Computational Thinking Mediating Connections Among Representations in Counting

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Abstract. There is increased focus on exploring the role of computation in students' learning of mathematical concepts, and the notion of computational thinking has gained prominence. In this poster, we demonstrate ways in which students make connections among different combinatorial representations, and we argue that computational thinking mediated such connections.

Keywords: Computational Thinking, Combinatorics, Mathematical Representations

The role of computation in students' learning of mathematical concepts has received increased focus in recent decades. As such, the notion of computational thinking (CT) has gained prominence among computer scientists and STEM educators. We define CT as a way of thinking that one uses to formulate a problem in such a way that a computer could effectively carry it out (Wing, 2014). In this study, we interviewed two pairs of undergraduate students, who were novice counters and relatively novice programmers. Each pair was interviewed for 15 total hours, during which they sat together at a computer and used basic Python coding to solve counting problems. In this poster, we share one aspect of this project that focuses on the role of CT in helping students connect mathematical representations as they solve counting problems. The ability to make connections between mathematical representations is highly valued by mathematics educators as a means for students to make sense of mathematics and deepen their understanding (Pape & Tchoshanov, 2001; Stein, Engle, Smith, & Hughes, 2008). Counting problems can be difficult for students to solve (Batanero, Navarro-Pelayo, & Godino, 1997) and facilitating connections between representations may improve student understanding of such problems. We present findings that answer the following research question: *How does CT help students make connections among multiple representations in counting problems?*

We identified five mathematical representations that arose in our interviews: i) computer codes, ii) outputs, iii) lists, iv) tree diagrams, and v) expressions. In the poster, we demonstrate ways in which students make connections among combinatorial representations and discuss how CT mediates these connections. For example, one pair answered the question "*Write a program to list all possible outcomes of flipping a coin 7 times*." They related output of code (Fig. 1 shows partial output) and a tree diagram (Fig. 2), saying, "So, this [the tree diagram] is what we were talking about with the third column [of the output] as like it's splitting into four." In the poster we offer additional examples and explore why we think CT afforded such connections.

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heads heads tails tails tails tails tails
tails heads tails tails tails tails tails
heads tails tails tails tails tails tails
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128
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Figure 1: Partial Output

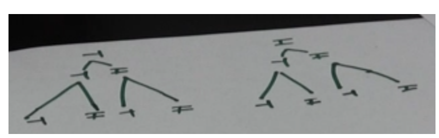

Figure 2: Tree Diagram

In our observations of students working with combinatorial problems, we are beginning to notice not only a unidirectional affordance between CT and mathematics, but a bidirectional effect where computational and mathematical knowledge are co-constructed. Our findings could have broad implications in terms of influencing practices that instructors employ when teaching combinatorial problems in particular, and possibly other mathematics problems in general.

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