Promoting collaborative problem solving through computational thinking and computer programming for K-8 students with disabilities

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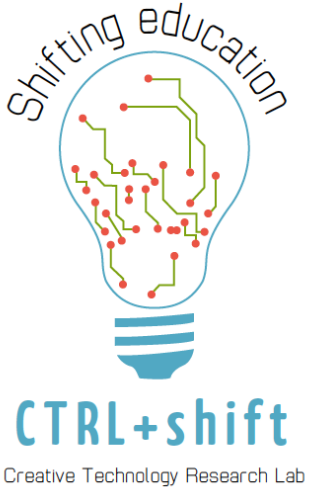
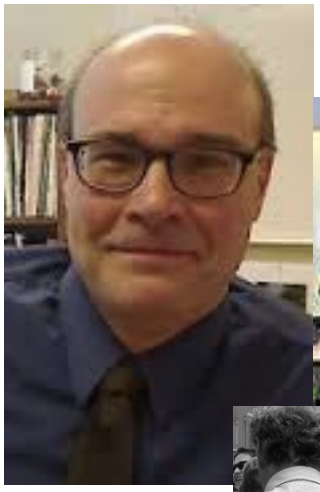
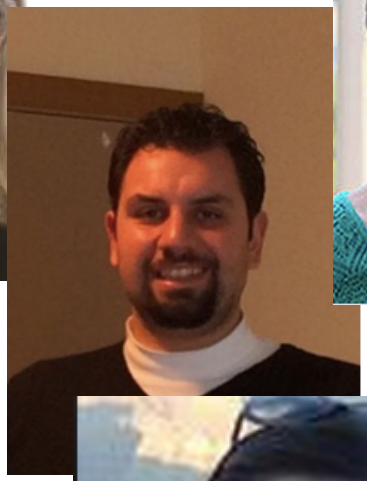


Roadmap

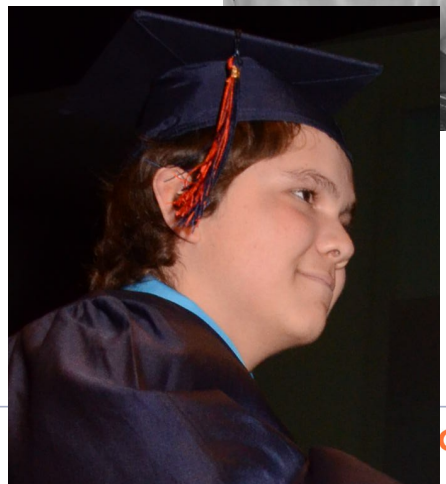
- Introductions and Overview
- Collaborative Computing
- Students with Disabilities
- Next Steps

First…this is a collaborative effort





Why focus on computing?

- **STEM Pipeline Argument:**
  - US Dept. of Labor Statistics says that by 2020, there will be 1.4 million computing jobs, but only 30% will be filled at the current rate.
- **Beyond the STEM pipeline argument:**
  - Real-world application of mathematics, opportunities to practice problem solving, persistence, collaboration
  - Equity

Research Study Context

There is a well established rationale for computing in K-12.

Few studies have examined computing with diverse learners.

None at K-12 with students with disabilities.

Our methods are exploratory because this is new territory… We have a lot to learn.

Our Approaches

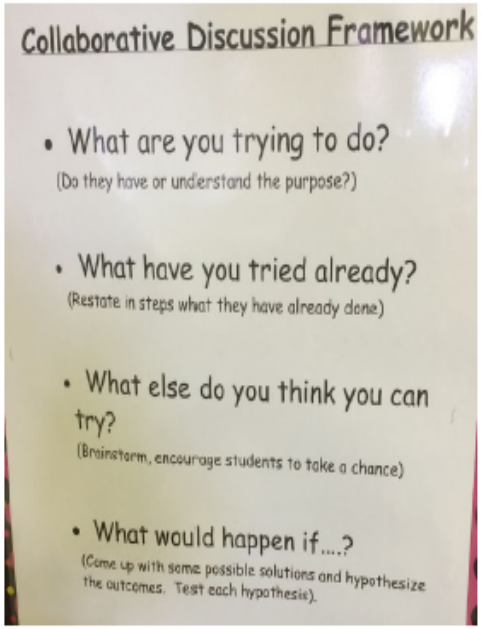
- Focus on Universal Design for Learning
- Use different computing platforms to individualize for students
  - Example: Graphically intuitive block-based programming
- Teach, model, and reinforce collaboration using a consistent framework
- Balance explicit instruction with open inquiry

Origins of the Collaborative-Computing Observation Instrument (C-COI)

Israel, M., Pearson, J. N., Tapia, T., Wherfel, Q. M., & Reese, G. (2015). Supporting all learners in school-wide computational thinking: A cross-case qualitative analysis. *Computers & Education*, *82*, 263-279.

Purpose

The purpose of this study was to investigate how elementary school teachers with limited computer science experience in a high-need school integrated computational thinking into their instruction.



