Collective **A**rgumentation **L**earning and **C**oding (**CALC**)

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This material is based upon work supported by the National Science Foundation under Grant # 1741910*. 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.*

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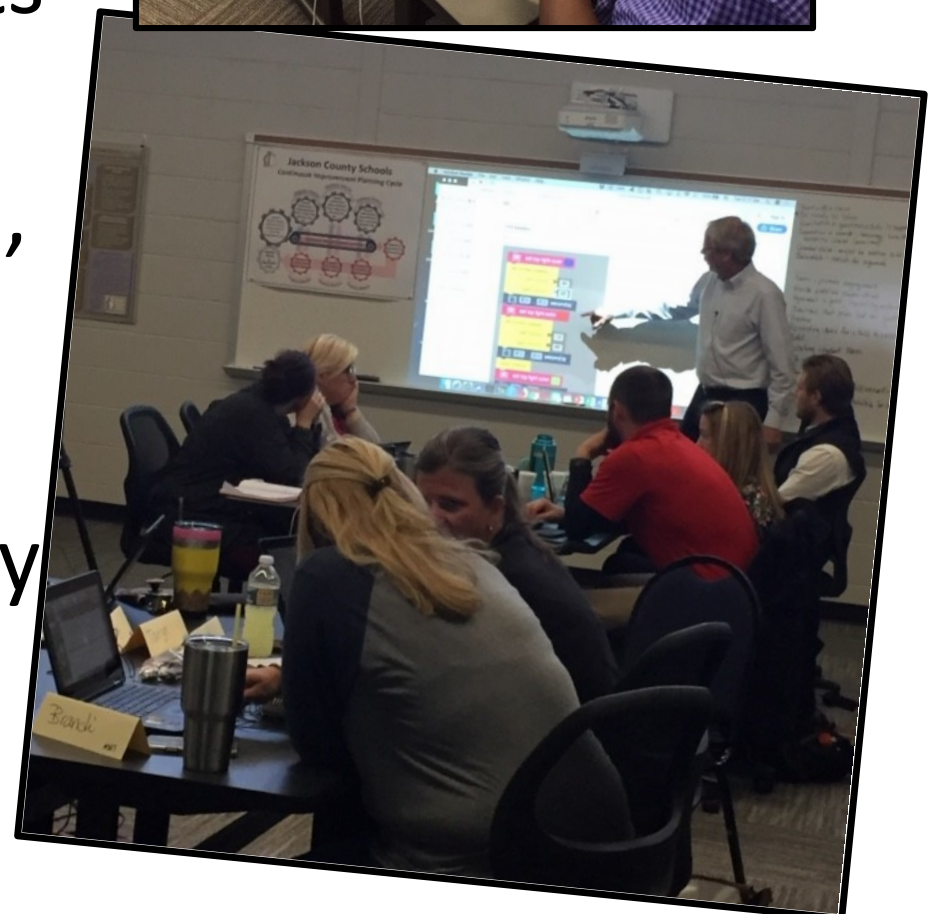
Our Premise

If teachers could understand coding better, and if they could 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.



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Why argumentation?

