TRACING ELEMENTARY TEACHERS' LEARNING TRAJECTORIES FOR COMPUTATIONAL THINKING INTEGRATION

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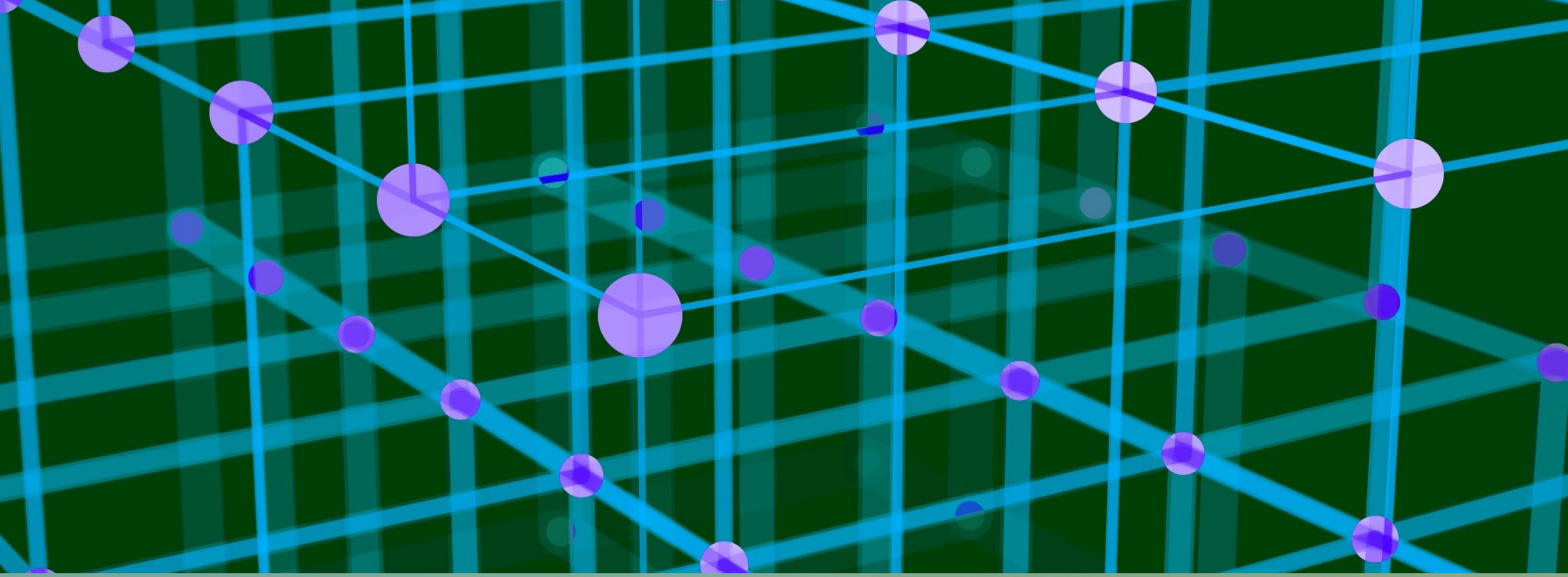
RATIONALE

- Computational thinking (CT) is a problem-solving process that mirrors the work of computer scientists and can be taught using unplugged and plugged-in activities (Wing, 2006)
- While typically taught in computer science courses, emerging research suggests that CT can be accessible to young children (Dwyer et al., 2013; Bers et al., 2014)
- Infusing CT into content area curricula supports students in solving authentic problems, and deepen disciplinary learning (Grover, 2017)



THEORETICAL FRAMEWORK

DEVELOPING COMMUNITIES OF PRACTICE FOR CT INFUSION

- Teachers need explicit support in order to understand the goals of CT infusion, connections to content learning, and how to enact these pedagogies using virtual and hybrid tools (Rich et al., 2017, Yadav et al., 2018)
- In a community of practice (CoP), long-standing members of the community share knowledge, practices, ideas, and identities and newcomers become embedded within the social world of the community through the process of legitimate peripheral participation (Lave & Wenger, 2011)
- To infuse CT, content area teachers need carefully scaffolded learning experiences in which they have opportunities to engage in pedagogies of investigation and enactment (Grossman, 2009)