Park and Lash (2014)

Help Seeking

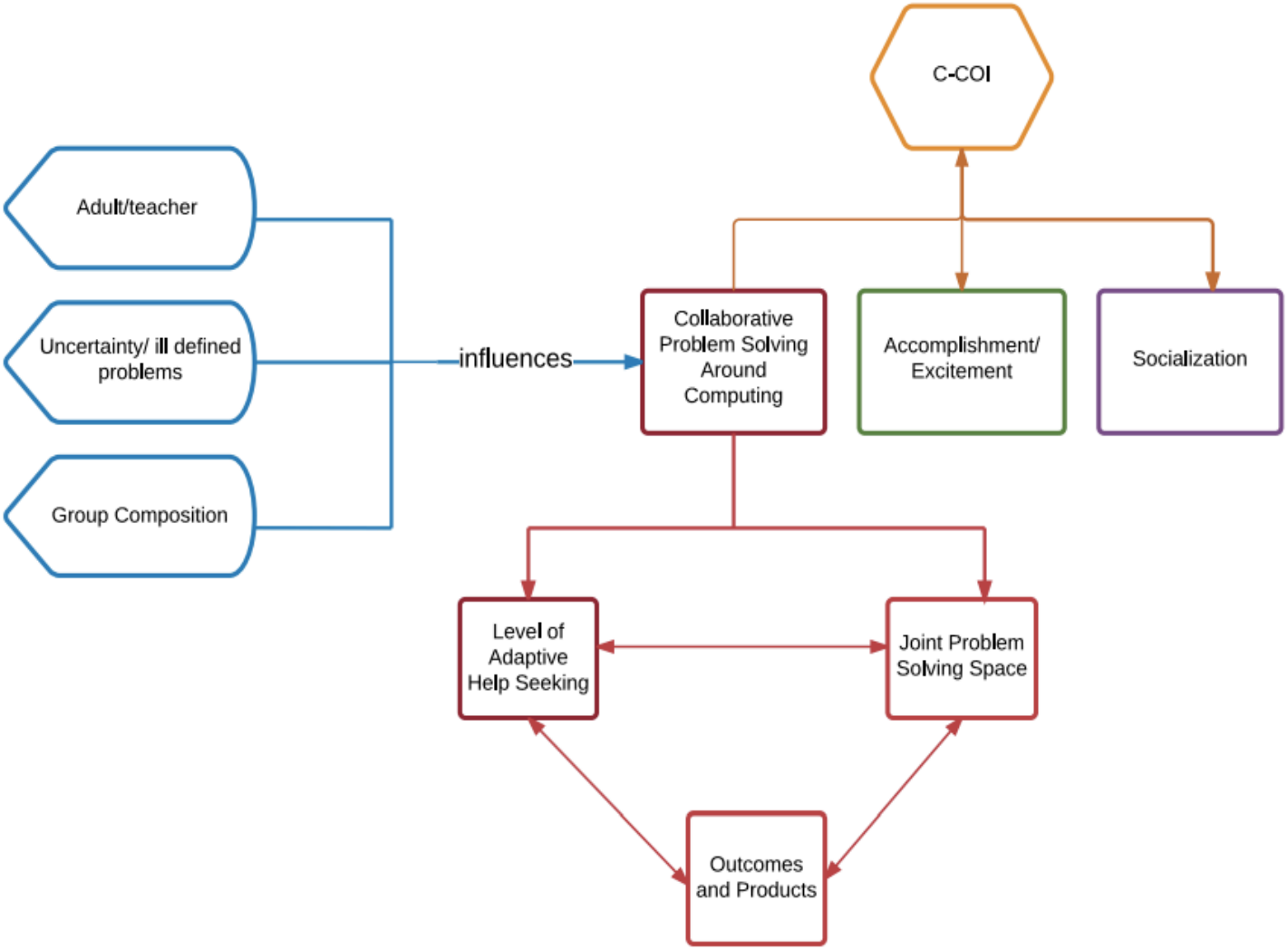
Collaborative & Individual Problem-Solving

Persistence

What can be documented from the C-COI?

Questions we wanted to ask:	Constructs:
How does the student request help? Who helped the student?	Adaptive vs. Negative Help Seeking
How does the student individually problem solve?	Persistence
What kind support(s) did the student receive?	Collaborative Problem-Solving
Did the computing experience result in skill/ concept acquisition?	Understanding CS concepts/ vocab.

Collaborative Computing Conceptual Framework



Israel, Wherfel, Shehab, Ramos, & Reese (under review)

Computing Flow Chart (Partial Screenshot)

C-COI Paper Version

NODE #1 BEGIN ALL NEW EVENTS

Time stamp of the event:			
EVENT #			
1A Student verbally addresses a peer or adult—**Go to #2**			
1B Student is initiated by the peer—**Go to #7**			
1C Student is initiated by the adult—**Go to #11**			
1D Student works independently and with or without self-talk (e.g. you see cursor moving) —**END**			
1E Student's cursor does not move—**END**			

NODE #2

EVENT #			
2A Student expresses problem—**Go to #3**			
2B Student expresses curiosity, excitement, or accomplishment—**Go to #5**			
2C Student socializes—**Go to #6**			
2D Student offers support to peer in response to peer's self-talk while independently working (will hear from peer video)—**END**			
2E Student offers support to peer without being asked while the peer is working independently (will hear from peer video)——**END**			

NODE #3

EVENT #			
3A Problem is related to general computer technology —**Go to #4**			
3B Problem is related to computing/programming—**Go to #4**			
3C Problem is related to academic content—**Go to #4**			
4D Problem is related to navigating software (e.g. logging in)—**Go to #4**			

