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Introduction

This project is a research-practice partnership between Outlier Research & Evaluation | UChicago STEM Education at the University of Chicago and Broward County Public Schools (BCPS). The project's goal is to find time for computer science (CS) in the already full elementary day. BCPS' strategy was to embed CS lessons in the non-negotiable literacy time block. To do so, BCPS developed two "transdisciplinary" problem-based learning modules for each 3rd, 4th and 5th grade ("Time4CS" modules) integrating science, reading, and social studies content with CS and computational thinking (CT) concepts and incorporate lessons from Code.org's "CS Fundamentals" course.

About Broward County Public Schools



Research Questions

The project's over-arching research question was: "What are the effects of implementing computer science within a transdisciplinary curriculum on grade 3-5 students' academic achievement and on their attitudes toward CS?"

Outlier examined two sub-questions:

RQ 1: Is the implementation of an integrated STEM/ELA and CS curriculum associated with grade 3-5 students' academic achievement outcomes?

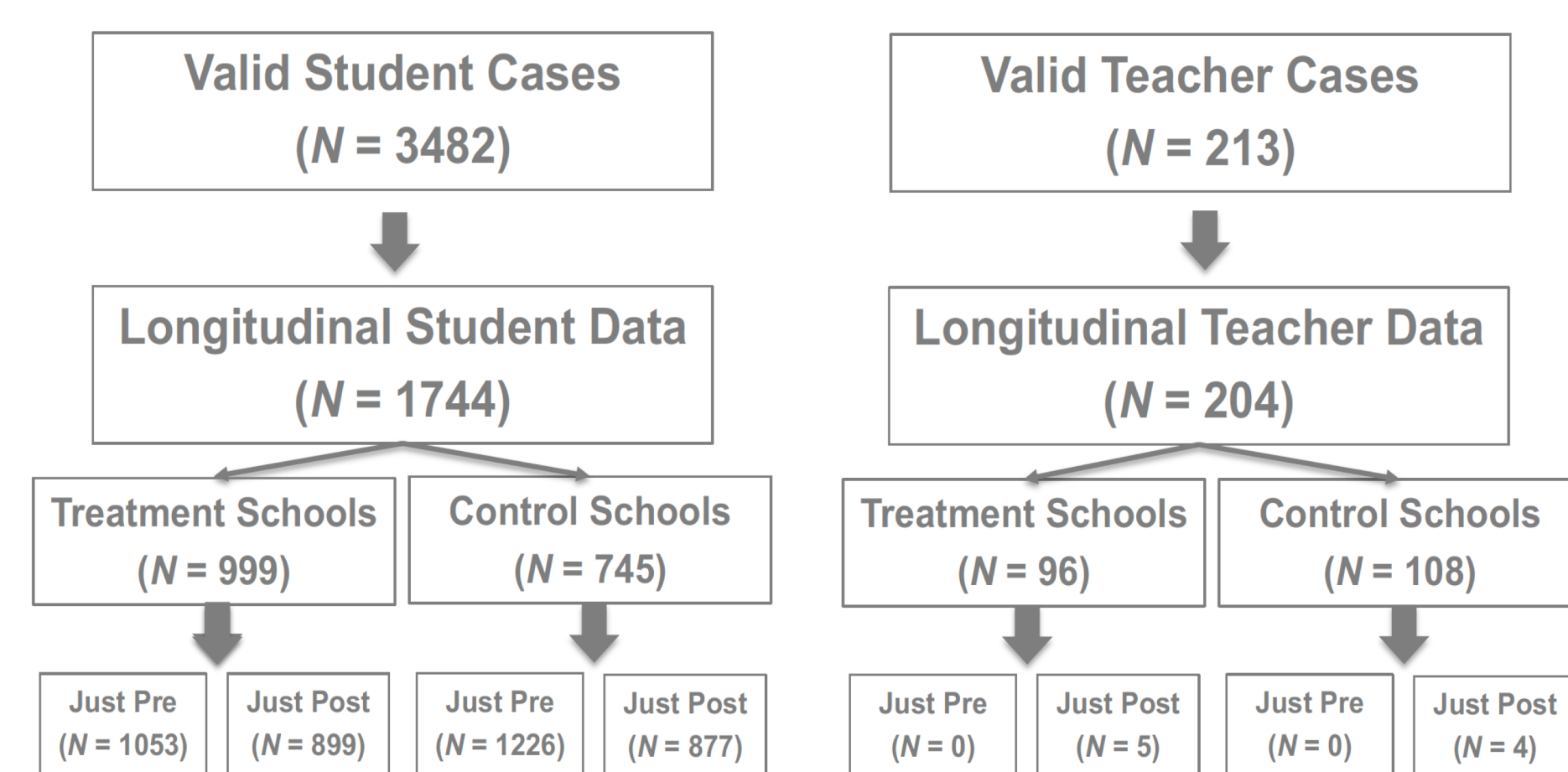
RQ 2: Is the implementation of an integrated STEM/ELA and CS curriculum associated with increases in grade 3-5 students' attitudes toward CS?