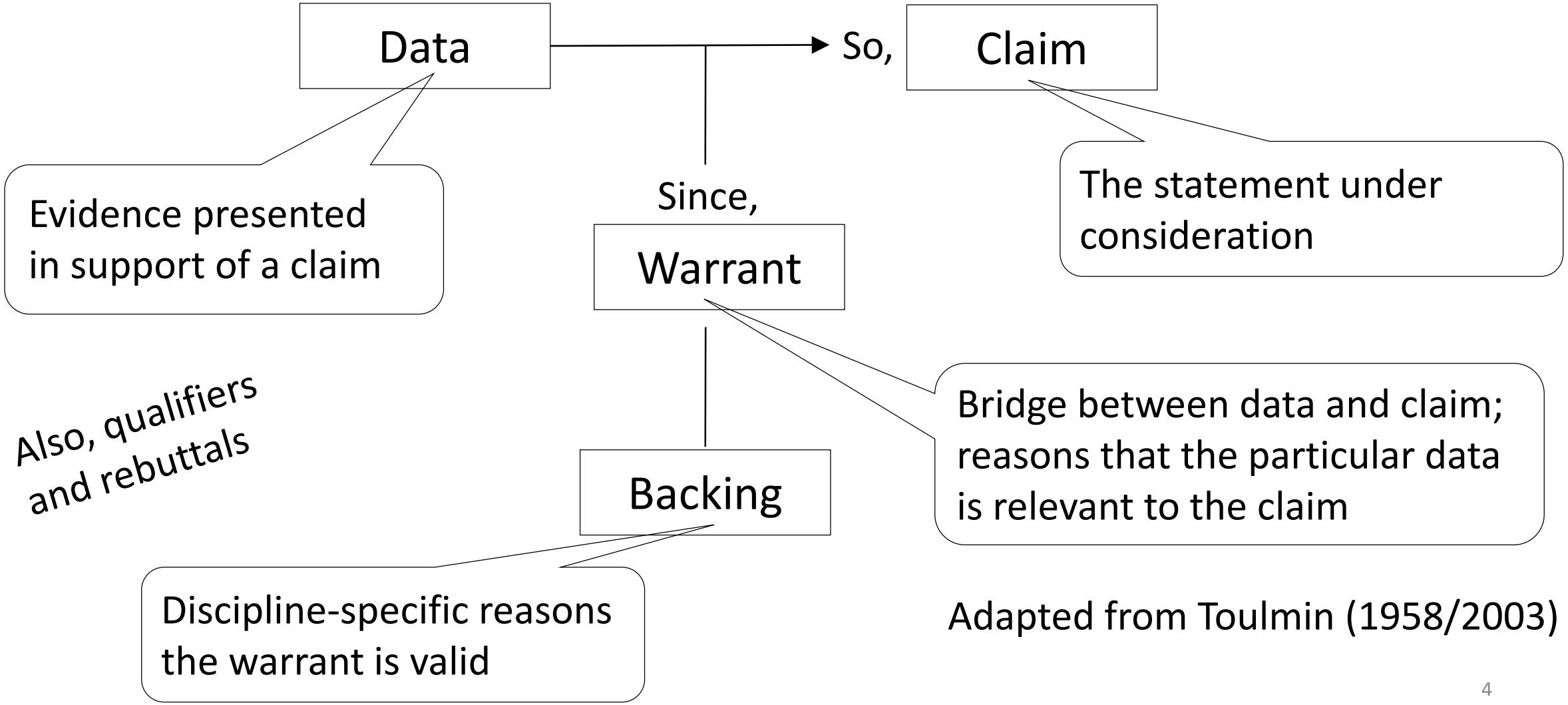
- **Georgia (and Common Core) Standards**

  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?”
  - explain their thinking to others and respond to others’ thinking
- **Academic skill needed in the real world**
- **Fosters learning in authentic and disciplinarily appropriate ways**

