16 children (10 boys and 6 girls) between the ages of 5 to 13 years old. The children have limited access to economical resources, including technological resources (i.e., computers or tablets).

We decided to work mainly with paper-and fabric-based prototypes because of their low-cost, familiarity and versatility. Research interest in making digital artifacts from craft material and specifically paper is increasing and more technologies such as conductive ink and textile sensors allow for the development of affordable interactive digital artifacts (Shorter et al., 2014; Saul et al., 2010; Qi and Buechley, 2014). Peer et al. (2014) are exploring the design of a curriculum for teaching STEM (Science, Technology, Engineering and Math) concepts to children through the use of digitally augmented puppets made from paper, fabric, LED lights and conductive tape. Perner-Wilson et al., (2011) argue that combining simple electronic components and traditional craft materials such as textile and paper can be more personal, understandable and accessible than predefined technical kits.

We decided to use locally available craft material as much as possible and limit introduced technological components. We categorized resources into collective and individual resources. Individual resources were assigned to each child and consisted of a LED light, a coin battery and basic craft material (e.g., crayons, paper, ribbons, feathers, clear tape). Collective resources were to be shared by everyone and included a laptop computer, connected to two external speakers and a Makey Makey board, as well as, large cardboard sheets and a roll of conductive tape. The Makey Makey board is an open-source circuit board that can turn any conductive object (e.g., aluminium foil, metal objects, even fruit and vegetables!) into a keyboard key (Collective and Shaw, 2012).

Process and Outcomes

The workshops were conducted over 5 days, with 2 days of planning, 2 days of workshops with the children and 1 day of debriefing. Our team met for approximately 5 hours for 2 days before the workshops to assign roles and plan the design activities, including the

format of the workshops. Each of the members of the facilitation team assumed one of a series of rotating roles, including workshop leader, group facilitator (i.e., working directly with children teams), materials person, and documentation (picture/video) person. Every morning we met and discussed tasks of the day prior to the workshops.

The days at the center started with warm up physical exercises with all the children in a circle singing songs and doing simple movements. These were followed by a short talk by the second author on one of the topics of the workshop, which included technology, biodiversity and the environment. These were followed by drawing activities where children provided an interpretation of the discussed topics. The children were then divided into four teams and worked on design and fabrication tasks with the help of team leaders. Older children were given responsibilities to help younger children and aid adult team leaders, a strategy to help keep them engaged during the workshops and to give them experience with responsibility. At the end of the workshop sessions, during a show-and-tell period, the projects were shown to adult administrators at the center and at the end of the workshops to outside visitors.

At the end of the workshops, with our help, the children had designed and fabricated two digital interactive installations that explored the theme of bio-diversity. The first installation consisted of a sonic mural (displayed in Figure 1). The mural was drawn on a large piece of fabric mounted on a wall of the room where the workshops were held. A map of the Oaxaca State, with various local animal regions, was drawn on the fabric (e.g., fish in the ocean...). A button (made of conductive tape) was placed in each region of the map. When a button was pressed, the sound of corresponding animals, as imitated in recordings made by the children, were played back. In this way, the map captured information about both the animals that live in each region, as well as, their sounds. The idea of using a mural was inspired by the mural painting tradition of Mexico that goes as far back as the Olmec civilization (Kenny, 2006). In modern times, the revolutionary art of important artists such as Diego Rivera, Jose Clemente Orozco and David Alfaro Siqueiros established Mexican mural painting as a major art movement (Rochfort, 1993).

The second installation consisted of 4 alebrijes "habitats". Alebrijes are fantastical Mexican folk art papier-mâché sculptures that were first created by the Mexican folk art legend Pedro Linares in the 1930's and, since their inception have become quintessential symbols of Oaxacan folk art (Bartra, 2000). The creatures are oftentimes a juxtaposition of different animal parts (e.g., snake with wings) and are especially loved by children. The habitats were made of large sheets of cardboard, where color and decorations were used to symbolize elements in the natural environments such as deserts, mountains and oceans. They were augmented with batteries and conductive tape strips that represented resources such as light from the sun or fertile earth. Each of the children designed

Figure 1. Caption: Sonic Mural (right). Initial design (bottom left) and in use (top left).