Instrument citation: Israel, Ramos, Wherfel, & Shehab (2015). Collaborative Computing Observation Instrument (C-COI). Board of Trustees of the University of Illinois at Urbana-Champaign. Available at http://mste.illinois.edu/c-coi

C-COI Online Version

Student-Peer Interaction

Timestamp: (mm:ss) 3 : 0 Proceed

- Peer does not know how to help
- Peer elicits another person
- Another peer joins the discussion about student problem
- Peer physically shows by taking over the students computer
- Peer verbally tells the steps explicitly
- Peer physically shows and explains at the same time
- Peer and student discuss problem
- Peer explains the problem
- Peer shares curiosity with student
- Student shares curiosity with peer
- Another peer joins the discussion about student's excitement
- Another peer joins the discussion about peer's excitement
- Other (use notes)

Notes:

Node 1: Capturing student's action	Node 2: Capturing student's expression	Node 3: Problem content
Student seeks attention Student is initiated by a peer Student is initiated by an adult Student offers elicited support to peer Student offers unelicited support to peer Student works independently without self-talk	Student expresses a problem Student expresses curiosity, excitement, or accomplishment Student socializes Other (use notes)	Problem is related to general technology Problem is related to computing/programming Problem is related to academic content Problem is related to navigating software Other (use notes)
Node 4: Help Seeking	**Node 5: Describing curiosity or excitement**	**Node 6: Describing socialization**
Student clearly states how they need help Student expresses need for help but is not explicit to the problem Peer offers help in response to the student's frustration Peer offers unelicited help Adult offers help in response to student's frustration Adult offers unelicited help Other (use notes)	Student is curious about something associated with their own work Student is curious about something associated with peer's work Student is excited about something associated with their own work Student is excited about something associated with peer's work Student wants to show or express accomplishment on their own work	Student socializes with peer, not related to computing Student socializes with adult, not related to computing Other (use notes)
Node 7: Peer or student's response to help seeking	**Node 8: Who is initiated?**	**Node 9: Response to initiation**
Peer helps student with a problem on student's computer Peer seeks student's curiosity/excitement/accomplishment on student's computer Peer starts socializing, heard on student's computer	Student initiates peer Student initiates adult Student dismisses their attempt to interact Other (use notes)	Peer verbally responds to the problem Peer verbally responds to student's curiosity/excitement/accomplishment Student verbally responds to peer curiosity/excitement/accomplishment Another person joins the student-peer interaction around
Node 10: Reporting Interaction	**Node 11: Adult's response**	**Node 12: Describing Interaction**
Peer does not know how to help Student and peer are interacting together on the student's problem Student terminates the interaction	Peer helps student with a problem on student's computer Peer seeks student's curiosity/excitement/accomplishment on student's computer Peer starts socializing, heard on student's computer Student helps peer with a problem on student's computer Student ignores the peer	Peer and student collaboratively discuss the problem, problem was solved Peer and student collaboratively discuss the problem, problem was not solved Peer explains the problem, problem was solved Peer explains the problem, problem was not solved
Node 13: Problem solved	**Node 14:Problem not solved**	
Problem was solved, student works independently Problem was solved, the student seeks attention from the same peer Problem was solved, the student seeks attention from a different peer Problem was solved, the student seeks attention from an adult	Problem was not solved, student works independently Problem was not solved, student seeks attention from the same peer Problem was not solved, student seeks attention from a different peer Problem was not solved, student seeks attention from an adult	

Measuring Collaborative Computing

- Collaborative Computing Observation Instrument (C-COI)
  - Use Screencastify software to capture all computing activities and audio of student collaborations
  - Dependent variables include amount of time persisting on tasks, methods of help seeking, collaborative problem-solving, and computing challenges.


EXAMPLE

Validity and Reliability

Phase 1: Recognizing the occurrence of an event

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Phase 2: Identified critical paths within each node and sub-nodes

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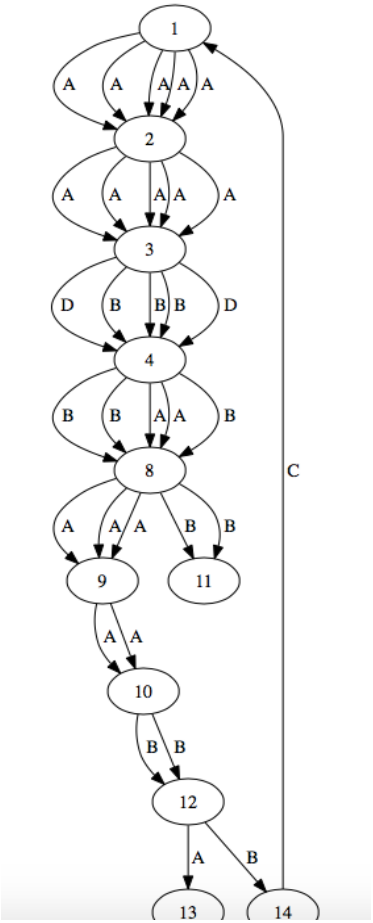
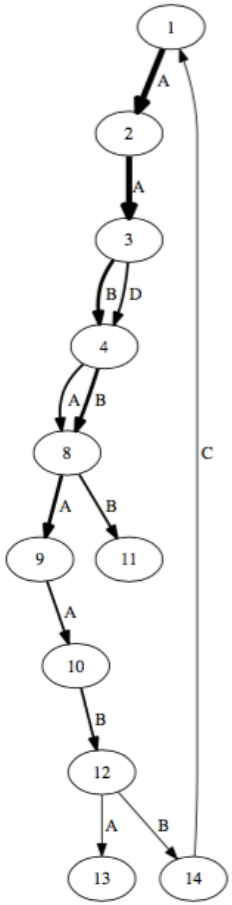
C-COI Instrument Directed Graph: One Student's Paths

