Collective Argumentation Learning and Coding (CALC)

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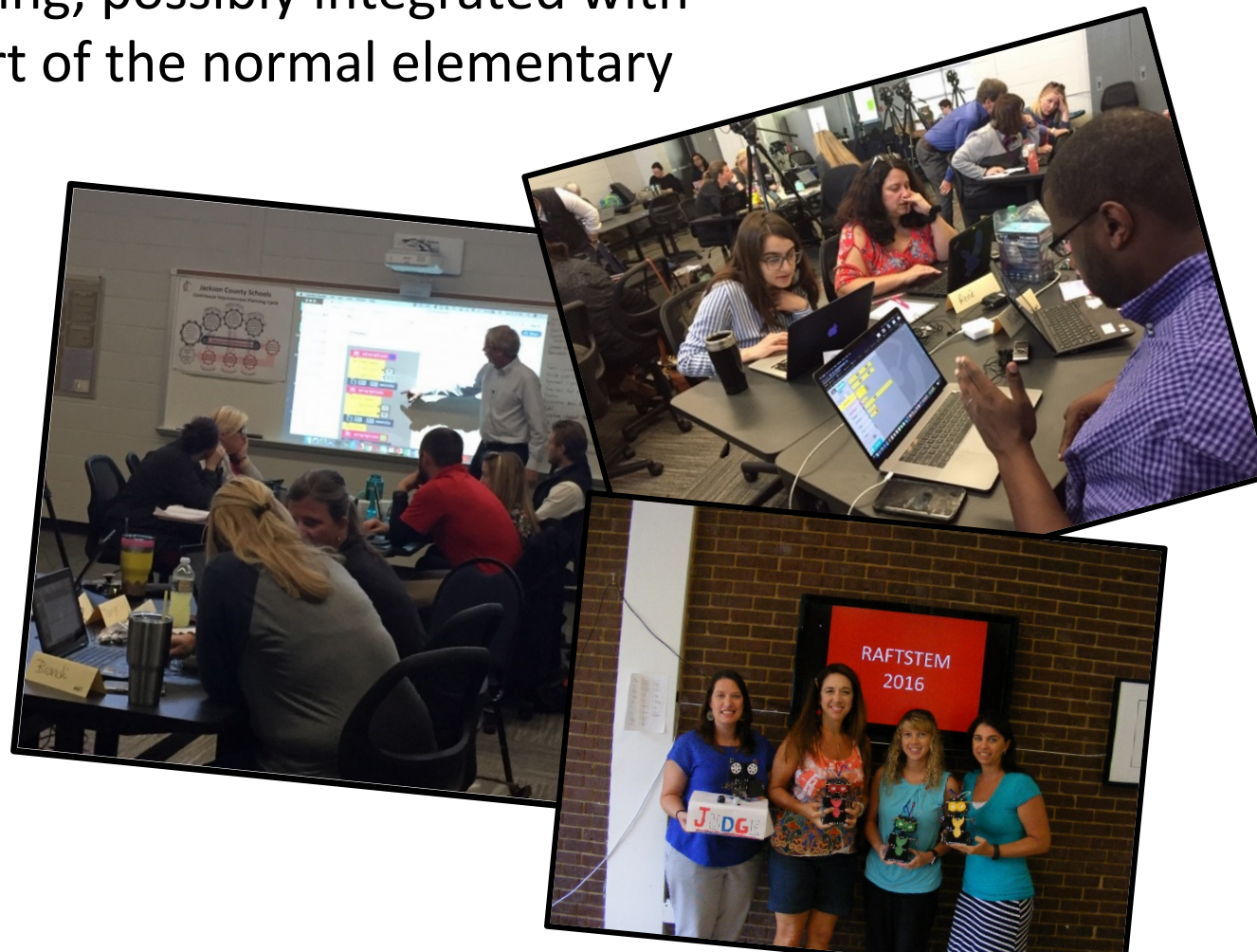
Based on our past work

If teachers can teach students to code using the same methods they use to teach mathematics and science, then coding, possibly integrated with mathematics and science, could become part of the normal elementary school curriculum



Why collective argumentation?

