

Augmenting Instructor Decision-Making With Data in Makerspaces

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Abstract: While deviation from formal learning environments is a strength of makerspaces, they can be challenging learning environments for many students as well. This work recognizes the need for instructors to not only support students in makerspaces, but also to personalize their approach in helping students. We designed a weekly personalized intervention cycle based on students' self-reported stated learning challenges and learning experiences. The effect of such personalized intervention was then evaluated using a repeated measure ANOVA. Findings suggest that students receiving personalized interventions expressed a lower sense of community. This suggests that while data can support the personalized assistance, a more nuanced approach may be needed to avoid unintended consequences. Overall, this research represents additional effort in the direction of personalization and an initial step towards augmenting teacher decision-making with data.

Introduction

Makerspaces in educational environments has been a testing bed in the switch from a more traditional subject-based and instructor-centered learning towards a more project-based and instructor-facilitated curriculum (Martinez et al., 2013; Martin, 2015). However, as instructors are not omnipresent in the space, they cannot be fully aware of the individual difficulties that each student is facing. Moreover, students enter makerspaces from a diverse range of backgrounds, carrying with them different levels of prior expertise, learning attitudes and working styles. Nonetheless, instructors in makerspaces can be supported through the deployment of a semi-automated process in providing personalized instruction.

Literature review

Academic makerspaces have been long touted to bring student success in STEAM (Science, Technology, Engineering, Arts and Mathematics). However, a closer examination of the benefits of makerspaces by Clapp et al. (2016) indicates that the benefits of makerspaces lie in the development of students' "maker's mindset", which includes the development of a sense of agency and community spirit. However, barriers to the development of such a mindset exist within makerspaces. For instance, students with little technical background might find entering the space to be daunting or encounter much difficulty when troubleshooting their projects. As such, facilitators ought to personalize their approach for each student. Yet, we lack research-based guidelines for implementing this kind of instruction as current literature in this field provides little insight into such personalized interventions within makerspaces (Litts, 2015). On the topic of automation, most research points to efforts in gathering aggregated information about student learning without any consideration for personalization (Chua et al., 2019). Thus, given the lack of current understanding in providing personalized interventions in a physical learning setting, this research aims to augment the facilitators' capabilities of doing so by creating a semi-automated process of personalized instruction.

Overview

Course overview

The digital fabrication course sits at the intersection of pedagogy and practice. Students in the course learn about digital fabrication tools like the use of basic electronics, microcontrollers, laser cutters, and more through a series of assignments.

Research questions

What is the effect of personalized interventions on students' maker mindset?

Methods

To address the research question, we conducted a study in which instructors were provided with information about different students' individualized learning profile and specific interventions which they could use to support that student. The process of creating learning profiles is semi-automated and draws on several data streams to

aggregate information for the instructors. Information sources include weekly student surveys and blog posts. Once the learning profile for each student is generated, we draw on an intervention database to provide instructors with recommendations for personalized interventions.

Results

A one-way ANOVA with repeated measures was conducted on standardized survey scores for students' sense of agency and community spirit. The results of the statistical analysis indicate that personalized interventions had no statistically significant impact on students' sense of agency, but they do affect the students' sense of community spirit. The negative score for students receiving personalized intervention shows that, on average, students with personalized interventions had a lower sense of community spirit as compared to students without personalized intervention.

Table 1: Effect of Personalized Intervention on Maker's Mindset

Maker's Mindset	One-way ANOVA with repeated measures	Score for Students with Personalized Intervention	Score for Students without Personalized Intervention
Sense of Agency	$F(2, 41) = 0.60, p = 0.4438$	-	-
Sense of Community Spirit	$F(2, 41) = 6.87, p = 0.0122$	-0.07	0.09

Discussion

The result that students with personalized intervention felt a lower sense of community spirit was unexpected. One interpretation is that when students become more time efficient as a result of personalization, they spent less time in the makerspace and this led to lesser opportunities for social interactions. In personalizing learning in makerspaces, perhaps the focus should be less about a more efficient design process, and more focused on guiding students towards productive frustration and collaboration. This study relied on the instructor to be the source of aid, so students may have gained more of a relationship with their facilitators than the other students in the course. While this result is unexpected, it gives warning that a more nuanced approach in personalization may be needed to avoid unintended consequences.

Conclusion

Makerspaces are dynamic spaces filled with students from diverse backgrounds, life experiences, self-efficacy, and attitudes, which makes instruction a job that requires teachers to be able to work under a high-cognitive load (Moos & Pitton, 2014). Our research attempted to aid facilitators in their ability to meet each student where they are, and in turn, give them a better experience and develop their maker's mindset. The use of surveys, personas, an intervention database, and student profiles allowed us to create a semi-automated system of personalization to augment instructor decision making. While we considered aspects of learning beyond just students' technical skills, our efforts to personalize concluded in students feeling less connected to their communities. This prompts additional questions on how personalization can be further nuanced to achieve different learning objectives, and our research serves as the beginning foundation for heading in this direction.

References

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