Detailed Directed graph

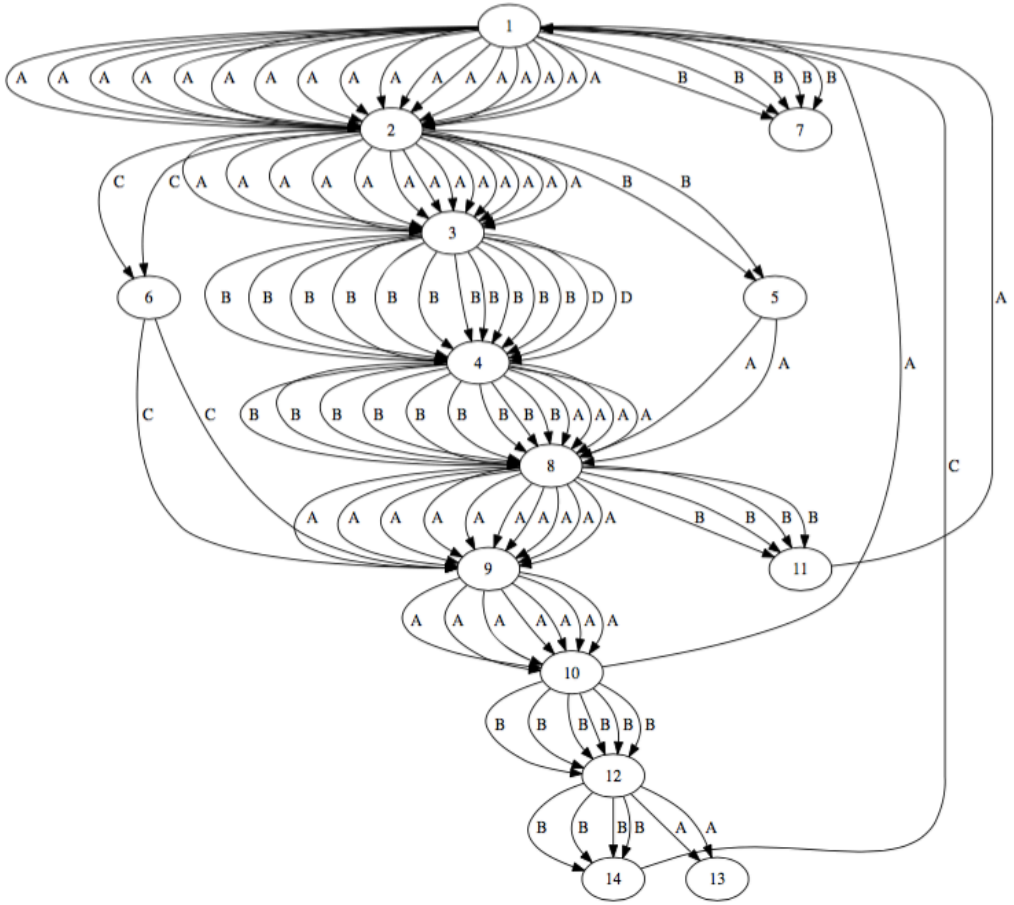


Weighted Directed graph



C-COI Instrument Directed Graph: Multiple Students' Paths

Detailed Directed graph



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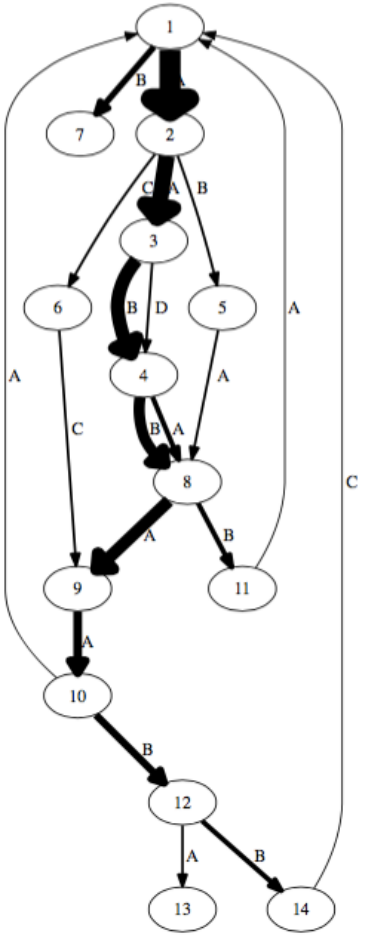


Findings and Tips

1. When working independently, some students spend a LOT of time on a single level, show persistence, but do not collaborate and do not successfully complete the level.
2. Most common collaborative events ended with problems not solved
    a. Students are not effectively using the collaborative script to solve the problem
    b. Students are not watching the video hints
    c. Students lack understanding of the computer science concepts that are associated with the problem
3. Lots of competition, especially in Code.org as compared to Scratch.