- Describe the proposed processes through which learning proceeds and offer a "specific set of expectations about children's ways of learning and a likely pace along a path that includes central, worthwhile ideas" (Clements et al., 2011, p. 139)
- Most extensively studied in the context of mathematics education, particularly in relation to student learning (Clements & Sarama, 2004; Confrey et al., 2014)
- Emergent research (Wittek et al., 2015) suggests that tracing teachers' LTs can explicate the learning and thinking processes that teachers go through as they adapt new pedagogical practices

LEARNING TRAJECTORIES

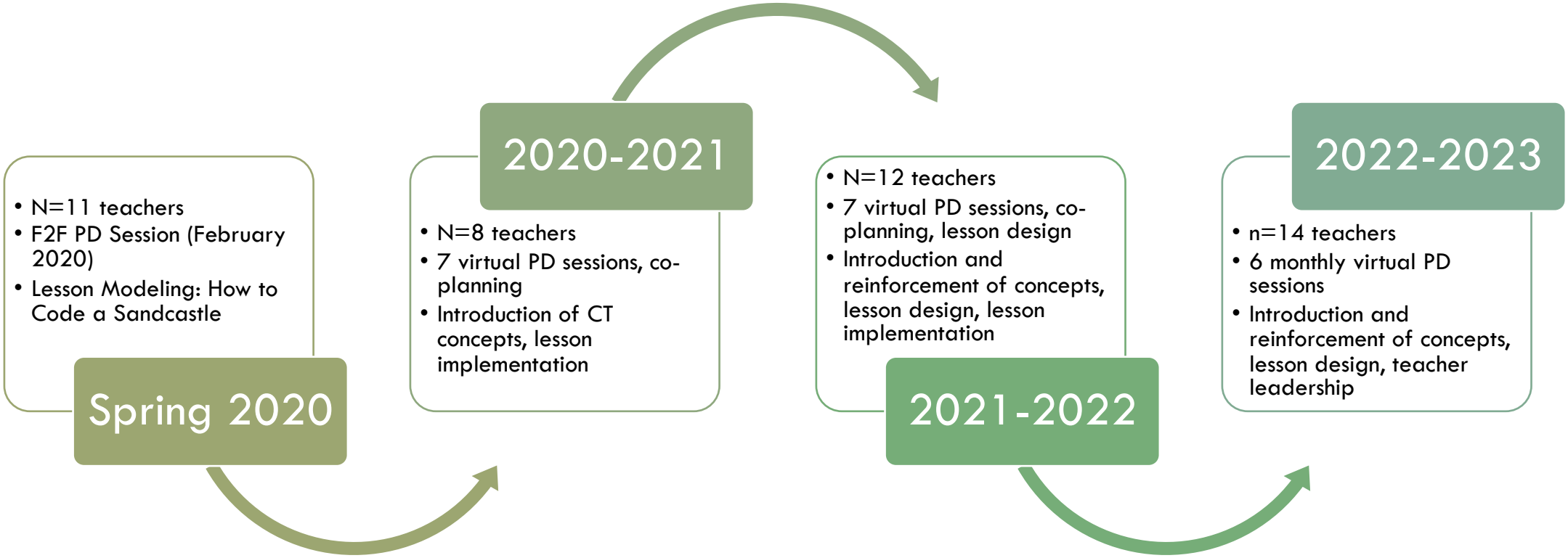
PEDAGOGICAL CONTENT KNOWLEDGE LEARNING TRAJECTORIES

- New construct: Pedagogical Content Knowledge Learning Trajectories (Jocius et al., under review)
  - Observable shifts in teachers' conceptualizations and implementation of a new practice (in this case, computational thinking)
- Draws upon theories and research of pedagogical content knowledge (PCK) to describe how teachers subject-matter knowledge for students (Shulman, 1986)
- Assumes that learning is a dynamic, iterative, and nonlinear processes (Pirie & Kieran, 1994), wherein teachers may operate at a particular level on a learning trajectory at one point in time, remain at that level while trying new pedagogical practices, or "fold back" to a "previous" level after encountering difficulty (Wilson & Stein, 2007)