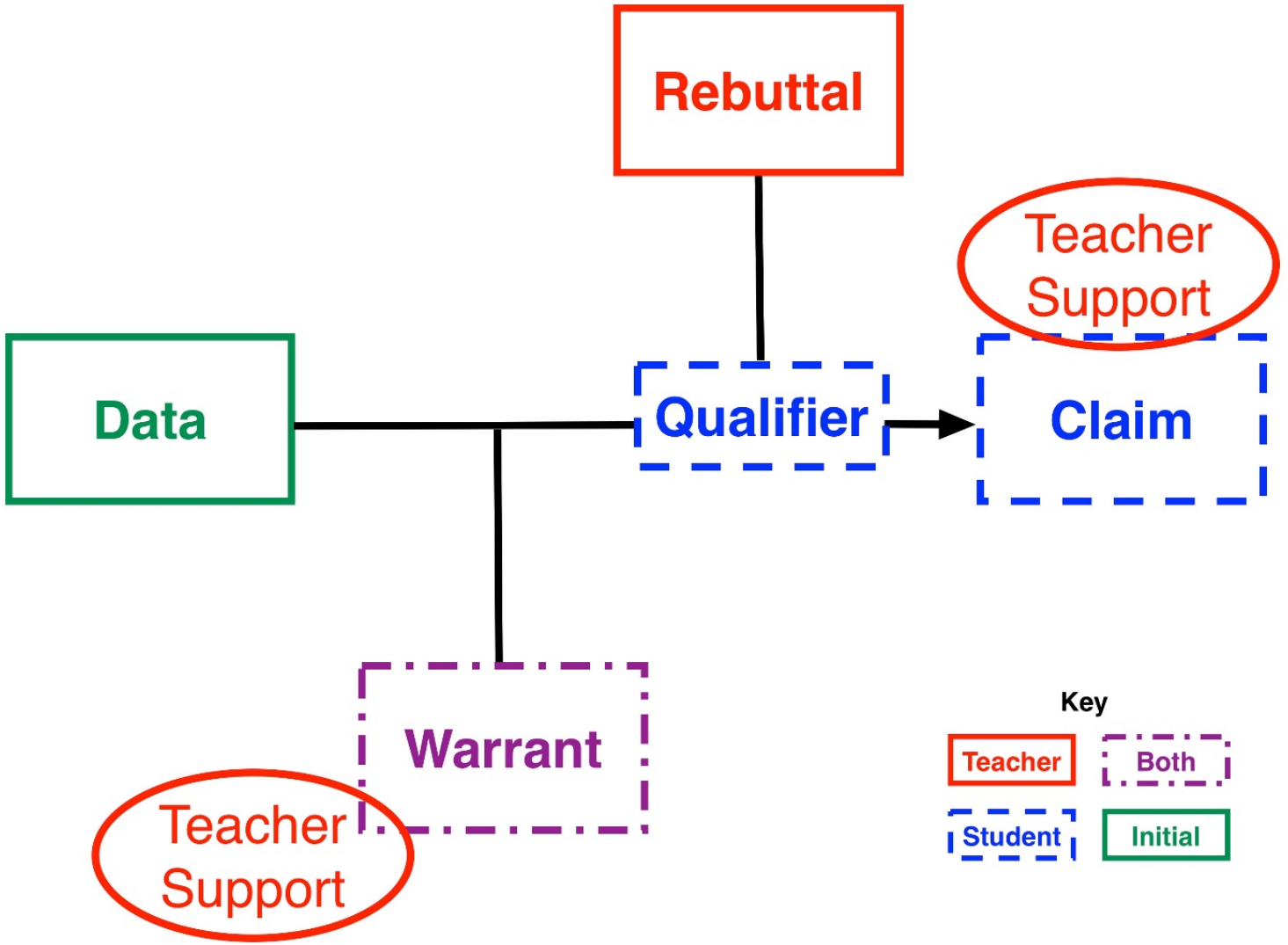
(Asterhan & Schwarz, 2007; Venville & Dawson, 2010)

Toulmin's Argument Diagram



Adapted from Toulmin (1958/2003)

Toulmin's Argument Diagram



From Conner (2008)

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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?

