


Developing Implementation Measures for K-12 Computer Science Curriculum Materials

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SRI International

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Principled Assessment of Computational Thinking

Overview

- Successful Implementation
- Measures
- Hypotheses
- Analysis and Results

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Overall Goal & Context

- Understand the specific relationships between computer science instruction and student learning
- Part of a study of that looks at how the implementation of the Exploring Computer Science curriculum affects student learning as measured by a set of validated assessments*

*E. Snow, D. Rutstein, M. Bienkowski, and Y. Xu. 2017. Principled Assessment of Student Learning in High School Computer Science. ICER '17. https://doi.org/10.1145/3105726.3106186

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Research Questions

Curriculum Enactment & Teacher Practice

- How and why do teachers implement the instructional strategies supported in the ECS materials and professional development?
- How, why, and to what extent do teachers adapt the ECS curriculum materials?
- What factors enhance or impede the successful implementation of ECS?

Impact on Student Learning Outcomes

- How does ECS implementation relate to student outcomes?

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What is Successful Implementation?

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Implementation Constructs

Teaching Quality

- Teachers' use of inquiry-, equity-, and collaborative-based teaching strategies

Curriculum Enactment

- Relates to lessons modified, skipped, and added
- Pedagogical and non-pedagogical reasons

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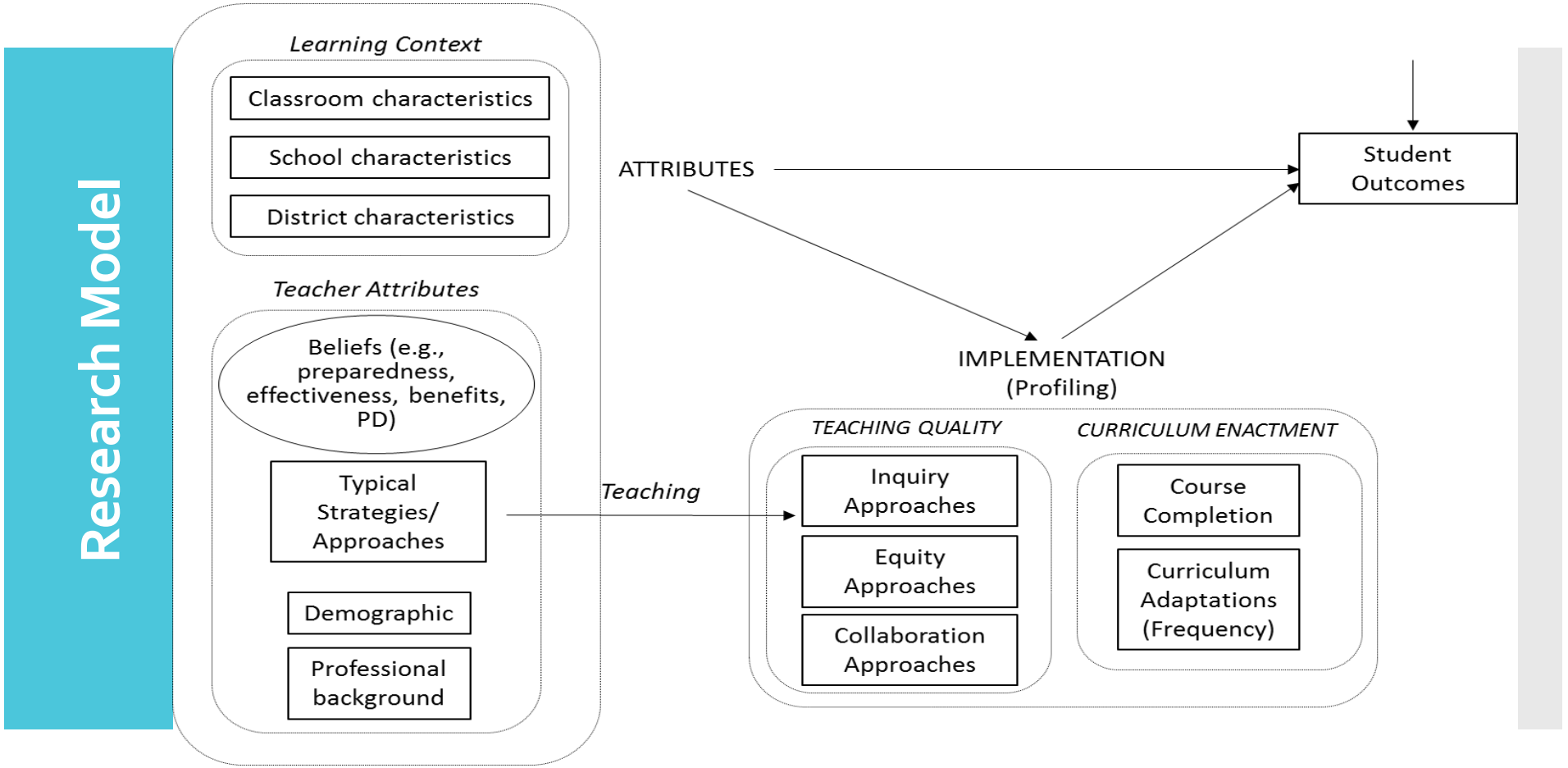
Successful Implementation of ECS: Teaching Quality