METHOD

{ Making CT }

THE MAKING CT PROJECT



HYPOTHESIZED TEACHER LEARNING TRAJECTORIES

Session and Date	Topic: CT Concept, Skills, Disposition	Hypothesized Teacher LT	PD Activities
Kick-Off: September 2020	Intro to Computational Thinking	-Define CT as set of particular concepts and practices -Develops familiarity for CT-integrated teaching by participating in lesson as learner	Developing Conceptions of CT Lesson - How to Code a Sandcastle
October 2020	Pattern Recognition Data Collection Collaboration	-Define CT as integrated problem-solving process -Describes and plans opportunities for teaching CT-infused lesson	Lesson - Being Squishy to Stand Out
November 2020	Decomposition and Algorithms Debugging Perseverance	-Identifies modifications for teaching CT-infused lesson based on teaching experiences	Lesson - Dragons, Decisions, and Decomposition
December 2020	Abstraction Paired Programming Perseverance and Collaboration	-Defines CT as problem-solving practices that connect to multiple disciplines and everyday life -Identifies opportunities for integrating CT into multiple instructional areas	Hour of Code Warm-Up Activities
January 2021	Algorithms - Conditionals Debugging Creativity	-Identifies opportunities for integrating CT into multiple instructional areas, including read-alouds	Lesson - How Does Earth's Garden Grow?
March 2021	Abstraction - Using Variables	-Details adaptations to lessons based on student learning -Describes adjustments in strategies to attend to students' CT and content learning goals	Lesson - How to Code a Rollercoaster
April 2021	Algorithms Using Functions for Automaticity	-Uses differentiated teaching techniques to attend to the needs of a variety of learners -Engages in long-range planning for CT infusion	Lesson - If I Built a House

DATA COLLECTION AND ANALYSIS

Initial Coding Cycle (Saldana, 2013)

- Reviewed initial hypotheses for the hypothesized LT of teacher learning
- Data sources: mid-year and end-of-year interviews
- Chunked interviews into idea units (Gee, 2011)
- Identification of emergent themes

