International Journal of Child-Computer Interaction ▮ (▮▮▮▮) ▮▮▮–▮▮▮

Contents lists available at ScienceDirect

International Journal of Child-Computer Interaction

journal homepage: www.elsevier.com/locate/ijcci

Leveraging cultural values and "ways of knowing" to increase diversity in maker activities

Nathan Holbert

Department of Mathematics, Science, and Technology, Teachers College, Columbia University, Box 08, 525 West 120th Street, New York, NY 1027-6696, USA

ARTICLE INFO

Article history:
Received 7 August 2016
Accepted 12 October 2016
Available online xxxx

Keywords:
Construction
Maker movement
Fabrication
Craft
Gender diversity
STEM

ABSTRACT

Though the "maker movement" has become an international phenomenon in recent years it has been mostly embraced by highly educated and wealthy men. As the makerspaces and fabrication labs become a more mainstream method used by schools to motivate students to explore STEM domains, lack of engagement among women and other underrepresented groups is a major concern. Building upon literature from the feminist tradition, the Bots for Tots project explores the affordances of activity framings and structures that tap into learners' cultural values and alternate mental dispositions to broaden participation and interest in maker activities. In this paper I describe a workshop where 9–10-year-old children were tasked with constructing "dream toys" for 4-year old students in their school. Data collected from interviews, observations, and student-built project suggest that when making is framed as being a set of practices, skills, and technologies to connect with one's community, young girls are likely to be initially motivated to engage in the maker activity, persist through construction challenges, and to show interest in further exploring making and technology.

1. Introduction

"I liked making things for somebody else because when they walked in the room they were so happy to see I made toys that they could play with".—Raquel.

Makerspaces and fabrication labs have become an international phenomenon in recent years. Make Media [1] reports over 150 licensed Faires internationally and the UK has seen a 10-fold increase in Makerspaces between 2010 and 2015 [2]. In the US, even the White House has gotten involved in the movement hosting the first White House Maker Faire in 2014 [3]. This new "maker movement" has been embraced by schools as a way to motivate students to explore STEM domains [4,5]. And yet, these fabrication labs and makerspaces have struggled to serve a diverse population of creators and have become heavily dominated by men and the highly educated and wealthy [6,7].

Despite the fact that women have been makers for centuries, making practices, activities, and materials traditionally performed and used by women have until recently, largely been neglected in popular and high profile outlets of the maker movement [8]. Efforts to connect computing and engineering to traditionally feminine domains such as sewing and fashion have led to a burst of activity within existing craft communities [9], the development of new fabrication tools and electronics [10–13], as well as elevated these practices to the core features and activities of makerspaces and workshops for girls [14,15]. However there is some perceived danger that relying solely on interest and assumed gender and cultural "norms", such as "girls like fashion", might inadvertently perpetuate gender and cultural stereotypes [15] and exacerbate existing community divides [16].

In this paper I argue that efforts to engage young people in computing and engineering should move beyond surface-level and gendered features of making and construction and instead consider deeper goals and values that may be driving women's participation (or lack thereof) in STEM fields. Drawing on the construct of "ways of knowing" from the feminist tradition [17] and data indicating women makers are driven by a desire to help and give back to their communities [18], the Bots for Tots project aims to leverage what Kafai calls, "women-centric knowledge" [15] without an overreliance upon women-dominated activities. Building upon the tradition of service learning [19], Bots for Tots explores the affordances of activity framings and structures that tap into alternate mental dispositions to broaden participation and interest in maker activities. While the larger project explores a range of underrepresented communities, here I describe a specific implementation designed to encourage participation among 9–10-year-old children

E-mail address: holbert@tc.columbia.edu.

http://dx.doi.org/10.1016/j.ijcci.2016.10.002
2212-8689/

self-identifying as girls. In this paper I propose that when making is framed as being a set of practices, skills, and technologies to connect with one's community, young girls are likely to be initially motivated to engage in the maker activity, persist through construction challenges, and to show interest in further exploring making and technology.

2. Making, technology, and diversity

Engaging kids in the activity of "making"—or in the planning and construction of digital and tangible artifacts—provides a powerful opportunity to explore some of the basic skills and ideas of engineering and design [20–22]. However, making and construction is more than simply becoming proficient with a 3D printer, learning how to calculate resistance, or gaining so-called "21st century skills". Making is about powerful ideas [23,24]. Making is a literacy—a way of reading the world as a collection of resources and materials to be composed, repurposed, and rearranged. Making is "what if?" and "why not?"– of positioning oneself as having power – of taking responsibility for challenges and obstacles faced by oneself and one's community and enacting solutions.

Despite the rhetoric around making and DIY ("do it yourself") as being for everyone [25] and its historical roots in the epistemological pluralism of constructionist thought [26,27], much of the public effort driving this modern reemergence of making, such as maker faires or construction kits, has unfortunately been designed (implicitly or explicitly) to appeal to white men and the wealthy. For example, 70% of those attending the 2014 Maker Faire in San Francisco were men, an overwhelming 97% had college degrees, and attendees had a median household income of $130,000 [6]!

