Playing with **mathematics, space, and programming** using robot coding toys: How do children develop Computational Thinking?

Background

Models of early childhood CT should reflect a developmental understanding of how children's CT develops over time. One approach is to develop learning trajectories (Sarama & Clements, 2009), which are descriptions of children's thinking as they progress toward goals in a domain and sets of tasks and assessments aligned to learning progressions. Key components of our project include:

- Iterative design of integrated coding-math tasks with robots, based on children's thinking.
- Leverage the expertise of a Design Team of Grades 1 and 2 teachers for designing tasks and formative assessments.
- Provide elementary educators and curriculum designers with a framework for understanding children's development of CT and support for integrating CT with mathematics.

Methods

Four phases of the project and use of Design-Based Research to study elementary students' developing understandings.

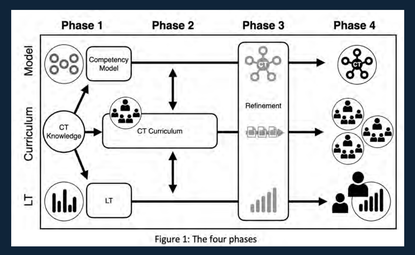
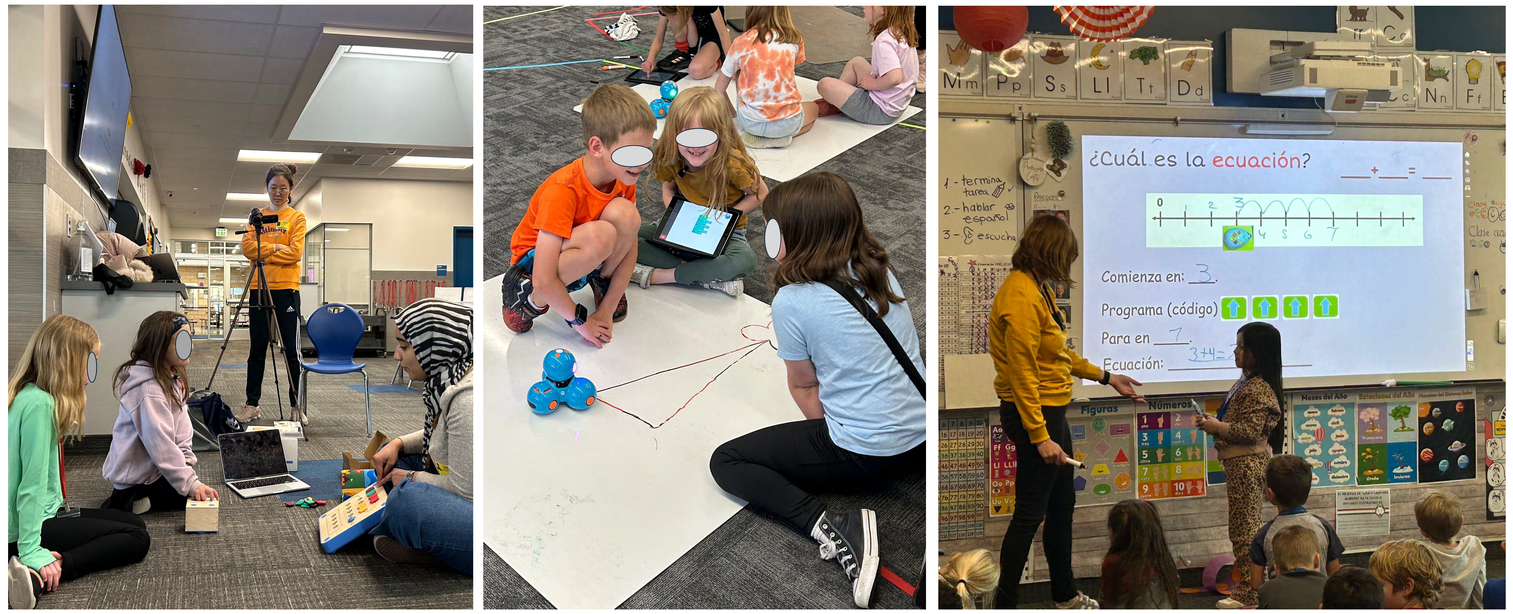