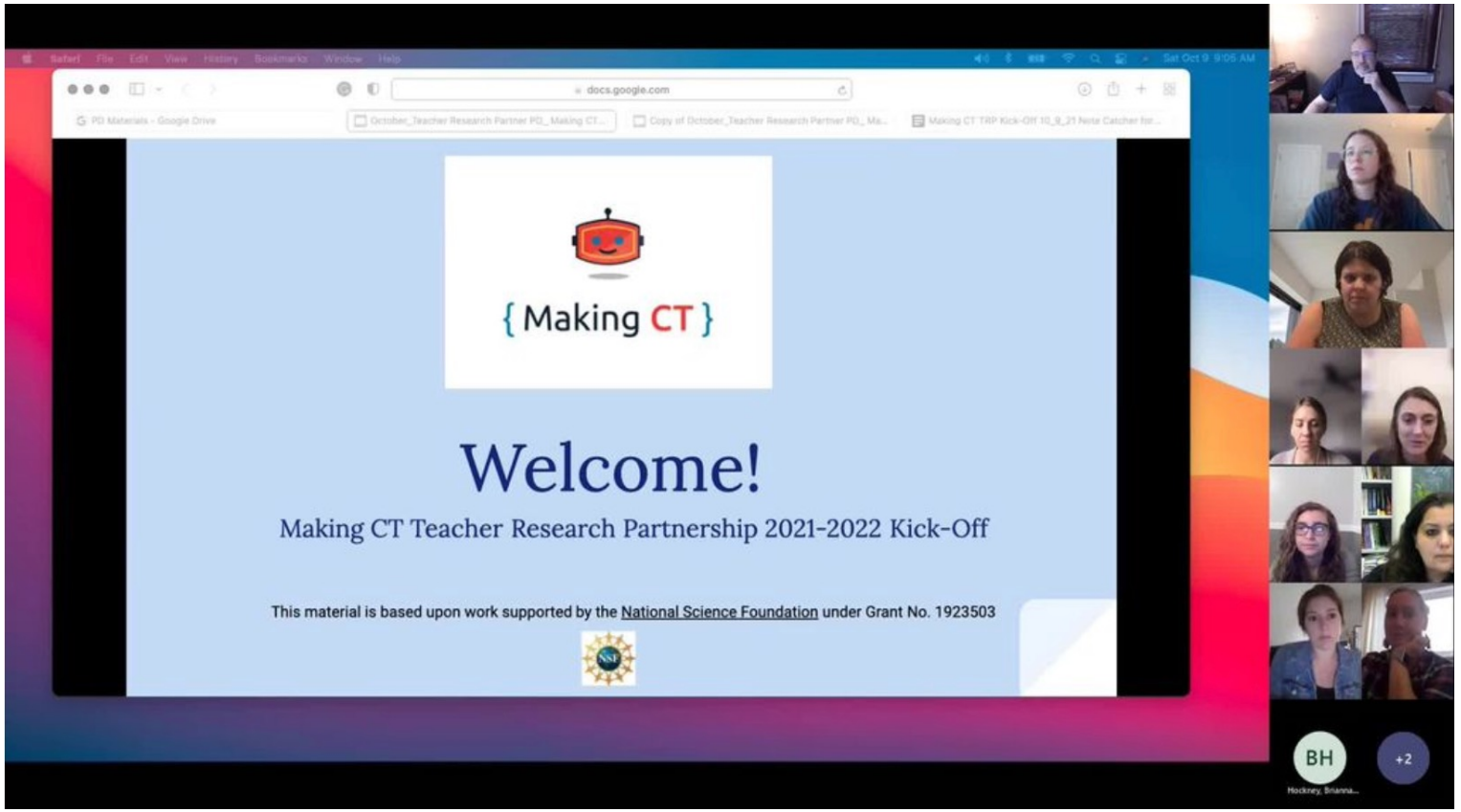
Axial Coding Cycle

- Organization into themes
- Teacher: definitions of CT, self-efficacy in implementing CT-infused lessons, and missed opportunities
- Student learning: instructional scaffolding, missed opportunities, cumulative CT learning, interdisciplinary integration, and productive failure

Refinement of LTs and Analysis of Teacher Progressions

- Research team met to refine codes, themes, and to consider initial hypothesized LT
- Led to development of two inter-related LTs
- Located teachers on both LTs at three points using pre-PD teacher surveys ($n = 8$), mid-year interviews ($n = 8$), and end-of-year interviews ($n = 8$).
- Trustworthiness (Strauss & Corbin, 1998): Triangulation with PD recordings, member checks, audit trail

FINDINGS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Welcome!
Making CT Teacher Research Partnership 2021-2022 Kick-Off
This material is based upon work supported by the National Science Foundation under Grant No. 1923503
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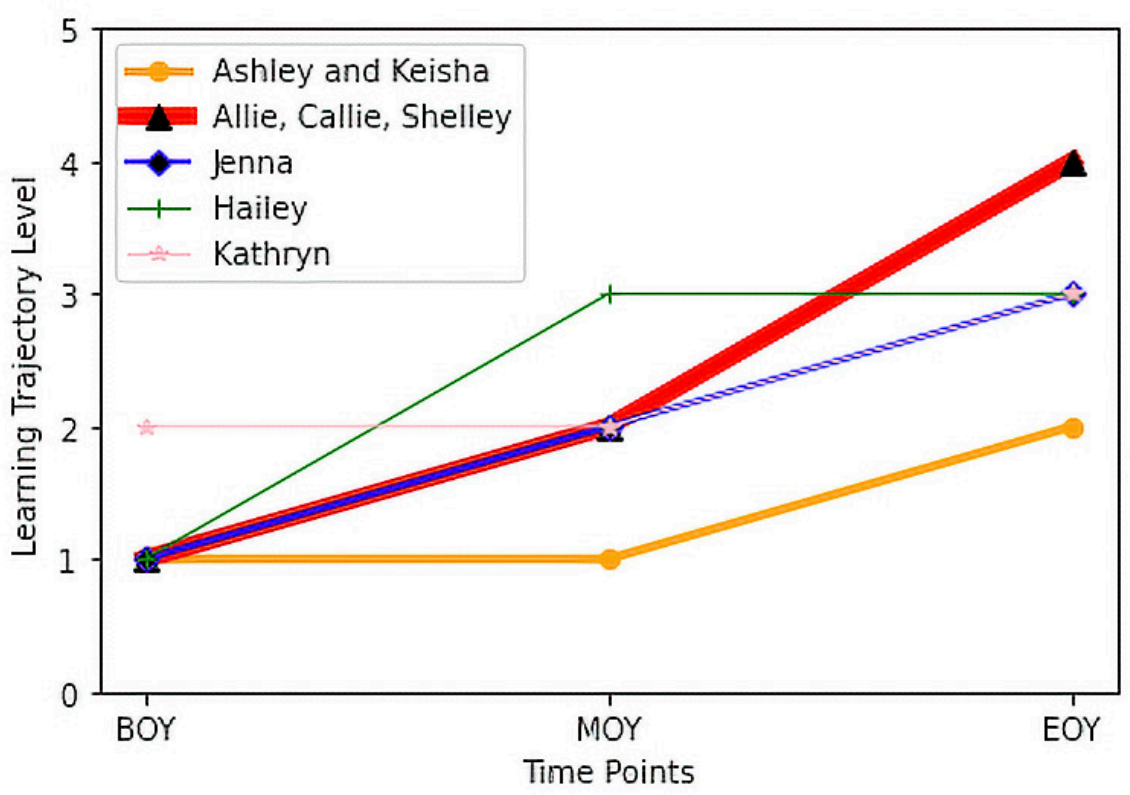
LT #1: INTEGRATING CT INTO DISCIPLINARY TEACHING