Equity, Inquiry, and Collaboration Instructional Strategies

- **Equity**: Curriculum activities reflect the notion that success in CS is attainable by and needed for all students regardless of their cultural, linguistic, or economic backgrounds.
- **Inquiry**: Emphasizes core concepts learned through engagement with disciplinary practices and open-ended problems, student-centered teaching approaches, and formative assessment
- **Collaboration**: Activities are designed to encourage students to work in a variety of collaborative settings including elbow partner and group research projects. This encourages conversations around computing topics.


Research Model
Learning Context
Classroom characteristics
School characteristics
District characteristics
Teacher Attributes
Beliefs (e.g., preparedness, effectiveness, benefits, PD)
Typical Strategies/ Approaches
Demographic
Professional background
Teaching
ATTRIBUTES
Student Outcomes
IMPLEMENTATION (Profiling)
TEACHING QUALITY
Inquiry Approaches
Equity Approaches
Collaboration Approaches
CURRICULUM ENACTMENT
Course Completion
Curriculum Adaptations (Frequency)

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Research Process

- Develop a set of hypotheses related to our research questions
  - Hypothesize the relationships among potential derived variables to try to address each of the research questions
- Define a set of variables
  - Based on the data we collected and the research goals
  - Determine how to aggregate data from different questions on the surveys
- These two tasks were done iteratively

Measures: Operationalizing the Model

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Data Collected

Student Assessments

- ECS Units 1-4: Human-Computer Interaction; Problem Solving; Web Programming; Programming
- Cumulative over these 4 units

Teacher Surveys

- Background
- Unit 1-4
- Professional Development

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Survey Data Overview

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Survey	Number of Teachers
Background	36
Professional Development	11
Unit 1	39
Unit 2	37
Unit 3	27
Unit 4	28

Survey	Number of Teachers
Background + Unit 1	26
Background + Unit 2	30
Background + Unit 3	22
Background + Unit 4	23

- 5 teachers responded to all surveys
- 34 teachers responded to the background survey and at least one unit survey

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Teacher Background Survey

- Teaching experience
- CS at your school
- Your degrees and coursework
- Professional experience
- Your teaching
  - Instructional activities in CS and non-CS classes
  - Beliefs about ECS
- Demographics

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Teacher PD Survey

- Benefits of PD on instructional activities and approaches
- General beliefs about PD
- Perceived barriers to implementation

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Teacher Unit Surveys

- Teaching assignment (unit 1 only)
- ECS classes
- Unit experience
- Unit content
  - Modifying/Skipping of topics
  - Sense of preparedness
  - Leading instructional activities: general and unit specific
- Unit summary
  - Successful instructional activities
  - Challenges
- Overall ECS experience (unit 3 and unit 4)
  - Availability of technology
  - Barriers to implementation
  - ECS curriculum adaptation

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Sample Teacher Unit Survey Questions

Inquiry-Based Practices

When teaching the unit, how often did you engage students in the following practice?

- Students develop their own solutions to problems

Equity-Based Practices

Which of the following instructional successes did you encounter?

- Opportunities for students to connect computational thinking to cultural backgrounds

Collaboration-Based Practices

When teaching the unit, how often did you engage students in the following practice?