Georgia Standards

Students are expected to

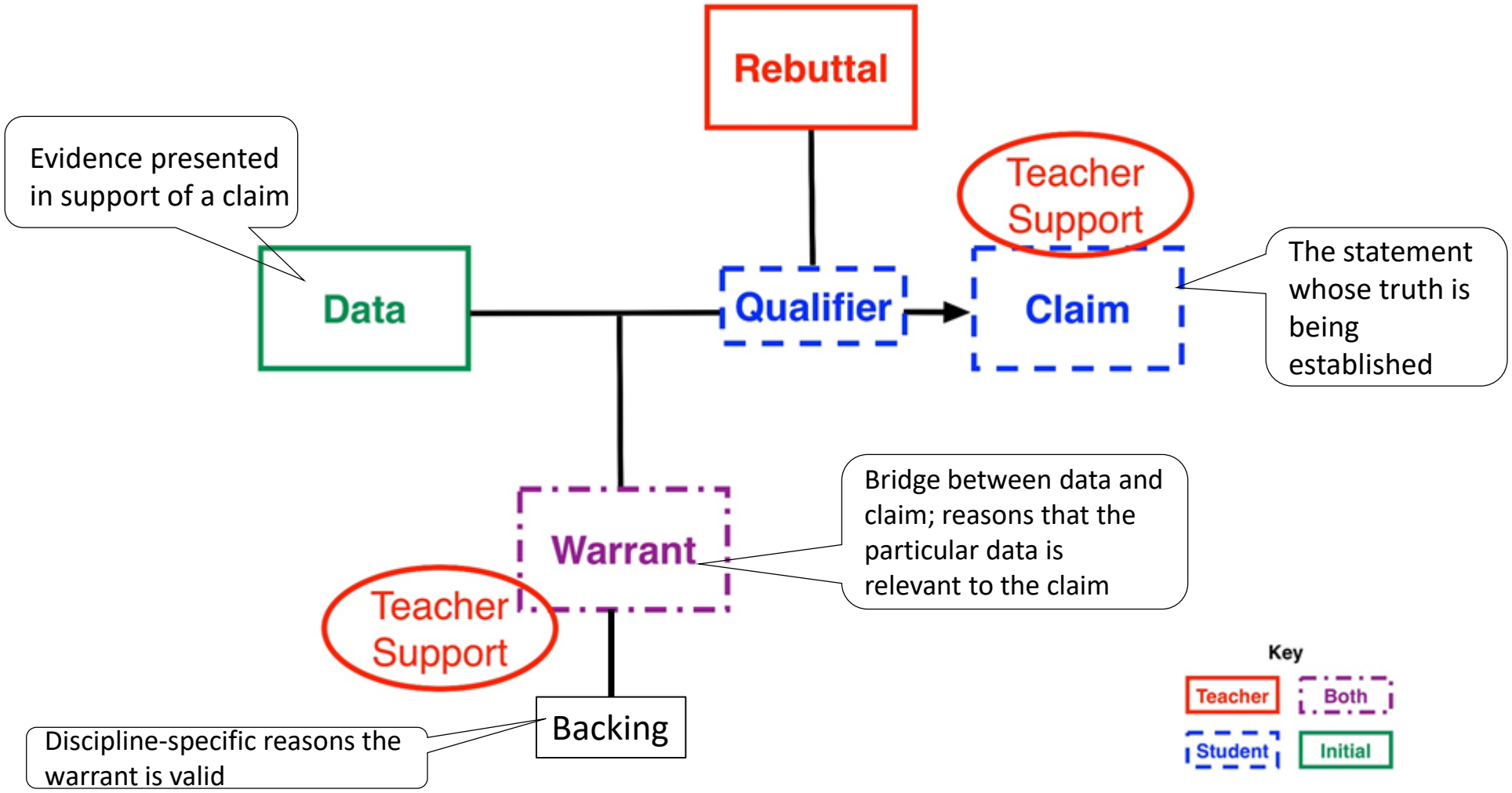
- construct viable arguments and critique the reasoning of others.
- participate in mathematical discussions involving questions like “How did you get that?” and “Why is that true?”
- They explain their thinking to others and respond to others’ thinking.

