Integrating Computational Thinking into Mathematics Instruction in Rural and Urban Preschools

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Audience

4- to 5-year-old children and their teachers in rural and urban preschools

Summary

Despite calls to integrate computational thinking (CT) into early childhood education, very little is known about children's CT learning and **how best to integrate CT** activities into preschool classrooms. Research, however, suggests that **embedding CT in basic math** instruction could create powerful learning experiences. Public media producers from WGBH and Kentucky Educational Television and researchers from Education Development Center have teamed up to explore the CT teaching and learning process in preschool classrooms through the research and development of classroom resources (a set of **hands-on activities and digital app prototypes**) that capitalize on the power of story and appealing characters. This project aims to build on foundational research in early math learning and in the burgeoning field of early childhood CT, while investigating how the two subjects can be integrated.

Research Questions

1. What kinds of **learning opportunities** arise when CT is infused into existing preschool math practices in underserved urban and rural classrooms? What kinds of challenges do children and teachers encounter?
2. What **meaning** do young children and their teachers make of prototype hands-on activities and tablet apps that introduce CT concepts and practices into math instruction?
3. What does the **CT learning process** look like in young children when they engage with prototype CT hands-on activities and tablet apps?
4. How does the **integration of CT** hands-on activities and tablet apps into math instruction impact children's learning of concepts relevant to both math and CT concepts (sequencing, patterns, algorithmic thinking) and CT practices (problem identification, debugging, iterating, modularizing)?

Research Design and Data Collection Activities

Key project activities include:

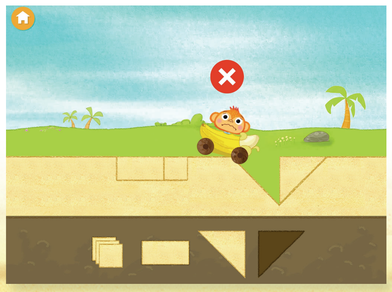
- **Investigate potential learning opportunities** when CT is infused into existing preschool math practices (as explored through the **Building Blocks** early childhood math curriculum).
- **Develop prototype tablet apps and hands-on activities** that focus on the CT concepts/practices of sequencing, debugging, and modularity and that align with preschool math instruction.
- **Conduct formative research** with 16 teachers in rural (Kentucky) and urban (Boston, New York) preschool settings using prototypes.
- **Analyze evidence** of the CT teaching and learning collected through classroom observations and post-implementation interviews with educators to inform prototype revisions and to investigate the CT teaching and learning process.
- **Develop and pilot** test a set of **learning task interviews** to explore children's problem-solving processes using computational thinking.

Results

While analysis is on-going, we have some preliminary results:

- **Learning Opportunities**
  - When CT is infused into existing preschool math practices, it **promotes children's systematic problem solving** process and supports children's being intentional and thoughtful when trying out solutions.
  - Since mathematics is already an established part of the preschool day, integrating CT could help teachers be **invested in promoting CT** to their young learners.
  - Many skills necessary for CT are already **embedded in teachers' math instruction,** including the mathematizing of children's every-day experiences.
- **Promising Practices and Lessons Learned**
  - Base CT activities on complex problems in **everyday experiences.**
  - Allow children **time to notice** something that may be causing a problem, and then to **identify the problem** themselves.
  - Recognize times that **CT is already occurring** in the classroom, and then support making those moments formal learning opportunities.
  - Consider that solving complex problems may require **more than one CT skill**, and that the learning of CT skills may benefit from **putting one skill in the foreground**.
  - Emphasize and **support CT's systematic process** of problem solving.

Debugging



Sequencing

Modularity

- Design resources in which both the CT and math (or other discipline) are **integral** to the activity.
- Use **consistent language** and strategies that promote processing.
- **Provide scaffolds** for English Language Learners that allow them to test out ideas, find problems, and demonstrate understanding without a lot of language. This may include using symbols that show what to do, using hand gestures, allowing the manipulation of objects, and providing demonstrations.

Products

- A document aligning CT learning and preschool mathematics instruction
- A theoretical model for CT integration into preschool mathematics instruction
- Prototypes of 3 apps and 12 hands-on activities that introduce CT in ways that align with math instruction
- A set of prototype CT learning task assessments

Implications of Findings

- The project's theoretical model, describing the relationship/integration among mathematical thinking, mathematization, computational thinking, and computational literacy, could provide a model for extending CT into disciplines other than math, enabling young children to engage in CT throughout their preschool day.
- The hands-on activities, apps, and CT/math alignment document will be of interest to others who are developing CT resources.
- Results from the project's exploratory learning tasks will expand the field's knowledge about how children approach questions, problems, or challenges using CT skills.

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