Chang, M. et al. (Eds.) (2019). Proceedings of the 27th International Conference on Computers in Education. Taiwan: Asia-Pacific Society for Computers in Education

Studying Computational Thinking through Collaborative Design Activities

Joey HUANG
Doctoral Candidate, Indiana University Bloomington, USA
huang220@iu.edu

Abstract: Previous studies have focused on examining individuals' computational thinking (CT) practices in varied learning contexts. This study aims to expand the current framework of CT by investigating how CT is practiced through collaborative design activities with Scratch. Using a mixed methods design, including video-recorded class observations, artificat analysis, this microethnographic study proposes collaborative CT by examining students' interactions and learning processes in a middle school classroom. By identifying the patterns of CT practices which emerged through collaborative design activities, this study informs how CT is socially practiced in small groups.

Keywords: Computational thinking, collaboration, collaborative design, computer science education

1. Introduction

Computational thinking (CT) will be a fundamental skill by the middle of the 21st century, just like reading, writing, and arithmetic (Wing, 2006). CT entails a series of problem-solving processes, such as recognizing patterns, and systematically breaking down a problem, and then composing an algorithmic solution. Collaborative design activities are defined to be a knowledge creation process which involves students actively communicating and working together to create a shared view of joint design ideas and decisions. Learning through collaborative design activities has been proven to deepen students' content knowledge through practices and advance their problem-solving skills to solve complex and multifaceted problems (Hakkarainen et al., 2013). Studies have shown that collaborative learning is beneficial for middle schoolers learning CT and programming knowledge, and these experiences relate to positive attitudes and confidence in learning computer science (Werner et al., 2012). Prior studies have focused on *individuals*' CT learning and developing in varied learning contexts besides computer science (CS). However, little attention has been paid to learning of CT through collaborative design activities, focusing on how CT is socially situated and practiced through collaboration (e.g., Chowdhury et al., 2018). To fill this gap in the prior research, the author worked alongside middle school teachers to investigate how students in middle school classrooms learn CT collaboratively to better understand the development of CT.

2. Research Goals

The aim of the study is to investigate how students learn CT through collaborative design activities in a middle school classroom and how these activities can be designed to facilitate CT learning. In this study I ask: 1) How do students learn CT through collaborative design activities? 2) What are the contextual factors (i.e., design activities, project type) that support CT over time? 3) How do students interact during collaborative design activities? To what extent do the interactions influence their CT practices? This study was a part of a dissertation research aimed to extend the current CT framework from individual to collaborative dimension in learning of CT.

3. Theoretical Framework

This study is grounded constructionist perspectives on learning (Papert, 1991), which illuminate the impact of learning by creating, iterating, and interacting to investigate students' CT learning through collaborative design activities. In this study, I applied Brennan and Resnick's CT framework, particularly focusing on CT concepts (e.g., loops, conditionals) and CT practices (e.g., testing and debugging), to examine students' CT practices through collaborative design activities with Scratch (https://scratch.mit.edu/), which users can create their own interactive stories, games, and animations via block-based programming.

4. Methodology

The study was conducted in an urban public middle school in a midwestern U.S. state. Participants included 12 students in four focus groups in an elective programming course for 8th graders. The author worked closely with the teacher to create collaborative design activities for a five-week curriculum, which was adapted from *Creative Computing* (Brennan et al., 2014). The methodological approaches included video and artifact analyses to examine students' learning processes.

5. Preliminary Results

Preliminary coding results showed that patterns of CT practices emerged through collaborative design processes. All four groups showed a greater number of experimenting and iterating practices during the planning stage. Additionally, all of the groups demonstrated experimenting and iterating in both the planning and coding stages; however, these practices were more pronounced in the latter stage. In the planning stage, students identified a concept for their project and developed a script to implement the design. In the coding stage, they were able to experiment and iterate their design by identifying the variables of the script and developing a plan to modify the variables.

6. Significance of the Study

This work contributes to the growing body of research on K-12 CS education. I hope to extend the current scope of CT by providing an in-depth exploration of learning and collaboration for younger students. By bridging the framework of CT with collaborative design activities, these findings enhance the understanding of CT in learning, collaborating, creating computing design projects.
For a broader impact, the study provides a provocative way to investigate CT and consider it as collaborative practice not for how we should manage or necessarily accommodate them within existing educational structures, but for what these implementation differences tell us about the forms of learning and literacy that are already instantiated within instruction aimed at fostering learning in CS education.

References

Brennan, K., & Resnick, M. (2012, April). New frameworks for studying and assessing the development of computational thinking. In *Proceedings of the 2012 annual meeting of the American Educational Research Association, Vancouver, Canada* (Vol. 1, p. 25).

Brennan, K., Balch, C., Chung, M. (2014). Creative Computing. Developed by the ScratchEd team at the Harvard Graduate School of Education and released under a Creative Commons license, CC BY-SA 4.0..

Chowdhury, B., Bart, A. C., & Kafura, D. (2018). Analysis of collaborative learning in a computational thinking class. In *Proceedings of the 49th ACM Technical Symposium on Computer Science Education* (pp. 143-148). ACM.

Hakkarainen, K., Paavola, S., Kangas, K., Seitamaa-Hakkarainen, P. (2013). Sociocultural perspectives on collaborative learning: Toward collaborative knowledge creation. In C. E. Hmelo-Silver, C. A. Chinn, C. Chan, & A. M. O'Donnell (Eds.), *The international handbook of collaborative learning* (pp. 57-73). New York: Routledge.

National Research Council. (2010). *Report of a workshop on the scope and nature of computational thinking*. National Academies Press.

Papert, S. (1991). Situating constructionism. In I. Harel & S. Papert (Eds.), *Constructionism* (pp. 1-14). Hillsdale, NJ: Lawrence Erlbaum Associates.

Werner, L., Denner, J., Campe, S., & Kawamoto, D. C. (2012). The Fairy Performance Assessment: Measuring Computational Thinking in Middle School. In *Proceedings of the 43rd ACM Technical Symposium on Computer Science Education* (pp. 215–220). New York, NY, USA: ACM.

Wing, J. M. (2006). Computational thinking. *Communications of the ACM*, *49*(3), 33-35.

DOCTORAL STUDENT CONSORTIUMS