- Academic skill needed in the real world

- Valued by multiple disciplines (Reznitskaya, Anderson, & Kuo, 2007; Sampson & Clark, 2008)

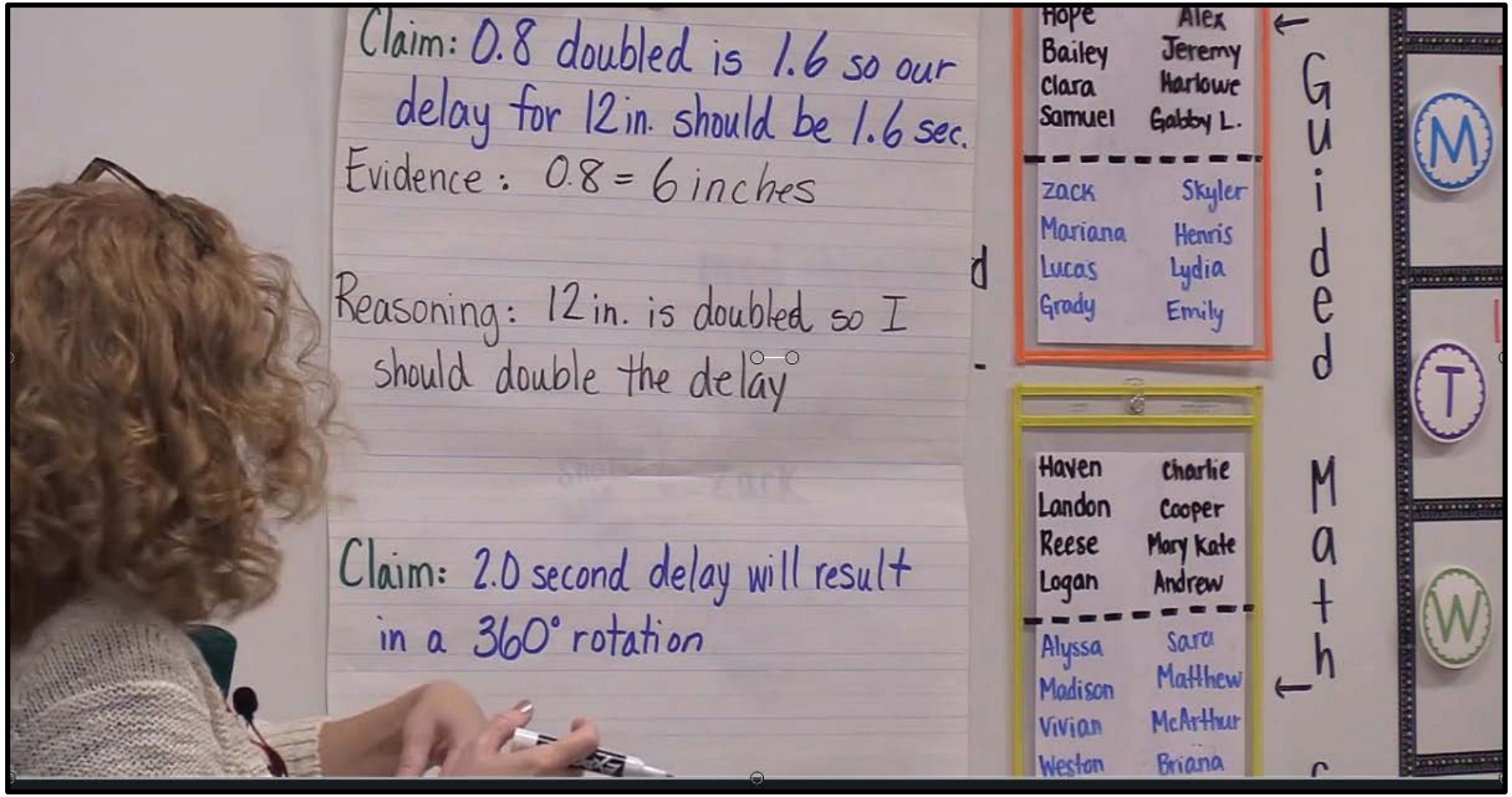
Toulmin's Argument Diagram

Adapted from Toulmin (1958/2003)