Figure 2. Caption: An alberije (top right), children working on alebrijes habitats (left and bottom right)

and decorated a unique alebrije from paper, fabric, and an LED light that would light up when placed on the strips in the habitats. We provided simple instructions on how to create alebrijes to the children and encouraged them to try out their new and different ideas and designs. By placing the alebrijes on different habitats, the children could turn their lights on and off. Figure 2 shows a habitat made by the children.

We used the installations to create a dialogue with the children about the importance of environmental awareness and using technology and design as problem-solving tools. The dialogue progressed step-by-step. The children first learned about how electricity works and tested their knowledge by putting together simple circuits. They later used this information to design and troubleshoot their handmade artifacts. We used the installations to talk about the importance of biodiversity and how it is important for each element to be present in an environment. For example, for the lights and sounds to work, the various parts of the installations (e.g., wires, batteries...) had to be correctly connected to each other. If one of these elements were missing the whole project would fail. We used this notion of interconnectedness to convey the idea that the children themselves are also

connected to other beings and in relationship with them. When problems arise in an environment, it is possible to use both tools (i.e., technology) and knowledge to address them and when existing resources are inadequate at addressing a problem it is possible to search for resources outside of one's immediate context and go beyond the limitations of a setting. The children experienced these ideas through working on their projects, rather than only hearing about them from us.

The children stayed motivated and worked on their projects until the end of the workshops. They each made a unique alebrije to be placed on the habitats and contributed to the decoration and construction of the habitats and the mural. They understood and applied the ideas that we explained about technology and electricity to their designs and came up with creative ideas on how to use technology to solve environmental problems. For example, when discussing global warming and its adverse effects on some animals, one of the children suggested, "maybe we can use electricity to freeze the poles again?" During the workshops, the children collaborated with each other to identify and solve problems, shared collective resources and asked questions about and commented on the ideas and concepts that were discussed. At

the conclusion of the workshops, they were proud of their efforts and showed their projects to other adults who work at the center and to outside visitors. The installations were not trivial to implement and it took several hours for each of them to become functional. We found that the effort needed to implement the installations were not dissuasive and, in fact, created a strong sense of pride and attachment in the children.

These results are promising and support our idea that making and design activities using digital media have potential to support psychological empowerment and learning in this context. These observations, however, are exploratory and need to be confirmed by more future research. Through conducting this project, we have contributed to a better understanding of the potential of maker activities to support self-expression and learning for children in low-income settings. We have shown that it is important to consider carefully the digital and non-digital materials that would be used and to incorporate relevant elements from the cultural context in which the activities are situated. Finally, we have also shown the importance of designing for collaboration and teamwork in these activities.

Conclusions and Future Work

In this paper, we described a series of maker workshops with children in Oaxaca City, Mexico. During the workshops, we designed and fabricated two culturally informed projects: a series of 4 digitally augmented alebrijes habitats and a sonic mural installation. We observed that the children were able to successfully grasp and apply ideas and collaborate with each other in problem solving and troubleshooting tasks. They showed pride in their work and were engaged throughout the workshops. We find this approach promising and plan to conduct longitudinal formal studies in the future to measure the generalizability and retention of learning and self-efficacy outcomes gained by the children during this process.

We believe our approach has potential to engage diverse populations in creative collaborative activities that employ design and fabrication processes both as opportunities for learning and as tools to support psychological empowerment. In this way, we believe our findings from the workshops can supplement the "design revolution" described by Pilloton (2009), who curated a series of socially aware product and service designs in her book. Through researching and exploring participatory processes that can engage diverse populations and bring about learning, empowerment and self-awareness, we wish to contribute to the movement that aims to use design to change the world for the better.

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