Study Methods

Teacher and Student Sample

16 schools participated

8 Treatment, which implemented 2 Time4CS Modules per grade 3-5
8 Comparison, which did not implement the modules



Data Collection

Student Measures	Teacher Measures
General School Affinity	Module Implementation
General School Self-efficacy	Teacher Instructional Practices
Computer Science Affinity	Years of CS Teaching Experience
Computer Science Self-efficacy	Innovativeness
Computer Science Identity	Resourcefulness and Coping
Computer Science Utility	
Achieve300 Literacy Scores & Florida State Assessments in ELA, Math, and Science	

Exploratory Study: Lessons Learned

Module Development

Time4CS Interdisciplinary Modules

- Driven by a problem-based learning (PBL) context
- Designed to be embedded in the elementary day's 180 minute literacy block
 - 90-minutes dedicated to literacy focus
 - 90-minutes focused on science/social studies grade level content standards in the context of the problem-based unit
- Grade levels were assigned a specific Code.org CS Fundamentals course integrated into the modules, and teachers had optional additional resources for CS to include (eg. Scratch, Khan Academy, Barefoot Computing)
- Computer science and computational thinking (CT) is integrated throughout with deliberate attention to CT terminology and transferable CT skills within the disciplinary context. For example, below demonstrates decomposition involved in developing a population model in Scratch.

BROADCASTING MESSAGES IN SCRATCH

In the table below, list the different messages you wish to broadcast in your Scratch program. Then write down in the appropriate column what you want each sprite as well as the stage backdrop to do when that message is broadcast.

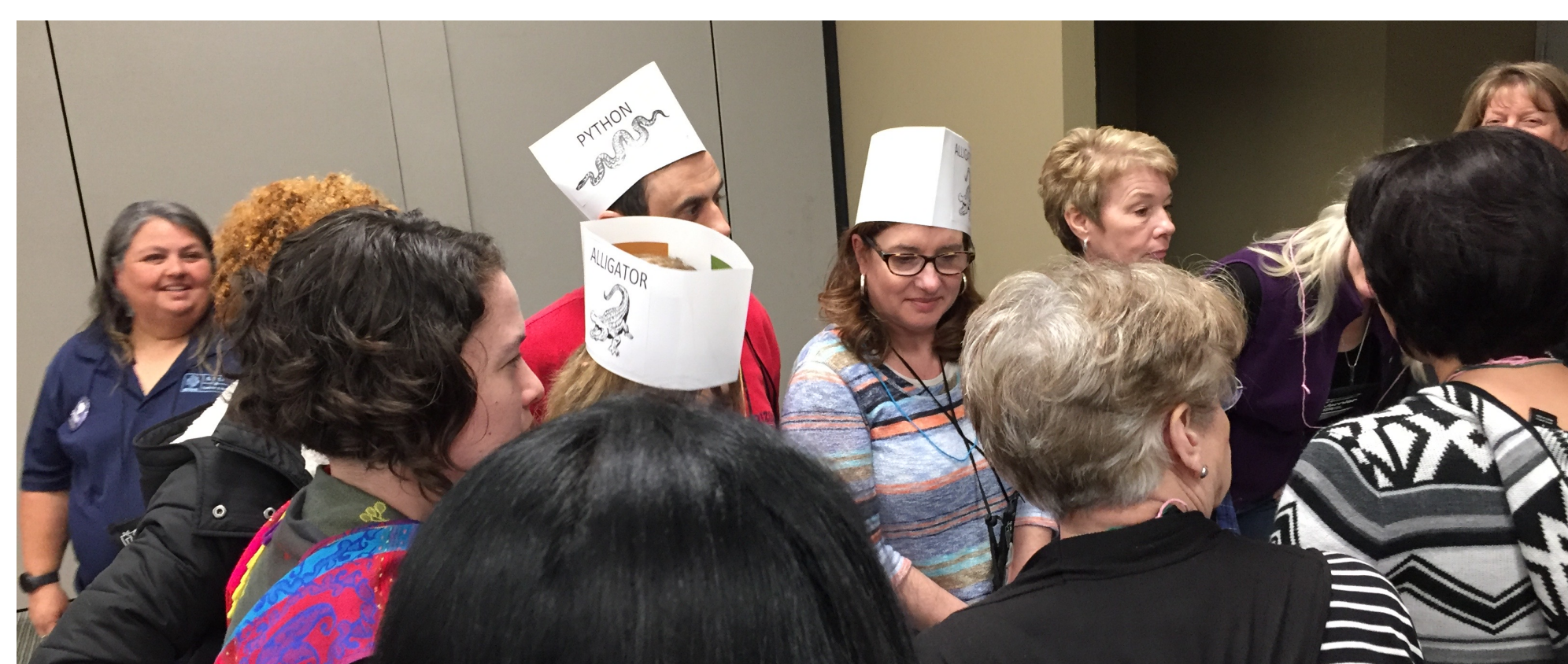
BROADCAST MESSAGE NAME	What will TRIGGER the message to be broadcast?	What will each of the following do as a result of the message being broadcast?				
		SPRITE 1 Alligator	SPRITE 2 Python	SPRITE 3 Rabbit	STAGE Backdrop	
1 Python Eats Rabbit	when python sprite touches rabbit sprite	nothing	make cheeping sound	Rabbit shrinks	no change	
2 Alligator Eats Rabbit	when alligator sprite touches rabbit sprite	increases alligator rabbit count + score by 1	nothing	Rabbit shrinks	no change	
3 bene over	when python sprite touches alligator sprite	hide	hide	hide	switch backdrop to gameover play random loop	
4 you win	when final number of rabbit count is greater than 5	hide	hide	hide	switch backdrop to gameover play happy music loop	