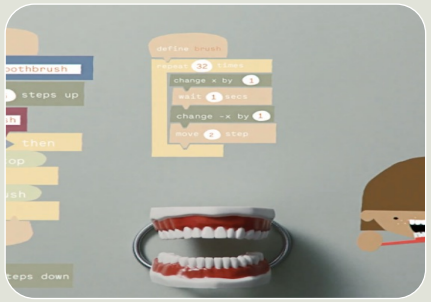
Level 1	Level 2	Level 3	Level 4	Level 5
• Defines CT as use of digital tools without reference to problem-solving • Lacks pedagogical knowledge of CT or self-efficacy to implement CT-infused lessons	• Defines CT as specific concepts and/or practices • Teaches existing lesson with no or limited modifications (e.g., chunking lesson for time, classroom management)	• Defines CT as problem-solving practices • Modification of existing lessons based on student CT learning needs	• Defines CT as problem-solving practices that connect to multiple disciplines and everyday life • Infusion of CT into multiple areas of teaching, such as read-alouds and warm-ups	• Consideration of shifts in student thinking about CT over time

LT #1: TEACHER PROGRESSIONS

- Level 1: “For me, coding is scary. It is. It's scary for me. I don't consider myself a super tech savvy person, having taught with a mimeograph machine and a chalkboard. Technology has advanced so much.” (Allie, 4th grade teacher)
- Level 4: “But the second time I focused more on the pattern making and they actually made the pattern with me. The drawn patterns, we all started with a circle and then it would be like then you add a little squiggle and then you add a triangle. And we talked about how when you first looked at it was a very complicated, complex pattern. But by breaking it down into those manageable parts, sure, we were able to recreate it using that algorithm to do this and then do that and then do the next.” (Callie, 3rd grade teacher)



PROFESSIONAL LEARNING ACTIVITIES FOR EACH LT#1 LEVEL



Definitions and discussion about CT; identifying examples of CT in practice and everyday and disciplinary life (e.g., brushing teeth, baking)

Participation in CT-infused lessons as learners; content analysis of children's literature; co-planning

Reflection on initial CT-infused teaching experiences; collaborative analysis of student work; co-design and co-teaching of lessons

Modeling of CT warm-up activities; collaborative long-range planning within and across grade levels

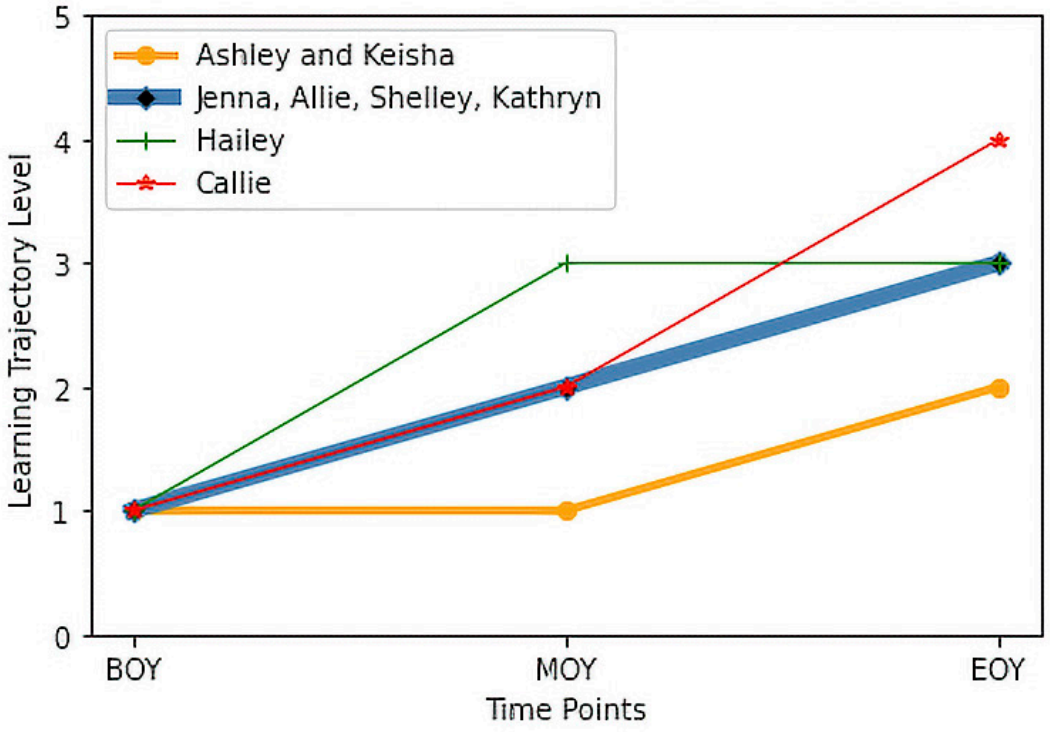
Discussion of cumulative student learning; horizontal and vertical planning