From Conner (2008)

Teacher debriefing the class after the second lesson on coding



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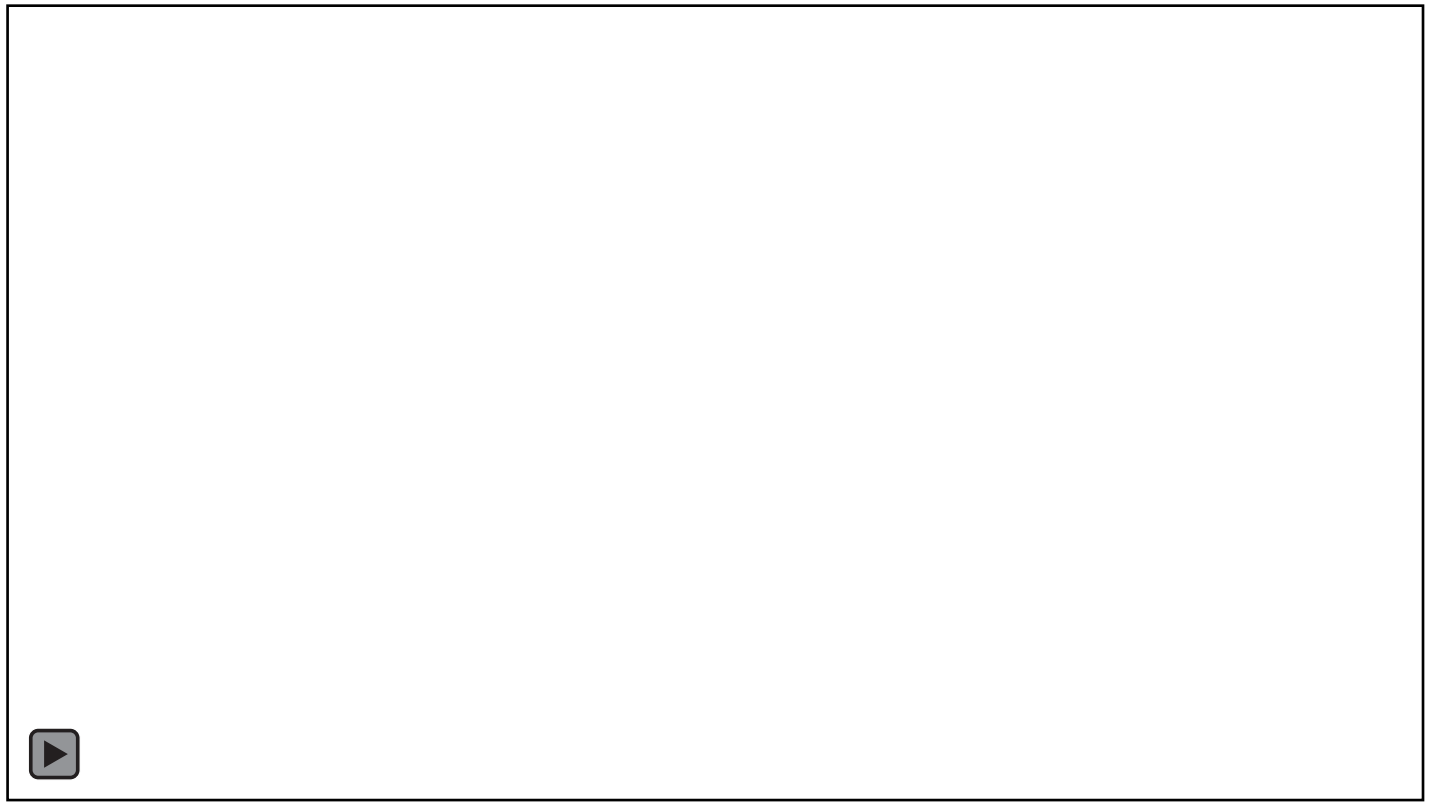
CALC: Collective **A**rgumentation **L**earning and **C**oding

Research Questions

- How does the **CALC** approach build elementary school teachers' content knowledge of coding?
- How do elementary school teachers use the **CALC** approach to support their students' learning of coding, mathematics, and science content and practices?
- What are elementary teachers' beliefs about using collective argumentation in teaching coding, mathematics, and science?
- What approaches to coding (e.g. trial & error, structured) do students use after **CALC** enactment?
- In what ways do students demonstrate an interest in STEM+C learning and careers after experiencing the **CALC** approach?