Implementation Measures

- Did teachers implement the module (yes/no)?
- Were lessons omitted from the module (yes/no)?
- Were lessons modified in the module (yes/no)?
- Were lessons added to the module (yes/no)?

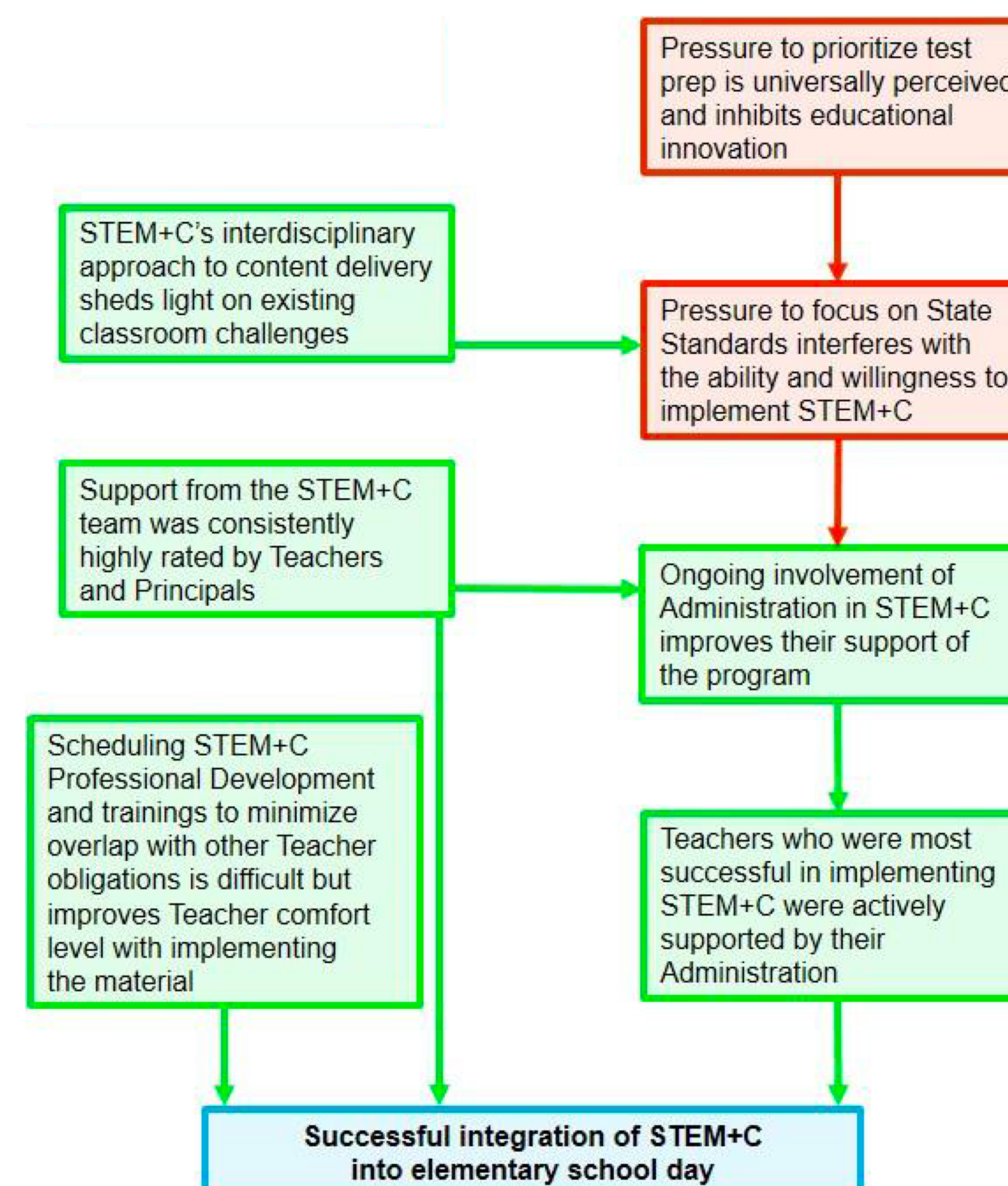


My students became engaged and enthusiastic about integrating technology in every aspect of our study. I also love to learn new things and challenge my students. Even my students with disabilities were engaged and enlightened. (Teacher, Grade 4)



Teacher Implementation

Barriers and Successes in Module Implementation



Lessons Learned: Regardless of when professional development and follow up training takes place, attempting to isolate the training away from other new content and technology helps Teachers to absorb and retain the STEM+C materials without feeling overwhelmed. In addition, providing a Quarter between training and implementation provides time for Teachers to reflect on the material, prepare their lessons, and ask questions.



I believe Computer Science is crucial for the children to learn but time is really limited. Interdisciplinary is wonderful and the children enjoy the content more and the knowledge also sticks more. It is just not an easy task to incorporate it all. (Teacher, Grade 5)

Initial Findings

Key Takeaway: Variables examined in this study were related to students' academic achievement outcomes.

More-detailed findings are summarized here:
Implementation of the Time4CS transdisciplinary module was not related to students' attitudes or academic achievement outcomes.

Regardless of school condition (across all students)....
Students had higher Achieve 3000 Lexile scores, and higher FSA ELA and Math scores in classrooms where teachers carried out higher levels of "Extra," non-grade specific Code.org Lessons.