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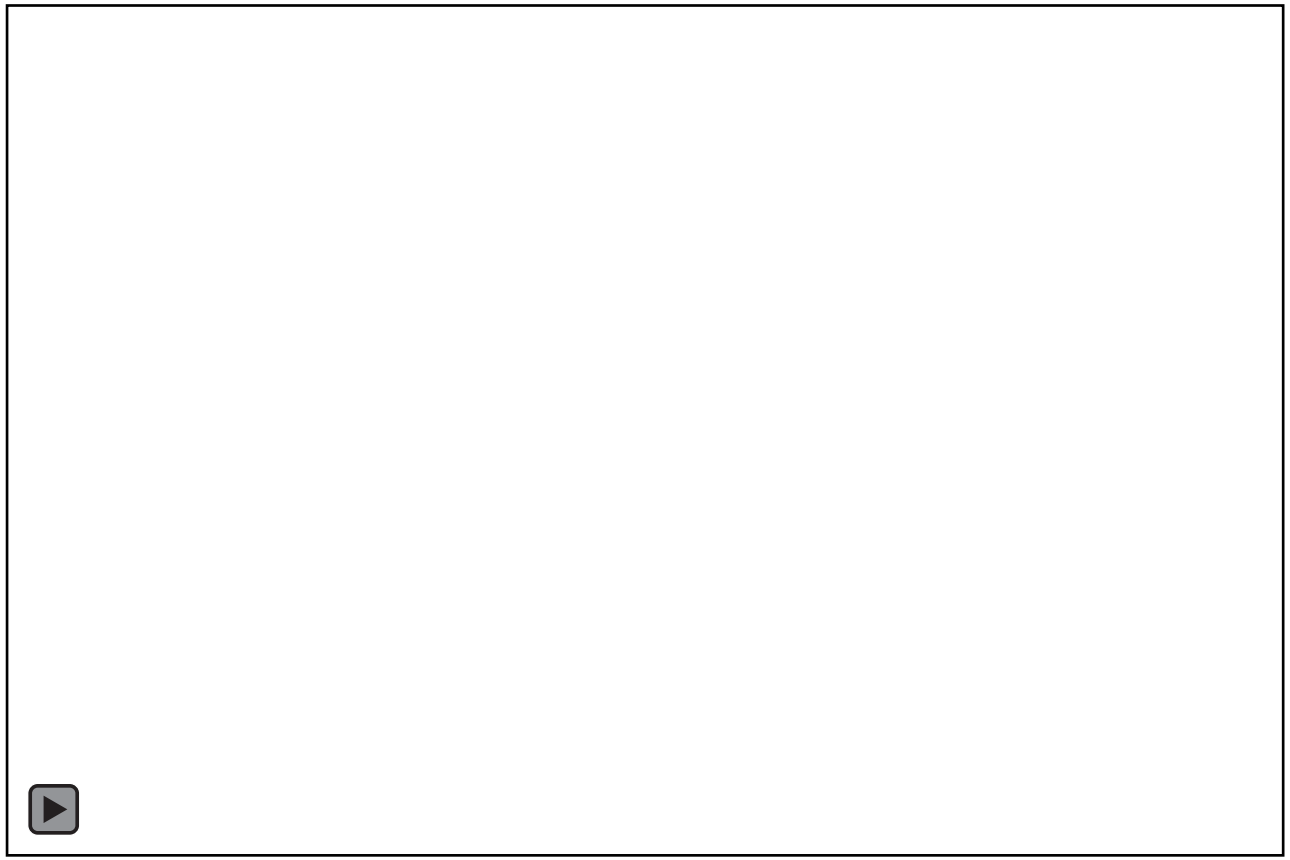
Beginning of first semester

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



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

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].

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

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)

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)

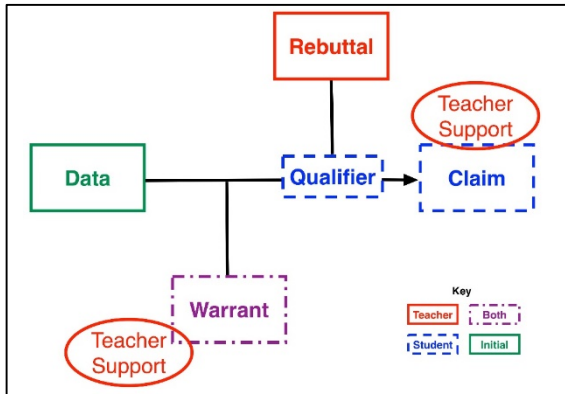
No [let's not make it 7 and 3] What are you doing? (21:58)