Case Studies of Students with Disabilities during CS/CT

- Part of ongoing research examining equitable and accessible CS/CT instruction
- Purposeful selection of students disengaged in CS/CT
- Classroom observations & interviews with general and special ed teachers, and support staff

Case Studies of Students with Disabilities during CS/CT

- RQ: To what extent are CT-specific supports needed for SWD to engage in CT instruction & activities?

- Yin (2009) four-step process for explanation building within a single case:
  1) Make a theoretical explanatory statement about the phenomenon (the student's experience during computing)
  2) Compare this statement to the data from a single case
  3) Revise the theoretical statement to better reflect the case
  4) Review the revised statement against the data from the case.

Cross Case Analysis

Horatio

- 4th grade student
- Has autism, intellectual disability, limited social communication
- Spends the majority of the day in the general ed classroom with 1-on-1 adult support
- Loves playing repetitive games on the computer
- Enjoys having his peers chase him, but does not initiate social interactions

Deacon

- 5th grade student
- Has fetal alcohol syndrome and LD with associated impulsivity, behavioral and attention challenges
- Spends the majority of the day in the general ed classroom
- Loves Minecraft!
- Enjoys hanging out with 2 peers in class

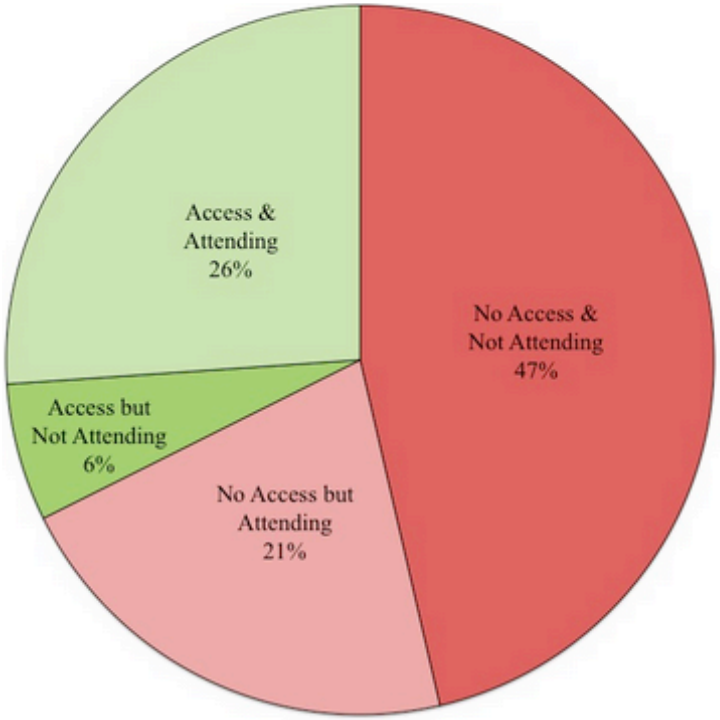
Initial Explanatory Statement

- Students with disabilities who are disengaged during CS/CT require CT-specific supports to successfully engage in CT activities, and when these supports are not available, they cannot meaningfully engage in those activities.

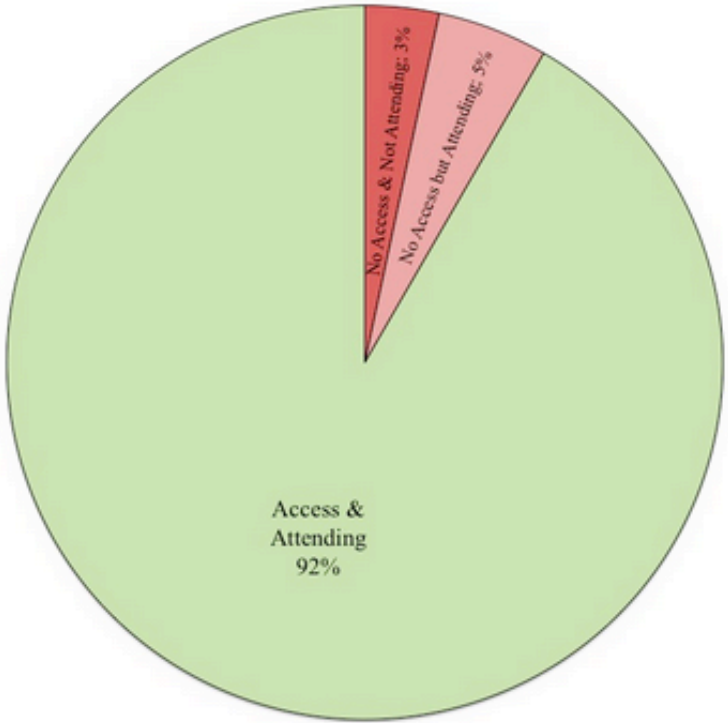
- Teachers & researchers all had this hypothesis initially.

Horatio (4th grade)

Initial Engagement



Final Engagement



After consistent days of limited access and engagement, we tried:
(a) access to materials, (b) verbal directions about what to do and how to do it, (c) models of problem-solving techniques, and (d) models of how to complete the assigned while the computer remained in front of him.