- Students collaborate or work in teams
- Students present or communicate their ideas to peers

Hypotheses

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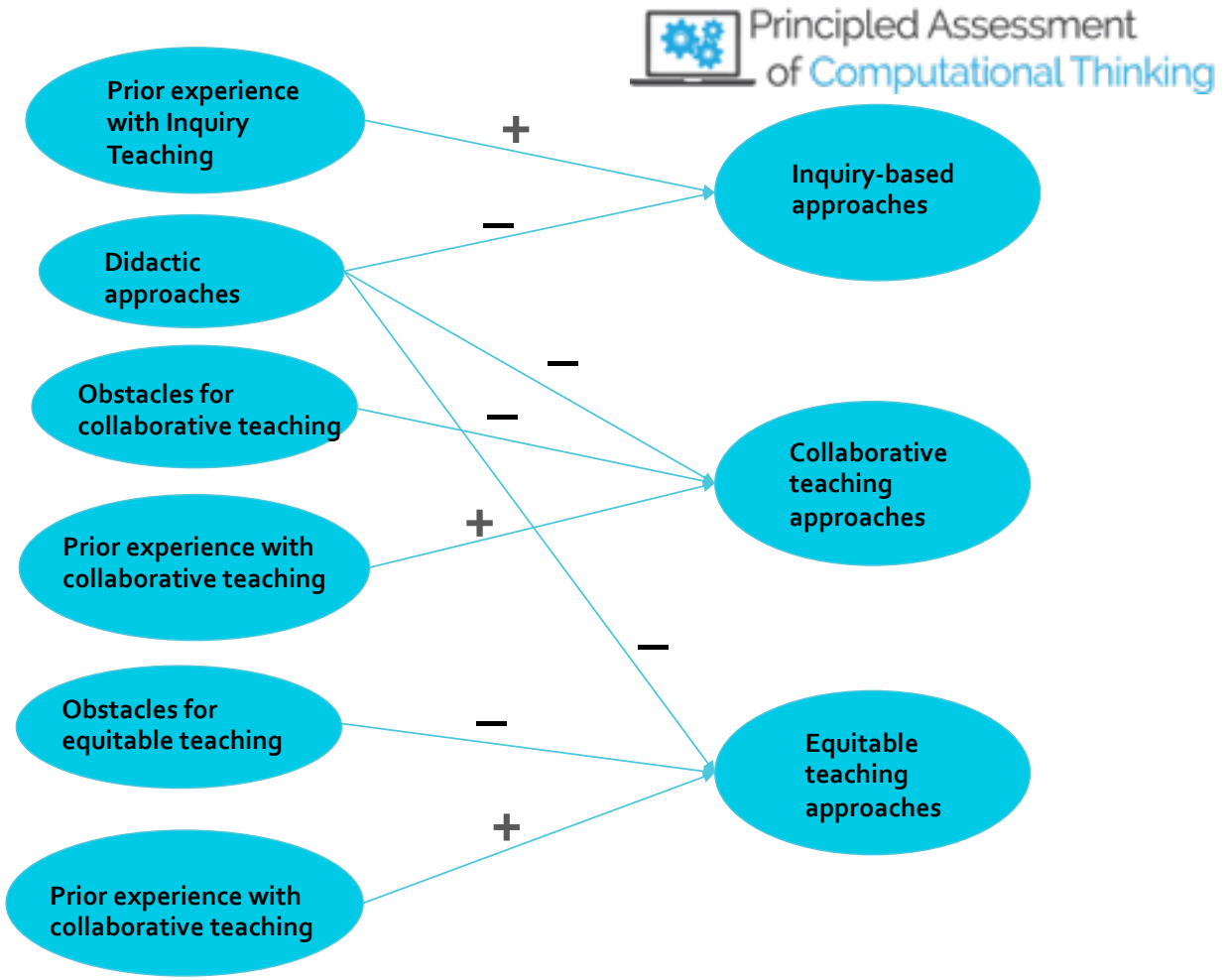
