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From Novice to Instructor: Inspiring Educators to Facilitate Maker-Centered Learning

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Abstract: Attaining the benefits of maker-centered learning requires well-trained educators to facilitate complex open-ended projects, a process that begins with teacher education. This study examines how educators experience maker-centered learning, and how they seek to apply these principles to teaching. Ten educator-students were interviewed from a graduate-level makerspace course. Our findings show that educators gained maker skills and a maker mindset along with experiential knowledge, which inspired specific technologies and learning goals for their future students.

Introduction

Makerspaces are environments of learning that encourage students to engage with making through the use of modern digital fabrication tools. Recent interest in makerspaces is fueled by research showing that participation in making encourages engagement with science, technology, engineering, and math (STEM) fields (Vossoughi & Bevan, 2014). Often though, the more salient takeaways from makerspace experiences are not in the form of content-specific knowledge—students come away with skills in collaboration, creativity, problem-solving, and a failure-positive outlook (Clapp et al., 2016; Hsu et al., 2017). Because of this, there is growing advocacy among educators to incorporate aspects of maker principles and activities into K-12 education. Running parallel to these calls is an emphasis on teacher education, since "educators equipped with theory, knowledge, and skills about making are needed to integrate making in formal learning settings" (Hsu, 2017). However, given the nascency of this movement, there is a lack of understanding on how to structure professional development (PD) courses for teachers and the effectiveness of these courses. A national survey on teacher education programs conducted by Cohen (2017) showed the need for an "increase in research on the role of maker principles and technologies in teacher education." While a few emerging studies have researched teacher PD through short-term makerspace workshops (Paganelli et al., 2017) or community-based makerspaces (Jones et al. 2020), there is a lack of research on the effectiveness of a formal makerspace course in shaping future practice and pedagogy for educators. This paper describes an exploratory study of aspiring educators in a semester-long makerspace course situated in a graduate school of education where they learned digital fabrication in the context of educational design.

Methods

The participants of this study were enrolled in a Master's-program level course titled "Making and Digital Fabrication in Education". This semester-long makerspace course had the dual aim of equipping students with the necessary skills to function in a makerspace and also training aspiring educators to become successful facilitators of maker-centered learning in a school-based setting. While the physical classroom was structured like a traditional makerspace equipped with laser cutters, 3D printers, and soldering stations, the course also sought to emulate learning in a school-based setting with more formal and structured learning. The students were trained on how to use the tools through a series of workshops and projects in the first half of the semester and worked collaboratively to design a novel learning tool in the second half of the semester. On a weekly basis, students were also exposed to readings on the makerspace movement, makerspace-related pedagogy, and makerspace research.

The ten interviewees for this study were selected from the eighteen enrollees based on their responses to weekly surveys which captured their self-reported states of learning and emotions. All interviews were conducted by the same member of the research team to ensure the reliability of the results. Questions in the interview protocol were semi-structured and generally categorized into areas that related to the interviewees' background, course experience, course takeaways, and future plans. After several rounds of coding and discussion, the research team derived a common set of codes that would be used to code the transcripts. In total, nine code families were identified with fifty codes created. As a final check on the reliability of the coding process, the researchers reconvened to code the last transcript together and achieved an inter-rater reliability score of 93.2%.

Results

Our findings showed that students acquired both maker skills and a maker mindset, and reflected on how these skills and mindset could be applied in their teaching practice. Another theme throughout the interviews was that students experienced the learning approaches central to makerspaces in new ways and considered incorporating these approaches into their future practice. A sample of the findings is summarized in the table below.

Table 1: Quote-based Findings

Theme	Descriptive Quote	Application to Future Teaching
Maker Skills	"...but without this class, I would not have been doing the electronics stuff, cause I was always kind of scared of working with electricity."	As an example, one prospective history teacher built a dynamic 3D map of evolving landscapes throughout history using the skills he learned in the makerspace. He hoped to share this model with his future students as a teaching tool.
Maker Mindset	"This class was more about learning how to fail. It's the growth mindset thing...and like teaching people to enjoy struggles."	"[my students] never really share their struggles with anybody else...But this mindset from the makerspace is transferable and I want to design a curriculum that can teach them that."
Hands-on learning	"When you're tangibly able to construct something, it just feels a bit more legitimate."	"I'm thankful that I took the course because it's very empowering for me as a teacher to become a designer to think about how you can merge the two worlds...all the tangible stuff. It's very useful in classrooms."
Collaborative learning	"You're always able to achieve more when working with another person than when working independently."	"my experience presented me with a possible way of teaching by building a community"

Discussion and conclusion

The findings showed that students benefited from the structured yet open-ended nature of the class. The formal aspect of the course which incorporated tool demonstrations and scaffolded projects helped make technical activities seem "less intimidating" and more "approachable", particularly for student-teachers from the humanities. At the same time, the informal learning opportunities explicitly built into the course allowed students to experientially study hands-on learning and community-based learning—approaches that they hoped to build into their own teaching. While students experienced benefits of learning in this setting, they expressed interest in more opportunities to consolidate their experiences and brainstorm ways in which they could "incorporate [the takeaways] into [their] own contexts." Some students felt that without the physical environment of the makerspace, they were uncertain about how to "maintain this momentum" for professional applications. Instructors should consider incorporating scaffolded activities that help transition student takeaways and help them maintain these takeaways outside of makerspaces. Overall, these findings provide support for formal makerspace courses geared towards future instructors and provide insights for improvements.

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