Snodgrass, Israel, & Reese (under review)

Teacher Interviews

Before Supports Quotes

- I felt last week like he had actually accomplished something on *Code.org*, but... when I see those little victories and accomplishments, I'm wondering, how much was it him working independently? How much does [the paraeducator] come into play? … I'm afraid it's more the latter.

  General Ed Teacher Transcript, p. 5

- I have tried to use hand-over-hand strategies for the computer and peer mentoring to keep him on task. These have not been too successful… … I think it might be helpful to have someone come in and show his teaching assistant and myself what we can do to make him more independent with coding.

  Special Ed Teacher Response, p. 1

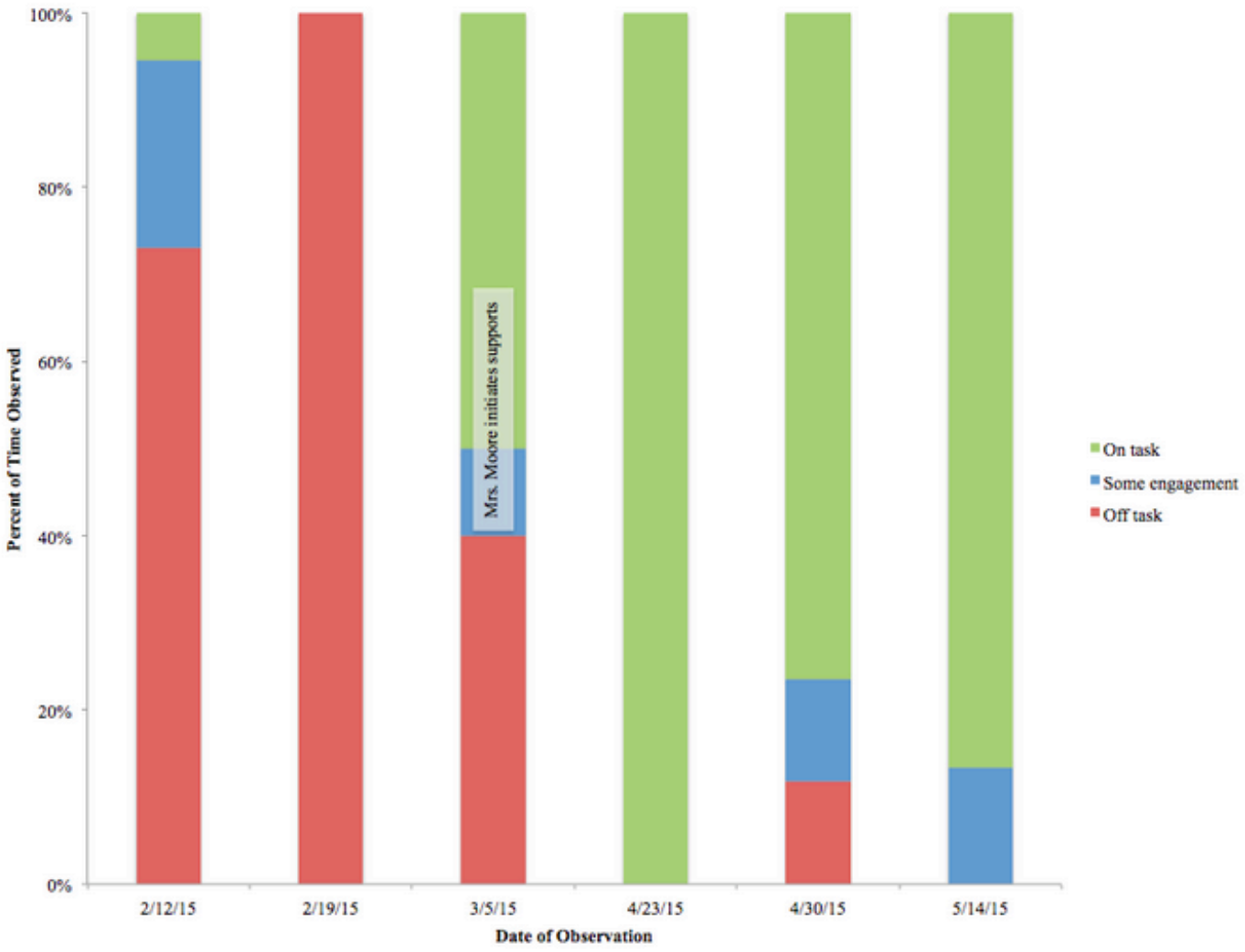
After Supports Quote

- I was just flabbergasted, because he's never done that! … He never tried and it's like [he said], 'Give it to me. I'm doing it today.' … That was fun!"