Figure 1: The four phases

Grade 1	Teacher CE	35	17
	Teacher AC	33	22
Grade 2	Teacher DD	36	31
	Teacher AN	36	21
	Teacher JK	48	24
TOTALS	5 teachers, 11 classes	188 students	115 hours of video data

Current Progress

We are conducting a retrospective analysis of 115 hours of video data and 113 design memos. Our analysis will result in a CT cognitive model, tasks, and assessments for Grades K-2.



Above, we illustrate our research settings. Below, we provide results on our analysis of students' thinking during a task integrating multiplicative thinking and the repeat loop code with the Botley robot. To the bottom right is our current cognitive model of Early Childhood Computational Thinking.

Figure 3. The Loop code as a context for multiplicative thinking because of the iterative nature of the Loop. In this example, the program tells the Botley robot to move 9 forward movements via 4 copies of 2 plus 1 forward (2 + 2 + 2 + 2 + 1 or 2 x 4 + 1).

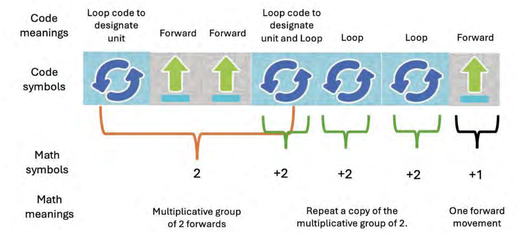
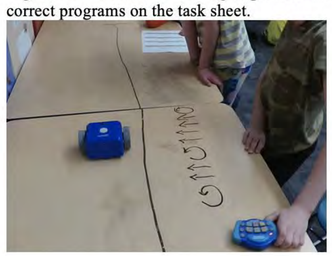
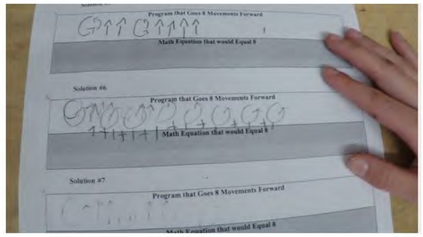
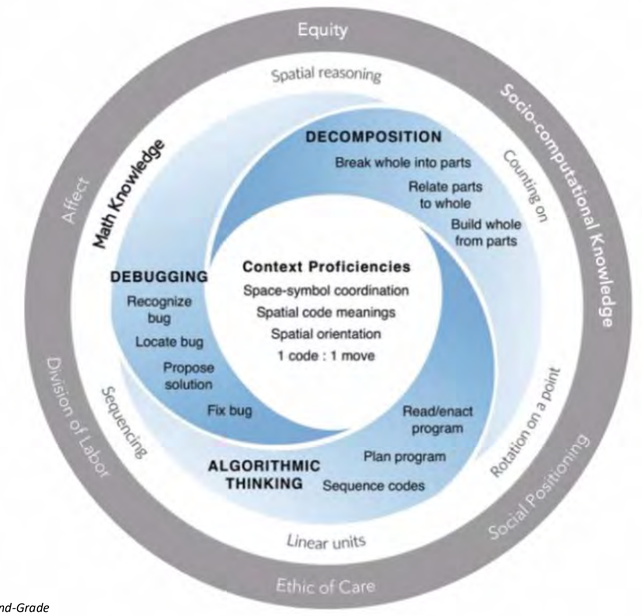


Figure 4. The students in this group often wrote their program ideas on the table, and after testing it, wrote their correct programs on the task sheet.







From Shumway, J. F., *Lund, C., ***Kozlowski, J., Silvis, D., Clarke-Midura, J., & *Ashineh, A. (2025, April). *Locking-It-In and Doubling: Mediating Second-Grade Students' Activity with Multiplicative Thinking*. [Roundtable Session]. Annual Meeting of the American Educational Research Association (AERA), Denver, Colorado.

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