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

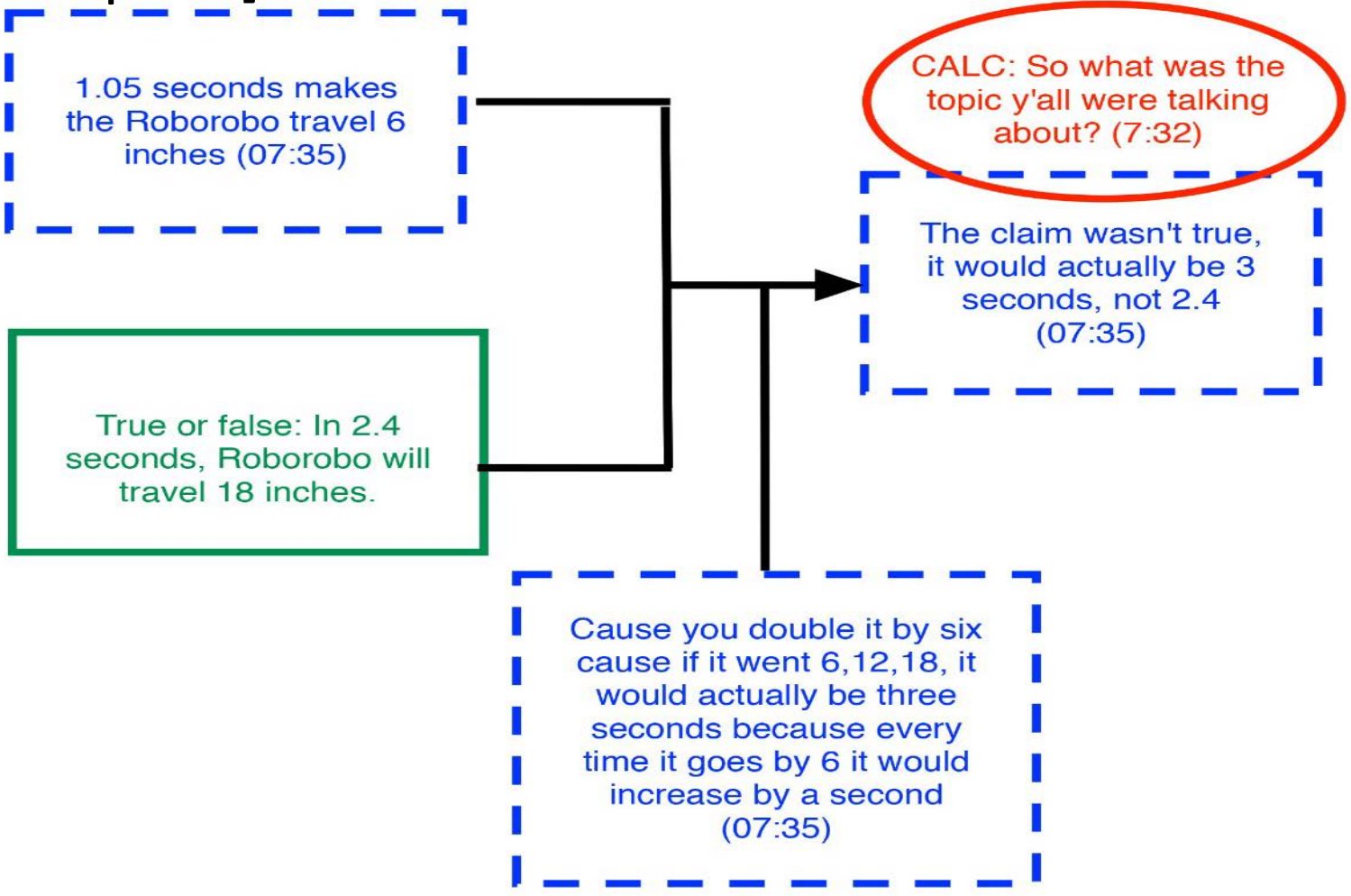
[But] It [7 and 3] will make it curve that way (gesturing) a lot more (22:05)