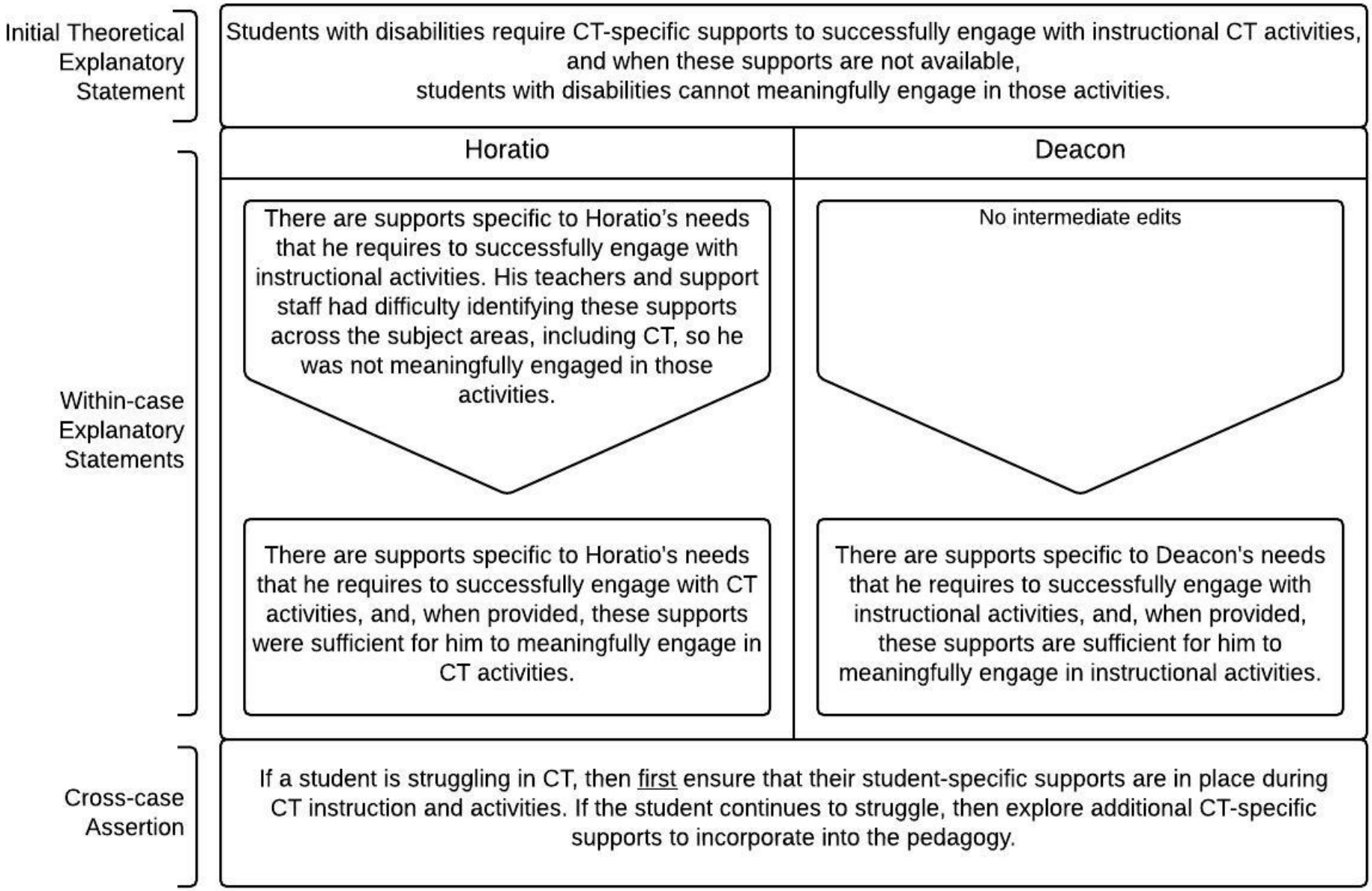
  Paraeducator Interview Transcript, p. 9

Snodgrass, Israel, & Reese (under review)

Deacon (5th grade)