Georgia 4th grade Math Standard MGSE4.NF4
understand decimal notation for fractions and compare decimal fractions

Lesson: Code the motor so your robot to travels 6 inches;
then what code do you change to make your robot travel 12 and 18 inches



First lesson involving coding

No it wouldn't work, you know how it behaved with 6 and 4, you make one go up a bit *(the motor speed code)* and one go down a bit, you said it would move a bit, let's try 7 and 3.

Task: Have the Roborobo go straight 12 inches

Change motor 1 (left) to 5.5 (20:40)

[Let's try] 6 and 5 [0:22:28]

You can't edit the motor it has to be a flat (whole) number (22:20)

Our last try was 6 and 4 and we over corrected the other way [right].

Students tried setting the speed chip to 5 and 5 (Left and Right) and observed the roborobo curving left.
And then, they set it to 5 and 4 (L/R) and observed the roborobo curving left.
Finally, they set it to 6 and (L/R) 4 and observed the roborobo curving slightly right. (21:37)

We should try 7 and 3 for the speed chip (22:03)

No it wouldn't [make it curve more but less] because you know how you put 6 and 4, you make one [motor speed] go up a bit and one go down a bit, you said that, it curved a bit. (22:07)

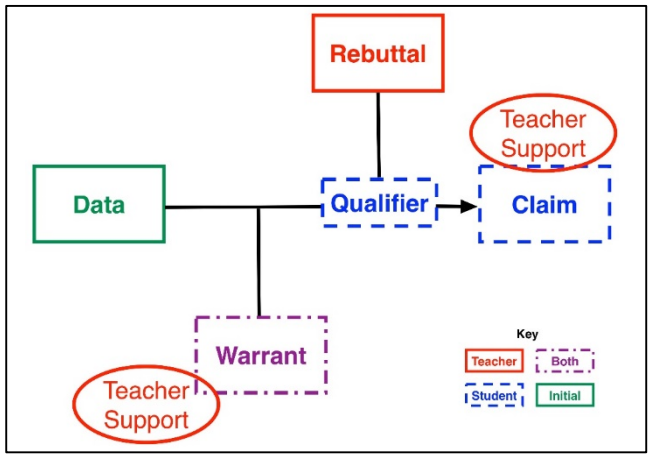
No [let's not make it 7 and 3] What are you doing? (21:58)

[But] It [7 and 3] will make it curve that way (gesturing) a lot more (22:05)

Why are you changing it [motor speed] to 7? (22:03)

Part of the discussion

No it wouldn't work, you know how it behaved with 6 and 4, you make one go up a bit *(the motor speed code)* and one go down a bit, you said it would move a bit, let's try 7 and 3.



Second lesson

After some instruction using CALC concept

Our data says 0.8 [seconds] for 6 inches and we said 3 seconds will get us 18 inches. We want to see if the claim is true or not. It turns out that it is false…the claim wasn't true because it would have, you have to double it. It goes 6, 12, 18 which is multiplying by 2 and 3. So to get to 12 inches we need to code [motor code speed] to 1.6 and for 18 inches we need to use 2.4.

1.05 seconds makes the Roborobo travel 6 inches (07:35)

