Collective Argumentation Learning and Coding (CALC)

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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)

Evidence presented in support of a claim

Data

Qualifier

Claim

Warrant

Teacher Support

Backing

Rebuttal

Teacher Support

The statement whose truth is being established

Bridge between data and claim; reasons that the particular data is relevant to the claim

Discipline-specific reasons the warrant is valid
Teacher debriefing the class after the second lesson on coding

Claim: 0.8 doubled is 1.6 so our delay for 12 in should be 1.6 sec.
Evidence: 0.8 = 6 inches
Reasoning: 12 in is doubled so I should double the delay

Claim: 2.0 second delay will result in a 360° rotation
CALC: Collective Argumentation Learning and Coding

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 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.
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.

No [let’s not make it 7 and 3] What are you doing? (21:58)
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.
Teacher debriefing the class after the second lesson on coding

Claim: 0.8 doubled is 1.6 so our delay for 12 in should be 1.6 sec.
Evidence: 0.8 = 6 inches

Reasoning: 12 in. is doubled so I should double the delay

Claim: 2.0 second delay will result in a 360° rotation
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)

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

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

0.8 doubled is 1.6 (0:00:12)

0.8 doubled is 0.16 (0:00:12)

I think (0:00:12)

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)

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 (0:00:43)

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 Roborobo should travel [whole number understanding] (0:00:12)

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

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

Make Roborobo travel 12 inches (0:00:43)
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.