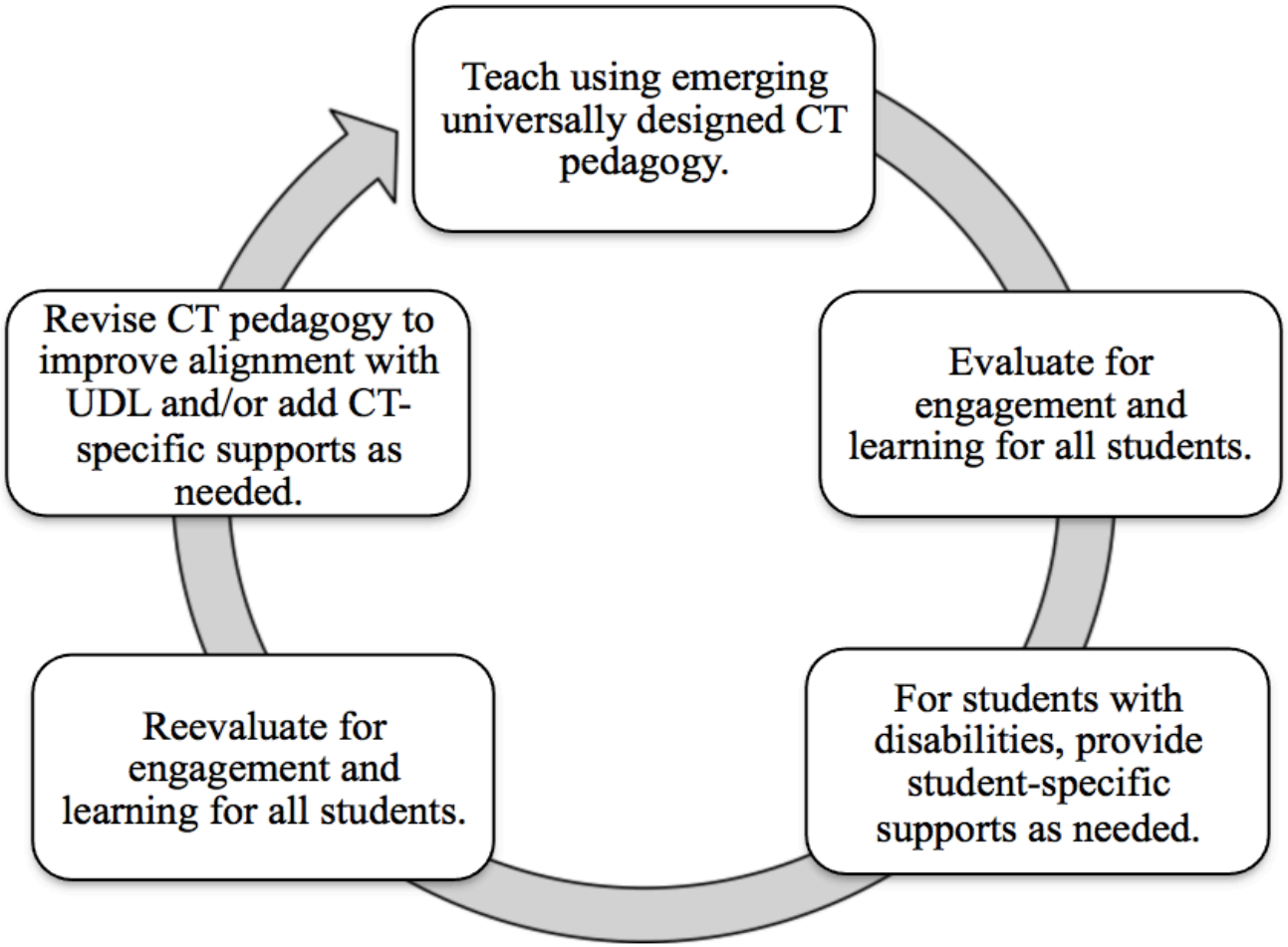


Snodgrass, Israel, & Reese (under review)



Snodgrass, Israel, & Reese (under review)

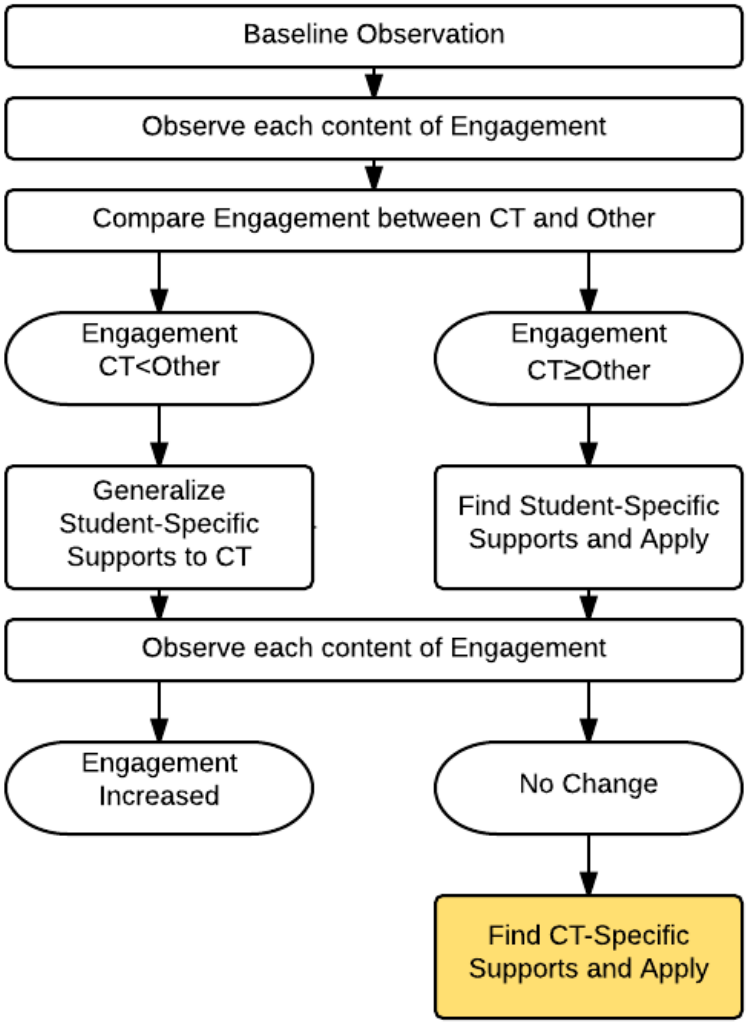
CT Instruction Evaluation and Refinement Framework



Snodgrass, Israel, & Reese (under review)

Plan for next case study

*"If a student is struggling in CT then **First** ensure that their student-specific supports are in place during CT instruction and activities. If a student continues to struggle, then explore additional CT-specific supports to incorporate into the pedagogy."*



Next Steps

- NSF STEM+C project is starting in January of 2016 to look at integrated computing and math instruction
- Look at individual and content-specific supports students with disabilities across content areas (including CS/CT)
- Continued exploration of collaborative computing
- Integrated computing and scientific argumentation

Shifting education

CTRL+shift

Creative Technology Research Lab

For More Information:

http://ctrlshift.mste.illinois.edu/