Broadening Computing: Infusing Culturally Responsive Pedagogy into the Design of Informal Learning Environments

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Abstract: This paper extends the research trajectory of an ongoing and large-scale project into the cognitive and affective aspects of youth's early developmental stage of computational thinking. Grounded on design-based research, this work presents a redesigned computing program through a university-library partnership. Specially, culturally responsive pedagogy was embodied throughout the redesign of the program. Preliminary findings reveal the potential of infusing culturally responsive design in informal environments, to foster youth's belongings and computational thinking. Significance and next steps of the work are also discussed.

Introduction

Computational Thinking (CT) involves skills that help children analyze and solve real-world problems drawing on computer science (CS) principles (Wing, 2006). In recent years, libraries, as unique informal educational spaces, have reinvented themselves as educational hubs to offer a variety of low-tech and high-tech activities intended to build youth's CT and reach greater diversity in computing (Willett, 2016). Many library programs, however, encounter constrains such as not having deep-content expertise besides their librarians in supporting youth's various interests related to computing (Rogowski et al., 2018). One way to address such constraints as well as to fully recognize the affordances of the libraries is through partnerships (Lee et al., 2017). This work presents one kind of partnership between a library and a university. In particular, this paper extends on our previous empirical work in informal learning spaces with an emphasis on infusing culturally responsive pedagogy (Ladson-Billings, 1995) to promote positive experiences in CS for female and racially minoritized students. For the purpose of this work, we first discuss the framework guiding the design of an informal computing program at a local library. We subsequently respond to the following research questions:

- How did participation in a culturally responsive computing environment facilitate peer collaboration and a sense of belonging within peer group?
- How did youth progress in their understanding of CT in a culturally responsive computing environment?

A culturally responsive computing framework

In this work, we situated the Use-Modify-Create model created by Lee and colleagues (2011) with culturally responsive pedagogy to establish the culturally responsive computing framework. This redesigned framework encompasses a cultural dimension, meaning that youth are not only able to set accomplishable goals based on their own interests (e.g., choose what product to design), but importantly, they can pursue such goals with the support and respect of others in the context (Kafai et al., 2014).

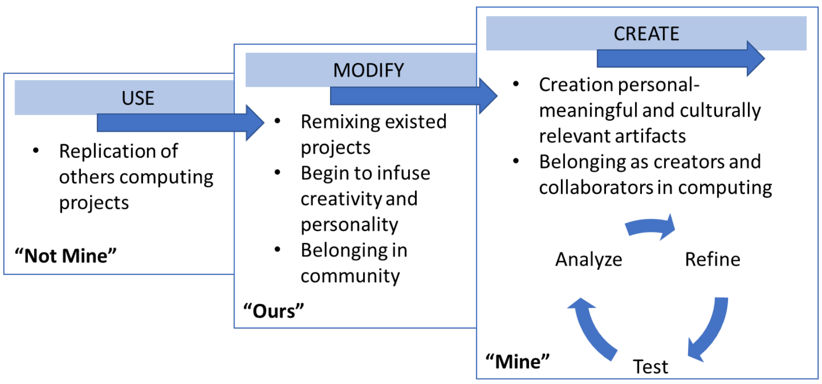

Figure 1. Culturally responsive computing framework developed based on the Use-Modify-Create model (Lee et al., 2011).

Methods

This work is situated within a university-library partnership offered through a larger effort that aims to broaden participation for underrepresented groups in computing. With such background, the Scratch Technology Club (STC) was established at an urban library located in a Mid-Atlantic city. Each semester, at least two undergraduates with computing background served as the STC program facilitators. The STC was offered on Saturday mornings for two hours over a ten-week period each semester for three years. Any child interested in participating was encouraged to attend at any time point of the program. In this work, we selected to report data collected in the fifth semester of the program, A total of 30 children attended throughout this semester.

To answer the research questions, we collected and analyzed lesson plans, fieldnotes, and youth's artifacts. Specifically, we performed social network analysis (SNA) to understand the relationships among youths' interactions (Grunspan, Wiggins, & Goodreau, 2017). We then utilized collective evidence and case analysis to establish youth's profiles and investigate youths' cognitive (e.g., remixing or creating) and affective (e.g., belongings to computing) representations.

Findings and discussion

Preliminary findings of the study reveal that youth formed a variety of collaborations during their creation of the computing artifacts in a culturally responsive computing environment. Among these youth, 25 had at least one experience in collaborating with other peers. Further, results from the SNA reflected that STC served moderately diverse youth groups, including ethnicity and gender. In addition, two metrics from SNA were referred to further describe the degree of the interactions. The *degree centrality* indicates the numbers of peers with whom each youth collaborated, while the *betweenness centrality* indicates the degree of belonging to different peer groups (Grunspan et al., 2017). Pearson correlation tests were subsequently performed, and the results revealed that there was a strong correlation between degree centrality and participation times ($r = 0.78$, $n = 25$, $p < 0.001$), as well as between participation times and betweenness centrality ($r = 0.71$, $n = 25$, $p < 0.001$) (Field, 2011).

More importantly, youth's sense of belonging was progressively established either to STC or to CS throughout interactions and programming with peers regardless of their prior computing background. Additionally, synthesized evidence of this study reflects the potential of using public library as an educational hub and a social place to advance youth understanding of CT and provide enriching computing opportunities. Yet, more work is still needed on how to establish such opportunities with libraries and external agents (e.g. partnership with other sectors) as well as empirical guidance for libraries and other informal spaces on how to develop effective programs that help broaden participation and diversity in computing.

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