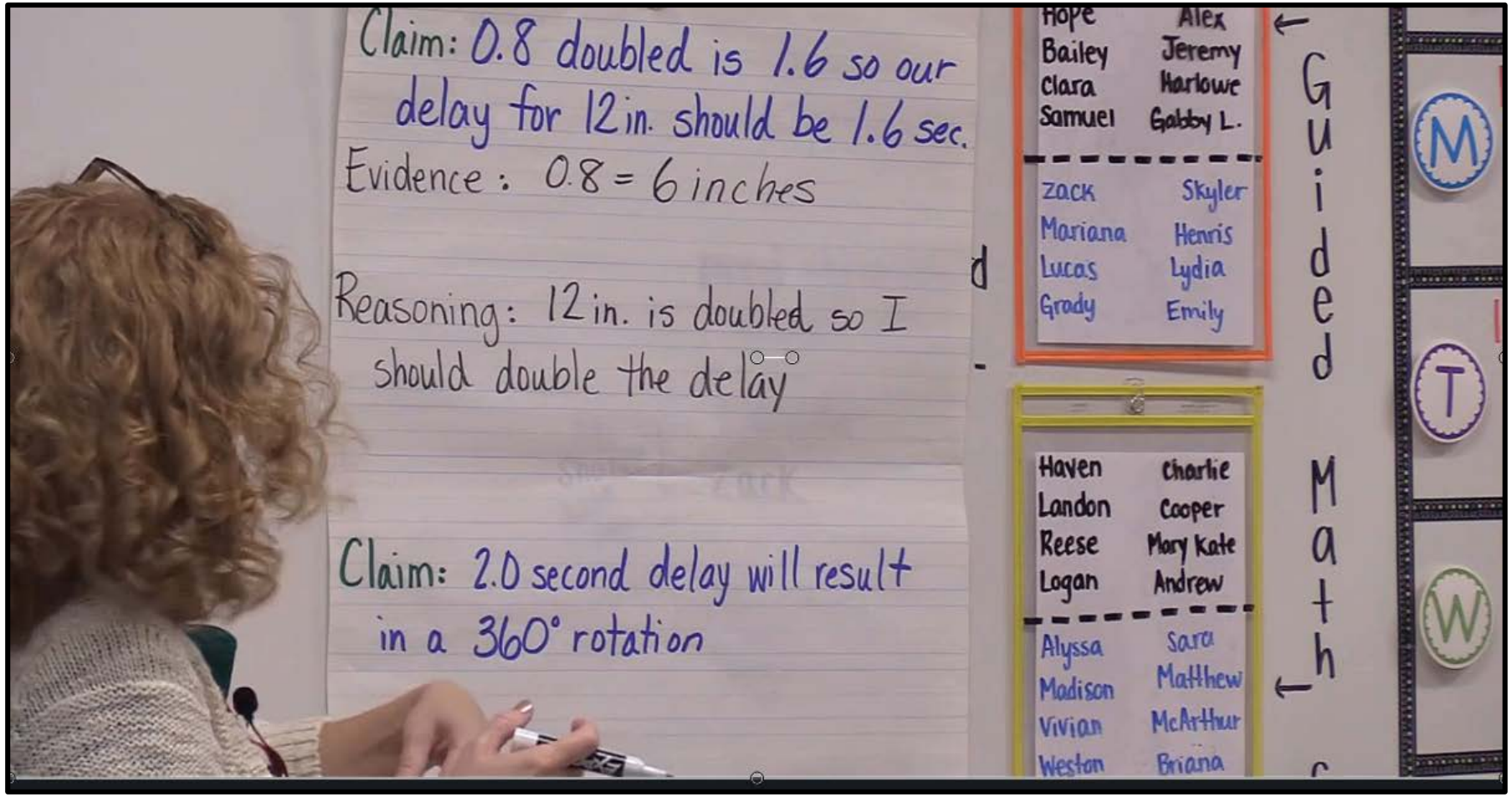
True or false: In 2.4 seconds, Roborobo will travel 18 inches.

CALC: So what was the topic y'all were talking about? (7:32)

The claim wasn't true, it would actually be 3 seconds, not 2.4 (07:35)

Cause you double it by six cause if it went 6,12,18, it would actually be three seconds because every time it goes by 6 it would increase by a second (07:35)

Teacher debriefing the class after the second lesson on coding



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Sarah Cohort 2018
Lesson 2, Day 1
Small group Camera Part 1
Rogic: Block-based coding

Make Roborobo travel 12 inches

0.8 delay will make Roborobo go 6 inches (0:00:12)

Writes on board 'evidence: 0.8 = 6 inches' (0:02:

So your data that you had, your evidence that you had when you were working was that eight tenths of a delay would take you how far? (0:01:58)

Where did this eight-tenths come from? Because when I did my robot, eight-tenths, I didn't get that in any of my delays. Where did that come from? (0:01:37)

[Other student], where do you think, he's already trying to predict, where do you think it came from? (0:01:53)

I think

0.8 doubled is 0.16

Our delay should be 0.16 seconds (0:00:12)

How did you come up with this? tell me what your thinking was? (0:00:43)

It [distance when I tried 0.16s] was a little bit smaller (0:00:12)

And then I realized that the bigger the number, the smaller [distance?] (0:00:42)

So I was confused (0:00:12)

Because the bigger the number, the further Roroborobo should travel [whole number understanding]

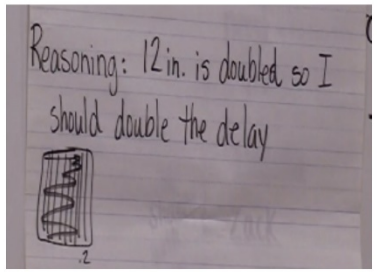
0.8 doubled is 1.6 so our delay for 12 inches is 1.6 seconds (0:00:43)

That was some data that they had recorded and from that they made this claim. Does everyone see that? From this they made that claim. (0:02:12)

But knowing that 0.16 is actually smaller than 8 tenths itself (0:03:42)

Well some people would think it would be just 16 hundredths, but you would have to [have] one and 6 tenths (0:03:42)

How do I know it's going to be 1 and 6 tenths? (0:03:37)



(0:04:17)

So if I have eight tenths (drawing diagram on board) and I doubled eight tenths, it would fill up how many wholes? (0:04:17)

Because I've got eight, right. This would be two-tenth and then I would have some more of a whole. So it's one whole and then how many of a whole? And then how many tenths more? (0:04:26)

Because the length is doubled… (0:03:05)

Time delay needs to be doubled (0:02:40)

RS: Eight-tenths doubled (0:03:02)

So who can help me understand how this led them to make that claim and is that claim true? Student 3, tell me how you think this evidence led them to make that claim. (0:02:26)

Tell me if I'm writing this correctly. 12 inches is doubled so I should double the delay. (0:03:20)

Because the length is doubled and 12 inches is doubled so I should double the delay (0:03:05-0:03:20)

Sarah writes out 'Reasoning: 12 inches is doubled so I should double the delay' (0:03:08)

And why did you double the eight-tenths? (0:03:02)