The greater the value that teachers placed on interdisciplinary teaching practices was related to higher student Achieve 3000 Lexile scores, and higher FSA ELA and Math scores.

Teachers from treatment schools where the Time4CS transdisciplinary modules were implemented reported carrying out higher levels of mandatory, grade-level specific Code.org lessons and higher levels of "Extra," non-grade-level specific Code.org lessons compared to teachers in comparison schools.
No differences resulted between treatment and comparison school teachers for "additional," non-Code.org computer science activities, such as Khan Academy or Barefoot Coding.

Student demographic characteristics were also related to academic achievement:

- Low-income students (receiving free-reduced lunches) scored significantly lower on Achieve 3000 Lexile scores, and FSA ELA, Math, and Science scores.
- Compared to White students, Asian students performed better on FSA Math and Science exams, whereas African Americans performed worse on FSA ELA, Math, and Science exams.
- Female students performed worse on the FSA Science exam.

Funding



This material is based upon work supported by the National Science Foundation under EHR STEM+C Grant #1542842, L. Milenkovic, PI; J. Century, co-PI.

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Acknowledgements

We would like to acknowledge and thank a few of the many that made this study possible:

Broward County Public Schools, parents, teachers, and administrators in each participating elementary school:
Treatment: Bennett, Deerfield Park, Eagle Point, Indian Trace, Pompano Beach, Riverglades, Silver Lakes, and Silver Shores
Comparison: Bayview, Dolphin Bay, Gator Run, Morrow, Panther Run, Sunset Lakes, Sunshine, and Village
and District administration (principal supervisors and Office of Academics)

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