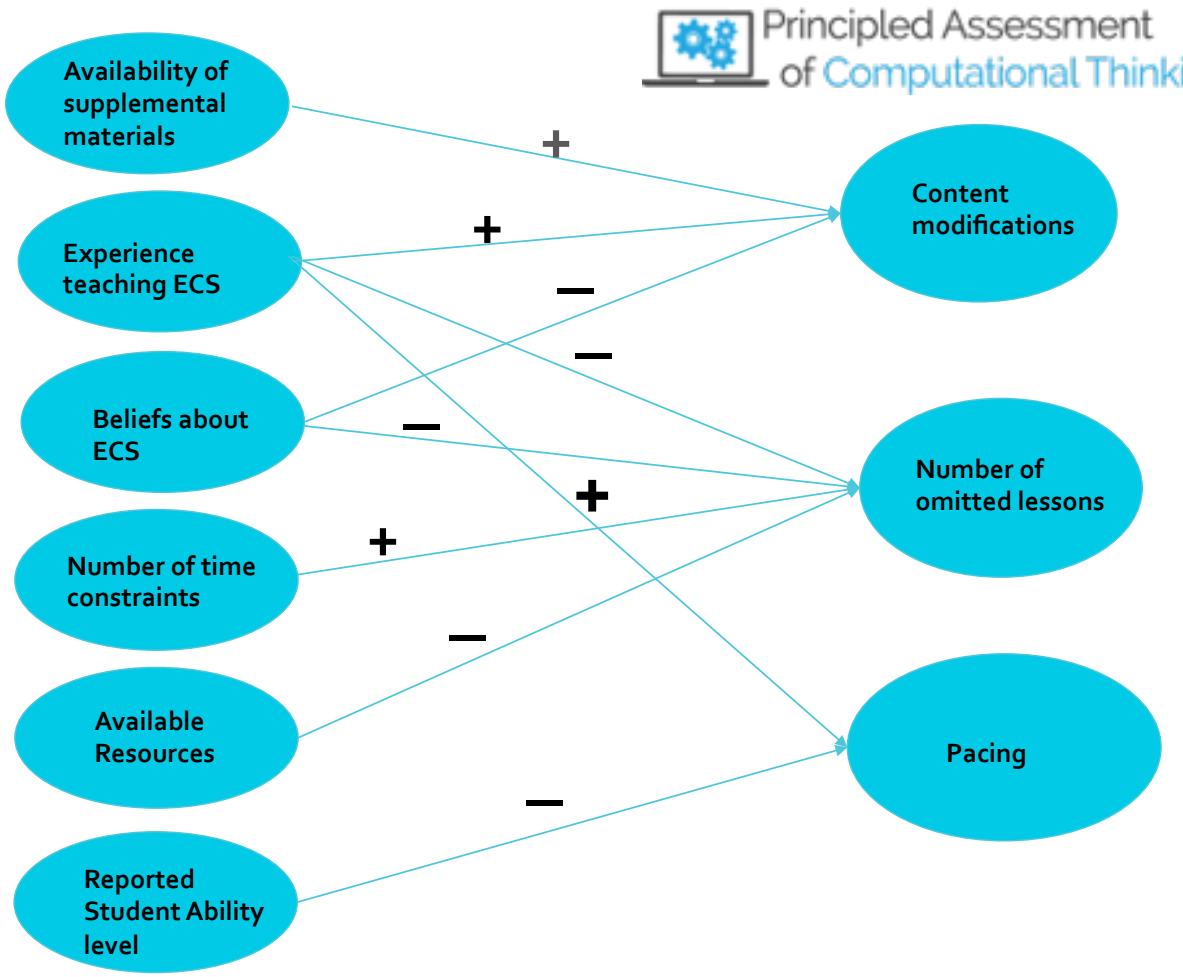
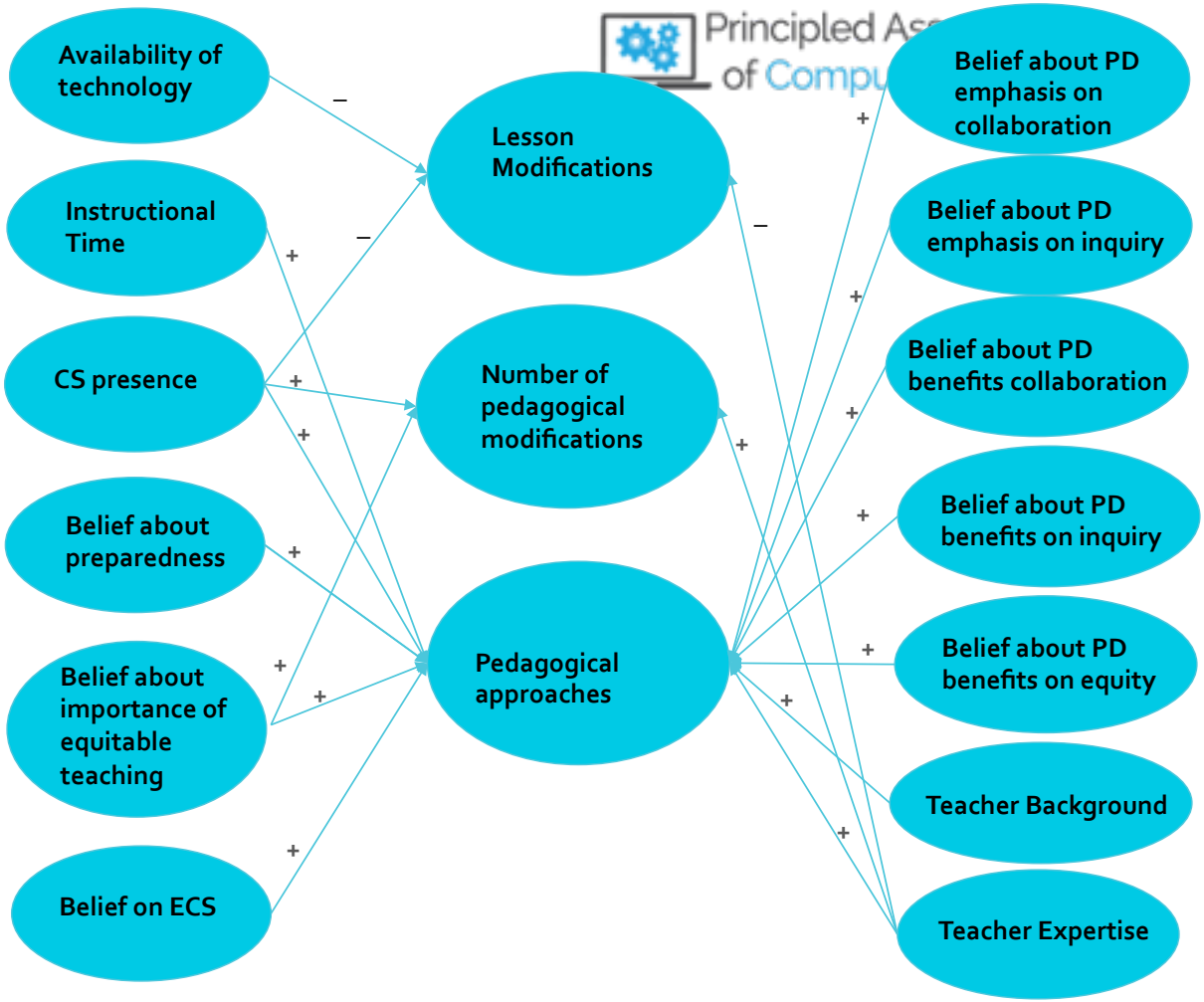
RQ1 - How and why do teachers implement the instructional strategies supported in the ECS materials and PD?