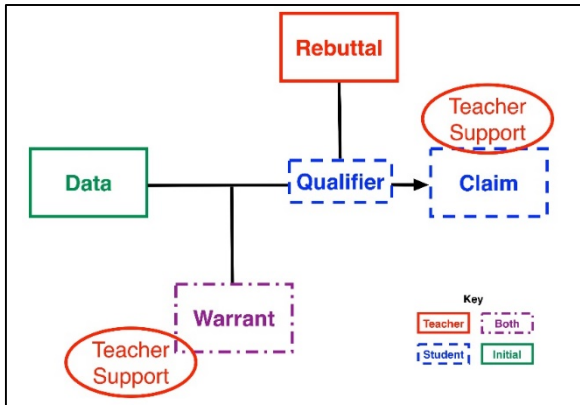
Part of the discussion

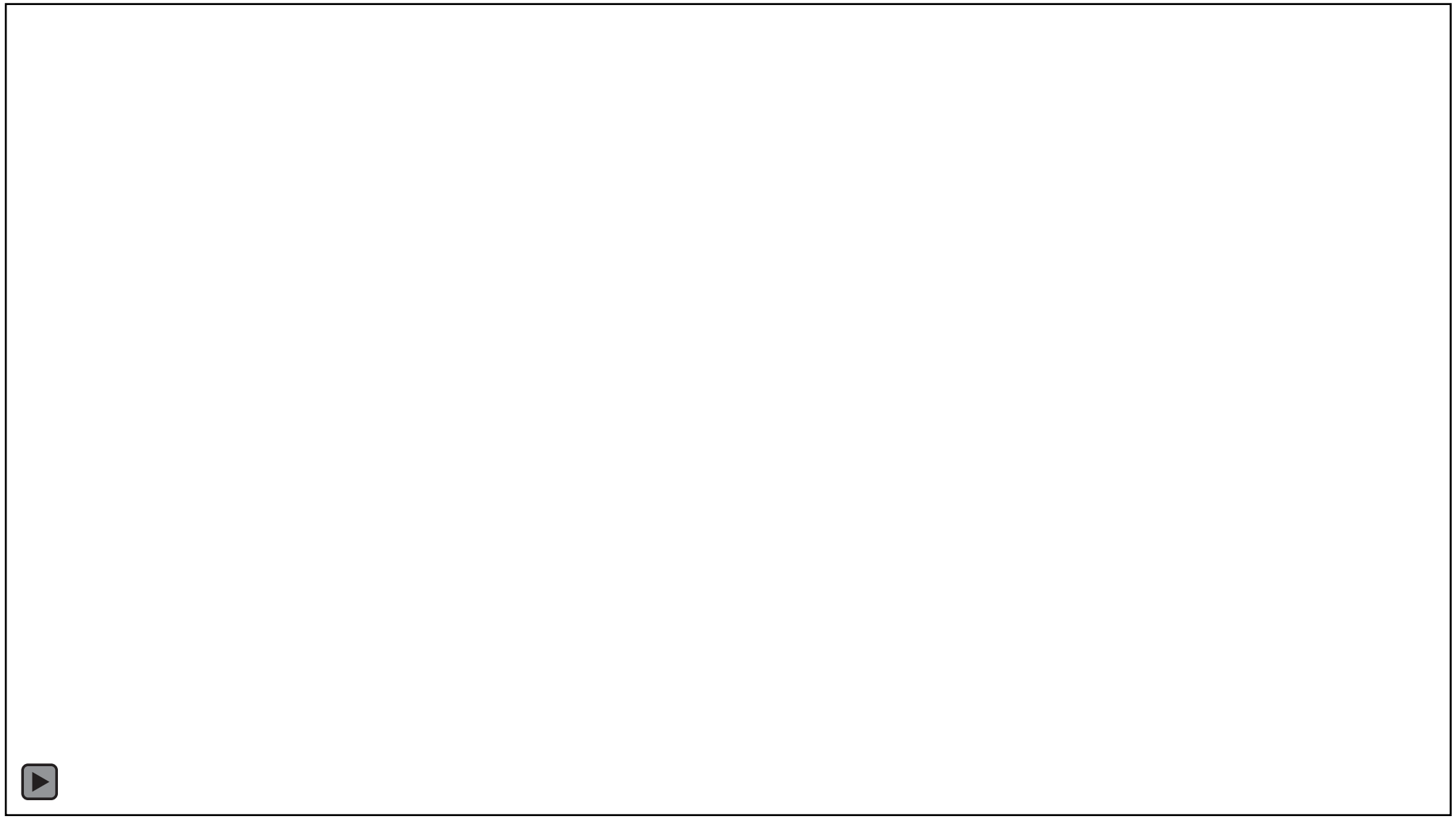
No it wouldn't work, you know how it behaved with 6 and 4, you make one go up a bit *(the motor speed code)* and one go down a bit, you said it would move a bit, let's try 7 and 3.