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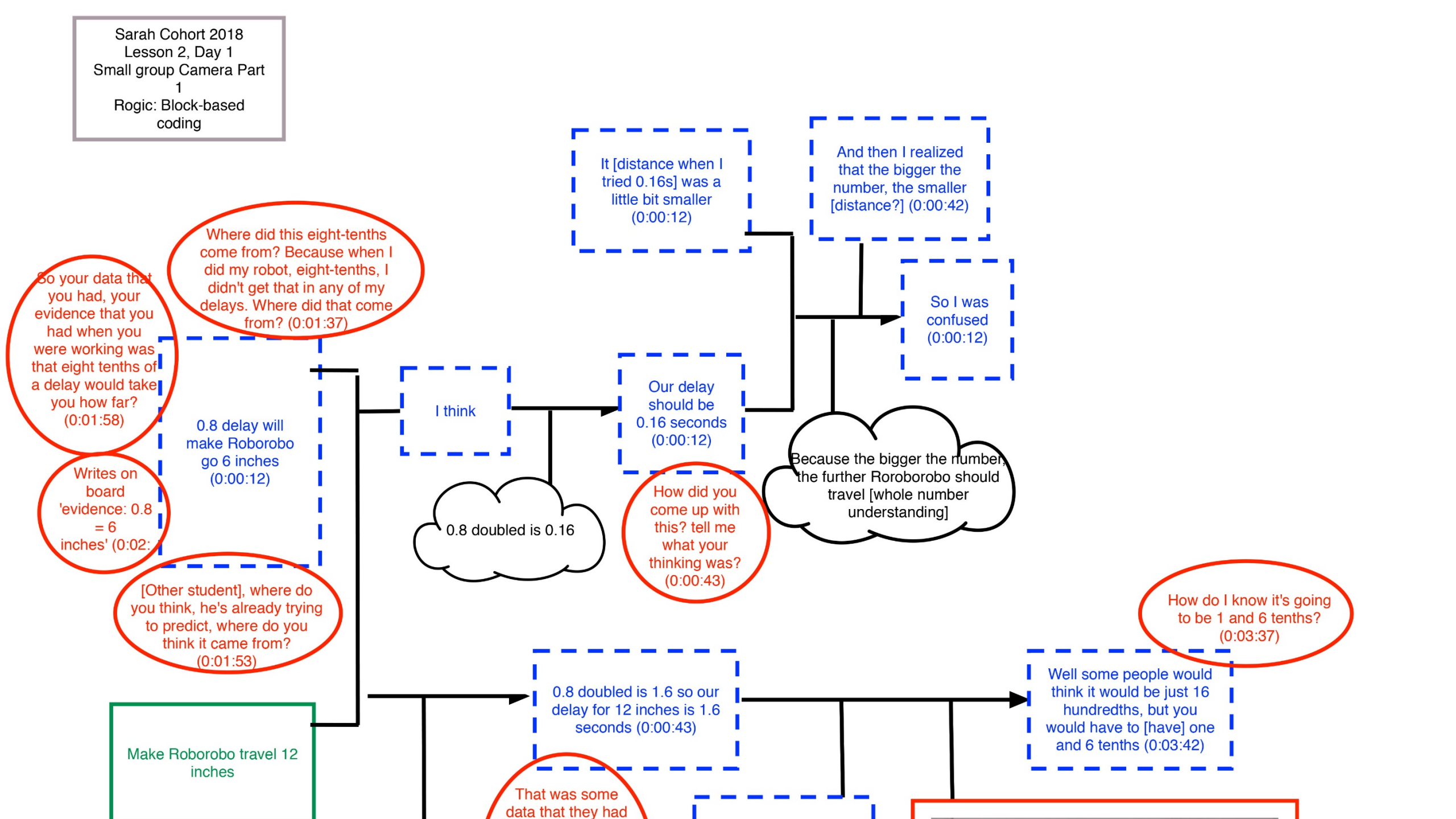

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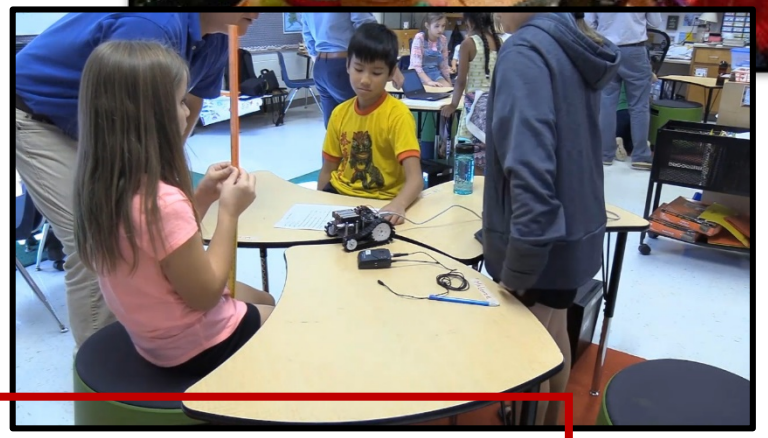
Findings



- Many teachers admitted they were not very comfortable with coding

- Challenged in teaching children how to use collective argumentation in coding and struggled with understanding the goal of CALC
  - *I understand that we're trying to steer away from the trial-and-error and making arguments, I'm just not sure I know what that means. I don't know what that looks like… I feel like I'm not there, but I don't know what I'm missing…*

- Cyclic Learning:
  - The elementary aged students reacted differently when engaging the CALC approach
  - For each new situation, the teachers had to learn how these reactions impacted a learning activity.

- Almost all teachers believed using argumentation helps children explain the process of coding and defend their answers.

- Optimistic about students' capability of learning to code

- Teachers acknowledged the CALC course helped them to change their role as the teacher