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? – Classroom Factors



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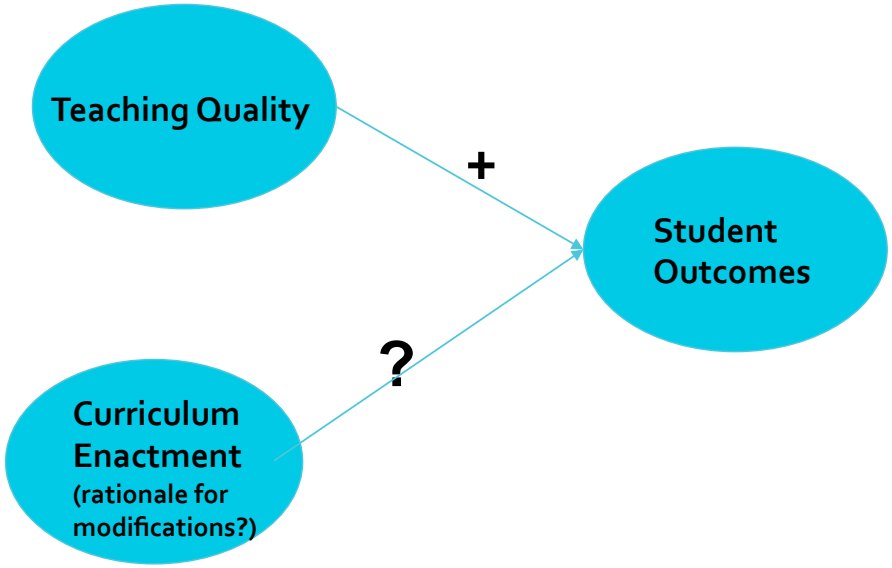
RQ4: How does implementation relate to student outcomes