LT #2: ATTENDING TO STUDENTS' CT

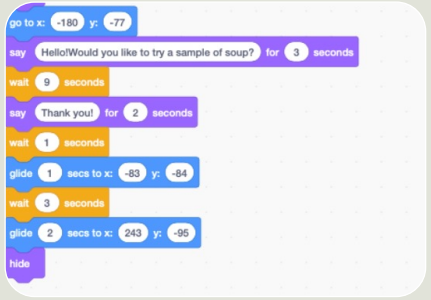
Level 1	Level 2	Level 3	Level 4	Level 5
• Sees CT as mostly or only supporting student engagement • Describes students' excitement about CT as divorced from standards and content learning goals	• Implements CT activities for particular groups of learners (e.g., gifted students, early finishers) • Implements CT as add-on activity (e.g., during half-days, not integrated with content)	• Describes patterns in student learning about CT • Asks questions or facilitates discussions to help students make connections between CT and everyday activities and disciplinary practice	• Describes adjustments in strategies to attend to students' CT and content learning goals • Details modifications based on student learning needs	• Considers students' own CT learning trajectories in planning learning activities • Monitors students' learning trajectories and charts them over time

LT2: TEACHER PROGRESSIONS

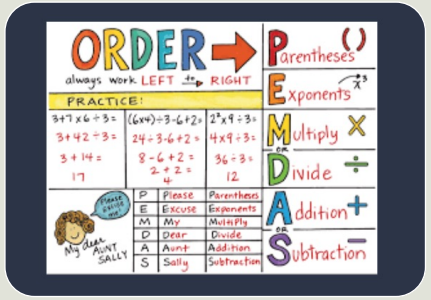
- Level 1: Goals for CT Infusion
  - “keeping students engaged”
  - “making lessons more student-centered”
  - “promoting engagement”
- Level 3:
  - “I said, well, can you draw a circle, like a little tiny circle? And they all did, so I just showed them the different parts of the pattern separately, all of them being very simple…I think that was a really key part for them to see that it's complex, but it's also really simple. A lot of simple things make a complex thing.” (Shelley, 3rd grade teacher_



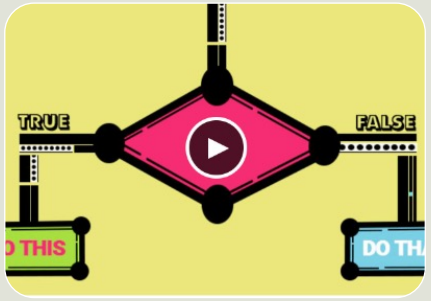
PROFESSIONAL LEARNING ACTIVITIES FOR EACH LT #2 LEVEL



Reflective discussion on CT learning and personal growth; participation in CT-infused lessons as learners