Science and engineering – two fields most aligned with the maker movement – are heavily dominated by white men [28]. Currently women make up only 15% of the engineering workforce [28] and hold only 26% of all computing occupations [29]. These alarmingly disproportionate ratios are due to a variety of factors including a disparity in access to crucial resources – like STEM construction kits and computers [30] – as well as larger cultural narratives and expectations that begin in childhood and persist and accumulate into adulthood.

One such factor that has been well documented is a lack of alignment between perceptions of science and engineering careers and personal values and goals. Many surveys and meta-analyses have suggested that women more often report personal values of nurturance and benevolence, rather than values more conventionally reported by men such as assertiveness or achievement [31,32]. Other studies suggest women prefer jobs that involve helping others [18,33], contribute to altruistic intentions [34] or communal goals [35], and are about people rather than things [36].

Belenky et al.'s [17] seminal work, *Women's Ways of Knowing*, contextualize these findings by suggesting women are driven towards connectedness—by the desire to connect with knowledge and with "the other" at a personal level. And yet, connectedness certainly rises above gender binarism. Belenky et al. [17] explicitly state, "Connected knowing is not confined to the poor, the uneducated, or the soft-headed. Nor is it exclusively a female voice" (p. 102). A desire to connect does not preclude interest in engineering or computing, nor does it imply girls are never interested in robots, rockets, and race cars! Rather, it indicates a deeper underlying mechanism driving the disparity in women's representation in STEM fields. Feminine values and ways of knowing are not only not elevated in the discourse around the practices of these professions [30], they are actively discouraged and belittled [37,38]. Therefore, efforts to broaden this discourse that rely too heavily upon gender stereotypes may then lead to further splitting of these domains along gender lines – engineering for girls vs engineering for boys – rather than an affirmation of the centrality of these feminine traits in the practice of engineering and computing [39–41].

One possible leverage point then to increase diversity in engineering, and computing is to highlight the way in which engineering and computing is about creating solutions to challenges faced by our communities and our society at large. Constructionism [23,42], a design paradigm which engages learners in the development and refinement of knowledge structures through the construction of virtual and tangible artifacts, positions making and construction as a highly social practice. Early constructionist designs, such as the Instructional Software Design Project leveraged making for others as a way of altering the teacher/student power imbalance [43]. In this project, fourth grade math students were positioned as game designers tasked with producing games to teach third graders fractions. This shift in framing meant that rather than being positioned as users of software or receivers of knowledge (as has been typical in educational technology solutions), fourth grade students became "teacher/explainer" and "designer/producer" [43]. In engineering education, Project-based Service Learning (PBSL) has been a popular method of exposing novices to both the practice of engineering and the value of engineering as a way to improve their communities and the broader world [19,44]. In these programs, which have proliferated at engineering schools throughout the US [19], rather than simply work on a project defined by the professor or university, students engage with community members to design and develop solutions to existing problems. PBSL has proven to be an effective way of engaging and retaining women and other underrepresented groups in university engineering programs [44–46].

Building upon the constructionist tradition of engaging a social community of learners and PBSL's method of designing solutions to benefit the local community, the Bots for Tots project frames making and technology to be a way of working together for the good of the community. In this way construction is a means of emphasizing people rather than things, of empathizing with the needs and feelings of the other, and "connecting" with the community.

3. Methods

3.1. Participants and context

The Bots for Tots project tasks elementary children to design and build a toy for younger children in their community. Workshop sessions engage participants in interviewing stakeholders, brainstorming and critiquing, prototyping, and construction (Table 1). In the implementation described here, all students in two fourth grade classes (ages 9–10) from a public elementary school located in a highly urban Northeastern US city were given a flyer inviting them to attend a free, five-day "making workshop" with the explicit goal of designing and building toys for their school's pre-kindergarten (preK) class (children typically 3–4 years old). Due to physical space constraints, the first ten participants to respond, and schedule a pre-workshop interview, were accepted into the workshop. One fourth grader that accepted and conducted a pre-workshop interview was unable to attend the workshops resulting in nine full time participants.

The research team consisted of two men (including the author) and six women. No more than four total facilitators were present for each session. Pre-workshop interviews were scheduled at the convenience of the parent and child and took place in a university conference room located within walking distance of the children's school. All workshop design and build sessions and post-workshop interviews took place in a small makerspace housed at the same university. PreK interviews and playdate took place at the children's school in the preK classroom.

Please cite this article in press as: N. Holbert, Leveraging cultural values and "ways of knowing" to increase diversity in maker activities, International Journal of Child-Computer Interaction (2016), http://dx.doi.org/10.1016/j.ijcci.2016.10.002