Studying Implementation of Secondary Introductory Computer Science: Preliminary Results

SRI Education

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Principled Assessment of Computational Thinking

Background & Need

- Computer science teachers face challenges when asked to (1) learn new content, (2) implement new teaching practices, (3) use new technologies (i.e., programming languages and Web markup tools), and (4) address simultaneous constraints imposed by school, district, and state-level policies.
- The widely adopted Exploring Computer Science (ECS) curriculum provides an inquiry-based approach to teaching computer science, aiming to make computer science accessible to diverse student populations.
- To help schools and districts implement computer science curricula more successfully, the CS3 project examines relationships among (1) implementation contexts (i.e., policy, teacher, school, community factors), (2) teaching approaches and curriculum adaptations, and (3) student learning of computational thinking practices in ECS classrooms.

Research Questions

RQ1. How and why do teachers adapt the instructional strategies supported in the ECS materials and PD?

RQ2. How, why, and to what extent do teachers adapt the ECS curriculum materials?

RQ3. What factors enhance or impede the successful implementation of ECS?

RQ4. How does implementation relate to student outcomes?

Constructs Underlying Research Questions

Teaching Quality

Teaching quality refers to the extent to which teachers' instructional approaches reflect the underlying principles of ECS and/or promote computational thinking in students.

- Do teachers engage students in computational thinking practices?
- Do teachers use inquiry-based instructional approaches encouraging students to investigate complex questions and problems?
- Do teachers promote equitable opportunities to practice computational thinking and make computer science problem relevant to the lives of diverse students?

Curriculum Enactment

Curriculum Enactment refers to the extent to which teachers implement ECS lessons as described in the materials.

- Are all ECS lessons and units completed and in the sequence described in the ECS materials?
- To what extent do teachers modify ECS lessons?
- Do teachers address ECS learning objectives (content and practices) in their lessons?

Teacher and Learning Context Attributes

- Demographic
- Professional experience/certifications (e.g., work experience, subject area)
- Typical teaching approaches (e.g., lecture, inquiry, projects)
- Beliefs about equity in teaching and learning computational thinking
- Experience with and perceived benefits of professional development
- Classroom attributes (e.g., access to computers, class duration)
- School attributes (e.g., department housing ECS, availability of other CS courses)

Highlights from Unit 1 Teacher Survey

Unit Pacing and Curriculum Modifications

- Teachers varied the length of Unit 1 considerably, perhaps due to the varying interests of students.
- Teachers varied in the number of topics that they modified, perhaps due to differences in the preparedness and comfort level with the ECS content, as well as interests of ECS students across instructional settings.
- Teachers modified Unit 1 for various reasons, including to meet the specific needs of students (e.g. increase or decrease the difficulty level or accommodate students with disabilities).

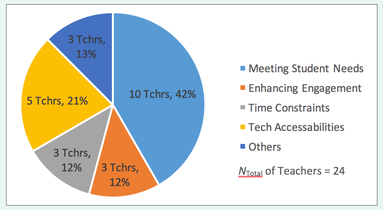


Figure 3. Exploring the underlying reasons of teachers modifying topics for ECS Unit 1.

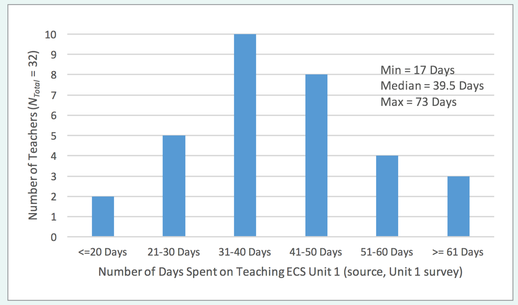


Figure 1. Teacher distribution on the length of time spent on ECS Unit 1.

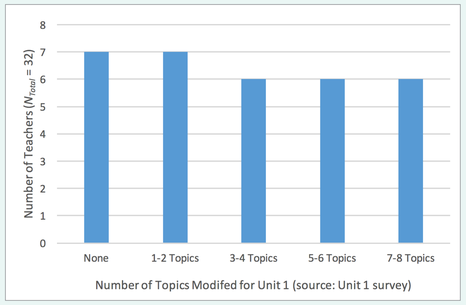


Figure 2. Teacher distribution on the number of modified topics for ECS Unit 1.

Example explanations for modifications include:

"For most activities, I included extra-challenging examples, extensions or reflections."

"Sometimes I brought in outside readings to engage students… so they were still being exposed to complex texts and completing analysis through [text-dependent questions] TDQ's."

Teaching Approaches

- EECS training emphasizes the key teaching approaches, and survey results reflect that emphasis. Responses indicate that teachers (1) believe inquiry-based teaching approaches to be critically important for students to learn CS and (2) enact these approaches with relatively high frequency (i.e., during every class or most classes). This suggests that teachers recognize the need to incorporate approaches such as reflection, problem solving, and communication to promote successful CS learning.

In interviews, teachers said:

"Inquiry is just an exploration, it's allowing them to think through and persevere, process after they have gotten the basic frame, I don't lecture, there is nothing I can lecture about because a lot of this is new to me."

"Inquiry to me is the students' ability or opportunity to access the material how they want to access the material themselves and how they get there and their understanding of it. I want them to be the ones to decide what to investigate ... I see this as a broad range, opening up type of class."

Barriers to Student Collaboration

- Teachers appear to face challenges when engaging students in collaborative activities. They report difficulties with assigning credit for group work and motivating students to work collaboratively. One explanation for this observation is that the culture of collaboration (i.e., expectations, learning dynamics) needs to be further developed in introductory computer science.

In interviews, teachers said:

"Many students just want to work by themselves and sometimes share out when it is time."

Research Plan

The CS3 project involves two broad strands of work.

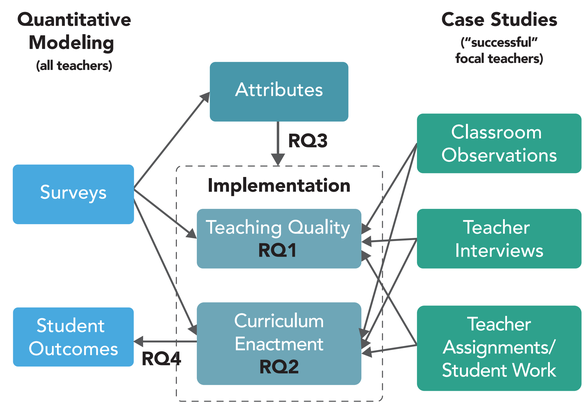
- Assessing student learning outcomes requires the team to develop validated measures of students' proficiency with computational thinking practices
- Characterizing the relationship between curriculum implementation and student learning outcomes requires an analysis integrating teacher and learning context attributes, teaching approaches, and curriculum adaptation

Sample

- Study participants are new and experienced ECS teachers in high schools in three regions of the US.
- Teachers of ECS come from diverse educational and professional backgrounds.
- ECS targets students who may not be prepared for more advanced computer science courses.

Map of Instruments to Constructs

The diagram below divides teacher data into 2 samples with all teachers on the left, and a subset of case study teachers on the right. The arrows point from the instruments to the attributes and research questions supported.



Analysis

Our analyses will link indicators of TQ and CE along with key attributes of the ECS teachers and learning contexts. We will explore the impact of these key indicators and attributes on student computational thinking outcomes, as measured by assessments for ECS Units 1 to 4, as well as a pretest and a cumulative posttest.

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ECS Exploring Computer Science

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