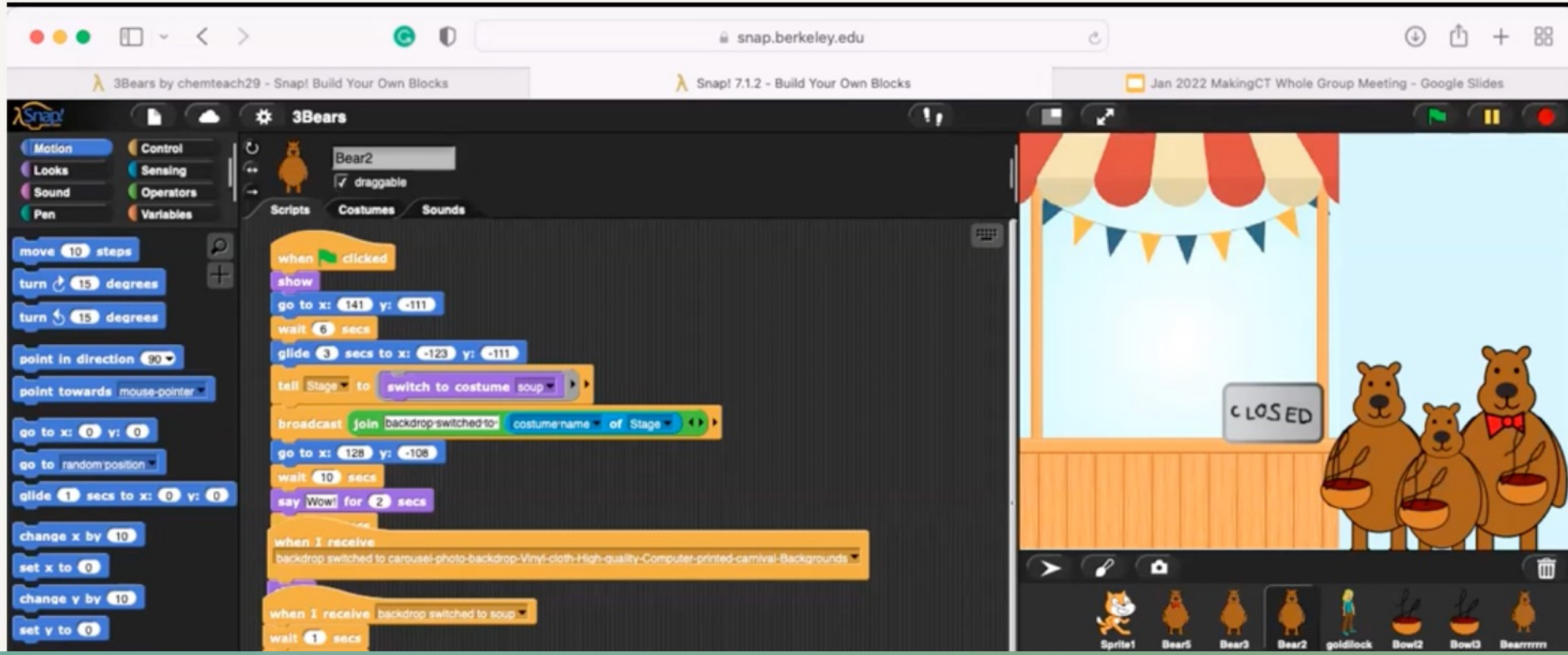
Small-group discussion of content learning goals; computer science and disciplinary standards mapping



Collaborative analysis of student work; co-design and co-teaching of lessons

Co-design of differentiated supports for student learning; collaborative design of CT assessments

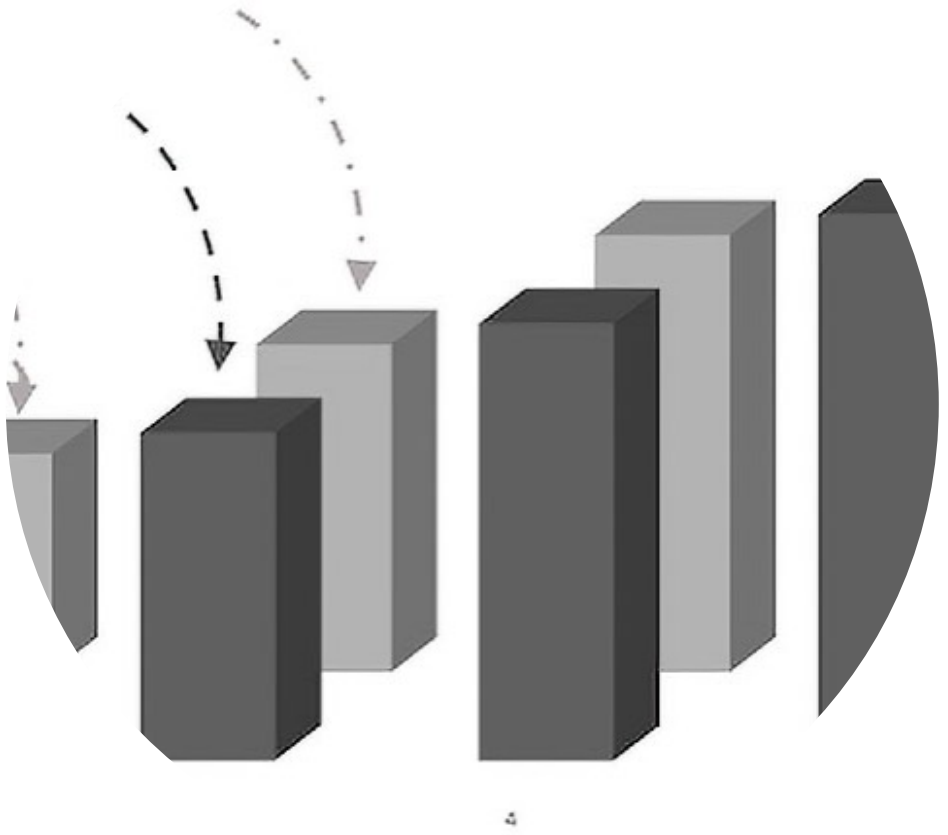
Support for analyzing student data; design of PD for other teachers in grade level team and school



