Exploring Social Interactions to Promote Computational Thinking Practices

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Abstract: This study aims to expand educators' understanding of what it means for younger students in the middle school classroom to learn computational thinking (CT) collaboratively. A total of 6.3 hours of video data were collected from a five-week implementation and analyzed to examine students' social interactions and CT practices. The findings show how groups of students applied CT practices through co-designing computational artifacts, helping to extend the methodological landscape in studying CT from collaborative level.

Computational thinking and collaboration

Computational thinking (CT) entails a series of problem-solving processes, such as recognizing patterns, and systematically breaking down a problem, and then composing an algorithmic solution (Wing, 2006). This study focused on the dimension of CT practices (Brennan & Resnick, 2012). Brennan and Resnick's framework defines CT practices as the practices that students develop as they program, such as experimenting and iterating, testing and debugging, and abstracting and modularizing. Particularly, the framework emphasizes the learning of CT through design activities in which a constructionist approach highlights the importance of students' interactions and engagement with design artifacts. They argue that the learning of CT is an interactive and reflective process which learners create, revise, and share their creations during the learning process. Learners develop their CT through the processes of making, reflecting, and reviewing. Interactions within small groups allow students to reflect on and explain their thinking which are likely to advance learning. Studies have shown that different interactions lead to effective or non-effective learning behaviors and engagement in a computational design environment (Campes et al., 2020). In CSEd, recent research used transcriptions and video data to examine how interactions influence students' learning, group dynamics, and engagement (Campes et al., 2020) through pair programming. However, few studies examine how interactions take place in small groups and how it influences CT (Huang & Parker, 2022). Thus, the goal of this study is to examine the following two research questions: *(1) How do students in a small group interact with each other during collaborative design activities? (2) To what extent do the types of interactional moves relate to CT practices?*

Methods

The data was collected in a public middle school in a midwestern U.S. state, which developed K-12 CS curriculum standards. The data was collected as part of a five-week curriculum in an Introduction to CS class. During the implementation, students worked in small groups to co-design computational artifacts with Scratch. The data included four triad groups, a total of 12 students (Female = 4, Male = 8). Majority of students were Caucasian (n= 8), two were Asian, and two were Hispanic. To better facilitate group work and have students familiarize with their group members, students spent a week engaging with group activities on Scratch in week 1.

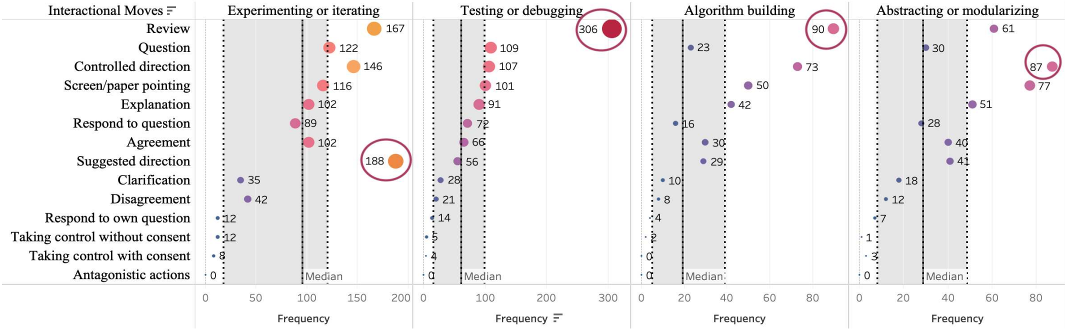
To answer the research questions, it was critical to capture students' interactions clearly during collaborative design activities. All sessions were recorded by two 360-degree cameras and transcribed to examine CT practices in small groups. A total of 24.6 hours of videotaped data from the five-week implementation were collected from both 360-degree cameras (12.3 hours per camera). One group, Tiger, had active verbal communication and interaction. These factors were key to observing practice through group work. Thus, I analyzed a total of 6.3 hours of video data to examine Tiger's CT practices and social interactions. Additionally, I employed and coded a 10-second video segment as the unit of analysis to examine practices through group work (Alcalá et al., 2018). The video recordings were coded by two researchers, and the inter-rater reliability was calculated by Cohen's kappa with k= .78. To examine students' social interactions, I applied the top-down and bottom-up approaches to develop the coding scheme to examine the interactions in a group of three students (Huang & Parker, 2022). To ensure the validity of the coding scheme, I tested the inter-rater reliability with two researchers and reached a statistically robust level, kappa = .72.

Findings: Relationships between interactional moves and CT practices

I concluded the results of 14 interactional moves to examine their relationships with the four CT practices. Figure 1 shows the number of intersections between each CT practice and interactional move. The size of nodes is determined by the smallest and largest code frequency of all displayed nodes and then divides the distance between these two values into seven equally sized value ranges. The larger node represents a higher frequency of the codes, whereas the smaller node indicates a lower frequency of the codes. The color of nodes corresponds with the size of nodes.

Figure 1

Distribution of the Interactions between CT Practices and Interactional Moves



Two major findings are shown in Figure 1. First, the highest interactions between CT practices and interactional moves were different by the practices. Review was highly intersected with the practices of testing or debugging ($\phi = .47$, $p < .0001$) and algorithm building ($\phi = .23$, $p < .0001$). This demonstrated that while students were spontaneously explaining their actions, they were engaging with testing or debugging and algorithm building practices. Suggested direction was the most frequent interactional move happened with experimenting or iterating ($\phi = .37$, $p < .0001$). This explained that while students were trying out and developing more on the project, they also made frequent suggestions for the next steps to the group. They were not sure about specific actions and directions while they experimented or iterated the project, whereas the controlled direction was highly intersected with abstracting or modularizing ($\phi =. 33$, $p < .0001$). While students broke down the step-by-step actions and direction, they also created modules and connected points that can apply to multiple situations. Additionally, they decomposed the problem and created procedures to design their project. Second, suggested direction happened more frequently than controlled direction with the practice of experimenting or iterating. On the other hand, for the practices of testing or debugging, algorithm building, and abstracting or modularizing, controlled direction happened much more frequently than suggested direction while students engaged with these three practices. This indicated that while students provided step-by-step or direct directions in their group, they also engaged with the practices of testing or debugging, algorithm building, or abstracting or modularizing.

Discussion and implications

This study examined the relationship between interactional moves and CT practices to extend the methodological landscape in studying CT from the lens of collaboration. The findings show how CT practices were interrelated and are potentially supported by specific interactional moves during collaborative design activities. The findings imply CT as a social practice, and the examination of interactions makes CT practices explicitly and visible to understand its achieving path through interactions. In other words, the findings demonstrated how each CT practice was achieved by specific interactional moves. Particularly, the findings regarding the relationships between CT practices and interactions can potentially provide useful information for educators to facilitate group work to achieve specific CT practices and use it as an indicator to structure the group activities for CT learning. The co-occurrences of these interactional moves and CT practices provide a way to further explore the implications of CT learning.

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