Analysis and Results

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Practicing Inquiry-Based Instructional Strategies

Levels of Inquiry-Based Instructional Strategy	Number of Teachers			
	Unit 1	Unit 2	Unit 3	Unit 4
L1: No practice regardless of success	0	0	0	0
L2: Low frequencies of practice + few success	3	2	0	0
L3: Low frequencies of practice + more success	5	4	1	1
L4: High frequencies of practice + few success	12	7	8	5
L5: High frequencies of practice + more success	17	22	18	22
Total N	37	35	27	28

- High levels of inquiry practices across all units
- Highly correlated with prior inquiry experience for Unit 1
- Somewhat correlated with the belief that ECS benefits all students (for Unit 2 only)

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Practicing Collaboration-Based Instructional Strategies

Levels of Collaboration-Based Instructional Strategy	Number of Teachers			
	Unit 1	Unit 2	Unit 3	Unit 4
L1: No practice regardless of success	0	0	0	0
L2: Low frequencies of practice + few success	4	4	4	5
L3: Low frequencies of practice + more success	1	3	5	4
L4: High frequencies of practice + few success	7	5	5	3
L5: High frequencies of practice + more success	25	23	13	16
Total N	37	35	27	28

- High collaboration practices across all units
- No statistically significant correlation with teacher factors and learning context factors

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Teacher Sample: Equity-Based Instructional Strategies

	Total Number of Teachers	% Teacher Indicated Successful Promotion
Unit 1	38	63.16%
Unit 2	37	64.86%
Unit 3	27	74.07%
Unit 4	28	64.29%

- High level of equity practices across units, although lower in Unit 1
- Correlated with the belief that cultural relevance does not decrease rigor (Units 1 and 2) and cultural relevance improves outcomes (Unit 3)
- Inversely correlated with the number of years teaching CS (Unit 2) and years of teaching ECS (Unit 2)
- Correlated with industry experience (Unit 3)

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Curriculum Enactment

	Total Number of Topics	Average Number of Topics Modified	Average Number of Topics Skipped	Percent of Teachers Adding Any Topic
Unit 1 (N=37)	8	3.57 (45%)	.19 (2%)	45.16%
Unit 2 (N=34)	9	3.35 (37%)	.32 (4%)	46.67%
Unit 3 (N=27)	11	7.11 (65%)	.81 (7%)	34.62%
Unit 4 (N=28)	18	6.54 (36%)	1.21 (7%)	42.11%

- Modifications correlated with prior experience with the curriculum instructional and collaboration strategies
- Teachers more likely to not modify if there was a well established CS presence at the school
- Skipped and modified lessons related to access to technology.

Curriculum Adaptation Examples

- Skip units or material that provides "leveling background"
- Adding additional content and supplemental material
- Giving students extra time and skipping units at the end of the course
- Use different tools (e.g., programming environment)

"Many of these tasks are too easy for my students"

"Students struggled with understanding web 2.0 applications."

"I am saving Scratch programming for our middle school."

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Relation to Student Assessment

- Students whose teachers had higher unit inquiry and/or collaboration practices performed better
- More experience teaching CS in general was related to lower performance
- More experience teaching ECS was related to higher performance
- CS presence in the school was related to higher performance

Discussion

- Overall, we found that the factors that related to student outcomes varied by the CS topic covered in the unit. There are other aspects that could be researched in the future.
- Instruments will be available from csedresearch.org

Thank you!

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