DISCUSSION AND NEXT STEPS

DISCUSSION

- Teachers generally progressed more slowly through the LT for attending to student thinking
    - Teachers' own CT knowledge may limit their progression beyond Level 2 on both trajectories, and that to move to Level 3 on either trajectory, teachers need to be at Level 2 on both LTs
- Teachers' progressions through the LTs were not necessarily linear, with some remaining at one level and even returning to previous levels
- Work with students also enabled an acceleration of their own learning as they considered how to best meet the needs of their students



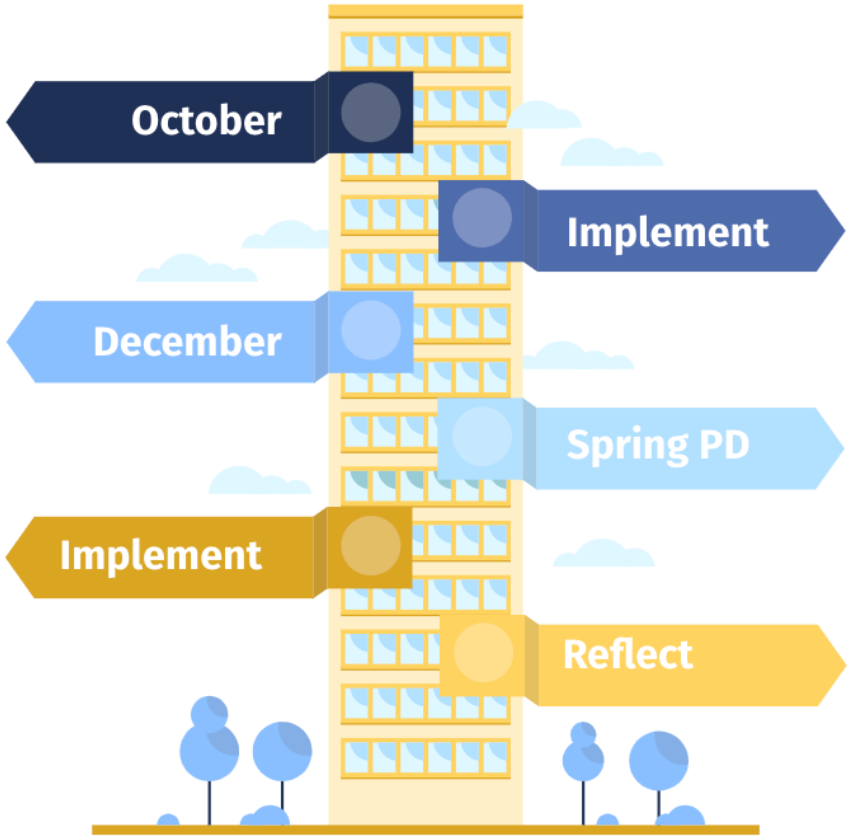
IMPLICATIONS

- Contributes a new construct, pedagogical content knowledge learning trajectories, that can be used to create and evaluate professional learning experiences across multiple contexts
- Support the development of CT-specific teacher PD for elementary teachers
- Need to continue to examine ways to infuse CT for more equitable access to computer science education for all students

NEXT STEPS

- Examine shifts in LTs across multiple timescales
- Utilize LTs to guide 2022-2023 sessions and to introduce others to the Making CT community
- Investigate which CT concepts (e.g., pattern recognition, abstraction, decomposition, and algorithms) are most challenging for teachers to implement
- Explore supports teachers need to introduce and reinforce CT concepts with students

2022- 2023 Project Timeline



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Reach Out!

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This material is based upon work supported by the National Science Foundation under grant #1923503. 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.