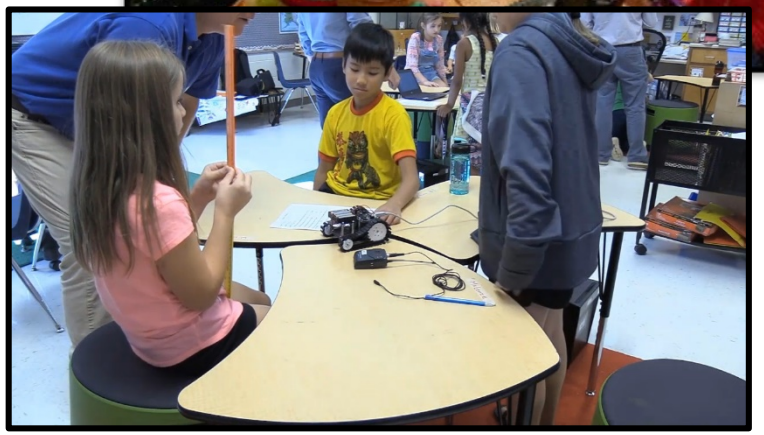
Our data says 0.8 [seconds] for 6 inches and we said 3 seconds will get us 18 inches. We want to see if the claim is true or not. It turns out that it is false…the claim wasn't true because it would have, you have to double it. It goes 6, 12, 18 which is multiplying by 2 and 3. So to get to 12 inches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







What we learned from our teachers



- At the beginning, many teachers 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… (Doris)

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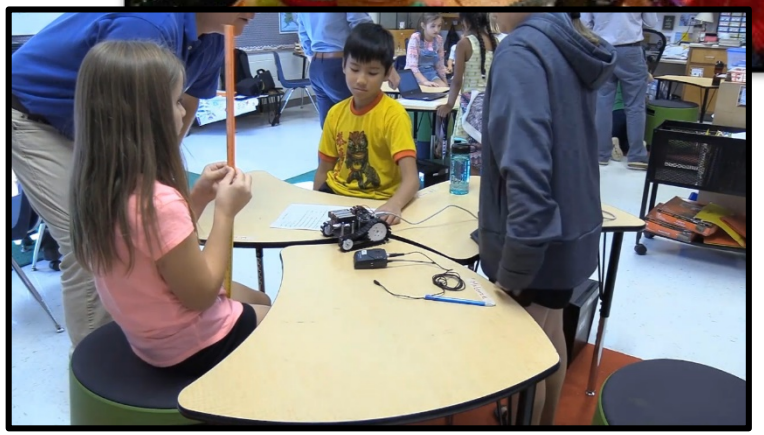

- Cyclic Learning:
  - The elementary aged students reacted differently when engaged in the CALC approach
  - For each new situation, the teachers had to learn how these reactions impacted a learning activity
- Almost all teachers believed using argumentation helps children explain the process of coding 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