The Importance of Teachers' Instructional Goals for Computational Thinking in a Virtual Robotics Classroom

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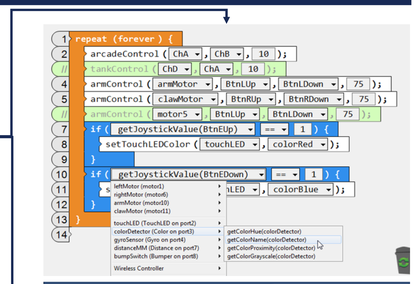
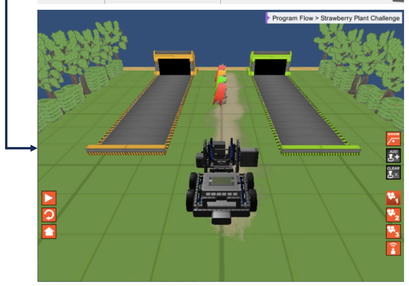
Background and Problem Context

- Computational thinking (CT) is an important component of teaching generalizable computer science skills to all students [1]
- Virtual robotics curricula offer engaging K-12 learning environments shown to teach generalizable programming knowledge and skills [2]
- However, robotics programs are taught in a variety of learning environments by teachers certified in a wide range of disciplines [3]
- Variation in instructional learning goals in these environments may contribute to observable differences in lesson enactment, student learning, and attitudes towards programming [4]



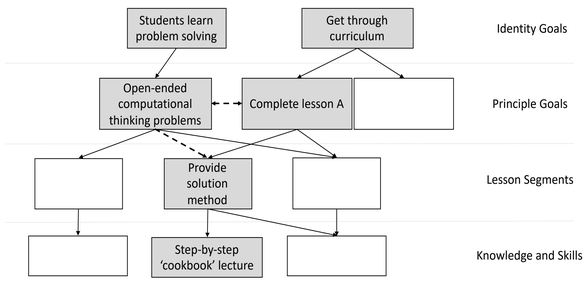


Research Questions

RQ1 How do robotics teachers conceptualize and articulate instructional goals around CT in their classrooms?

RQ2 Are student programming attitudes and learning of CT related to the instructional goals endorsed by robotics teachers?

Research Design and Methods



(Adapted from Davis, Janssen & Van Driel, 2016)

Theoretical Framework

- Instructional goals are likely to be emergent processes that are responsive to particular learning contexts [6]
- Goals explicitly stated at the lesson planning level may improve instructional design, and therefore increase student achievement [5]
- However, in complex learning environments like robotics, teachers may possess a hierarchy of multiple and often conflicting goals [7]

Measures

RQ1

Qualitative interviews, classroom observations and a goal-setting task

- Robotics educators, local region (*N*=2)

RQ2

CT Goal Endorsement Survey (α=.74)

- Robotics educators, various U.S. regions (*N*=10)
  e.g., "During class this week, my goal was that students would learn…[that programs execute command in sequence; to use seconds to operate the claw motor, etc.)"

CT Assessment (θ = .73)

- 6th-8th grade robotics students (*N*=206)
  e.g., "Which lines can be removed from the program to improve efficiency, while not changing the code output?"

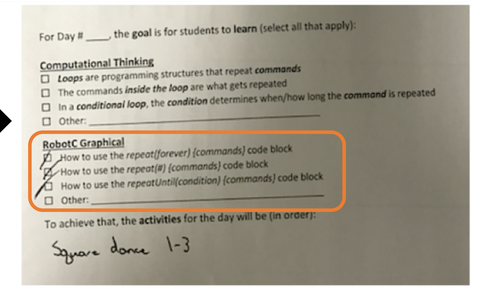
Attitudinal Surveys

- Interest (α=.87)
  e.g., "I wonder about how computer programs work"
- Identity (α=.88)
  e.g., "My family thinks of me as a programming person"
- Competency Beliefs (α=.83)
  e.g., "I could do advanced work in programming"

RQ1: Teachers' Computational Thinking Goals in the Classroom

"TYLER"

> I mean robotics, it's obviously computer science based, but its **computer science based problem solving skills**, so the **overall general idea of this class is all about problems solving skills**…I mean, that's what we're all about here…hands on problem solving skills for the most part.


For Day # ____, the **goal** is for students to **learn** (select all that apply):

Computational Thinking
- ☐ ***Loops*** are programming structures that repeat ***commands***
- ☐ The commands ***inside the loop*** are what gets repeated
- ☐ In a ***conditional loop***, the ***condition*** determines when/how long the ***command*** is repeated
- ☐ Other: _____

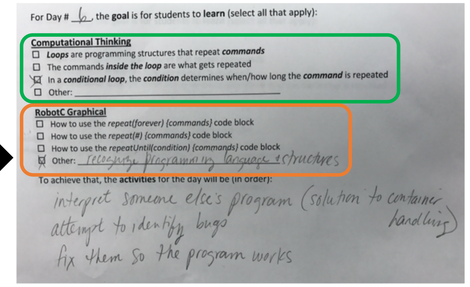
RobotC Graphical
- ☑ How to use the *repeat(forever) {commands}* code block
- ☑ How to use the *repeat(#) {commands}* code block
- ☐ How to use the *repeatUntil(condition) {commands}* code block
- ☐ Other: _____

To achieve that, the **activities** for the day will be (in order):
Square dance 1-3

- Both teachers endorsed similar, high-level **Problem Solving goals** during interviews
- However, different selection patterns of **CT goals** and **Programming goals** emerged at the pre-lesson planning level

"CLAIRE"

> I try to relate as much as possible with what we do in class to the real world…**I feel like my goal is not to teach them ROBOTC** or, you know, I feel like…**I want kids to learn how to problem solve and how to think.**


For Day # 6, the **goal** is for students to **learn** (select all that apply):

Computational Thinking
- ☐ ***Loops*** are programming structures that repeat ***commands***
- ☐ The commands ***inside the loop*** are what gets repeated
- ☒ In a ***conditional loop***, the ***condition*** determines when/how long the ***command*** is repeated
- ☐ Other: _____

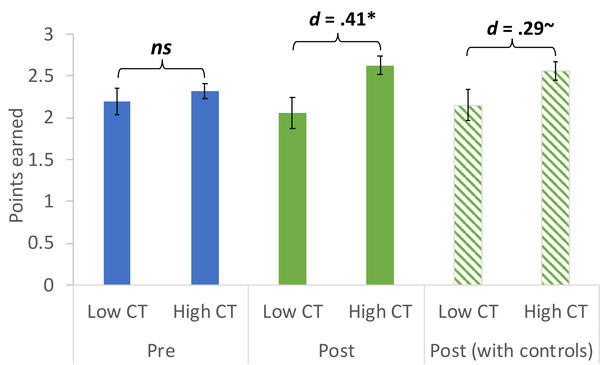
RobotC Graphical
- ☐ How to use the *repeat(forever) {commands}* code block
- ☐ How to use the *repeat(#) {commands}* code block
- ☐ How to use the *repeatUntil(condition) {commands}* code block
- ☒ Other: recognizing programming language structures

To achieve that, the **activities** for the day will be (in order):
interpret someone else's program (solution to container handling)
attempt to identify bugs
fix them so the program works

RQ2: Learning and Attitude Shifts by Instructional Goal

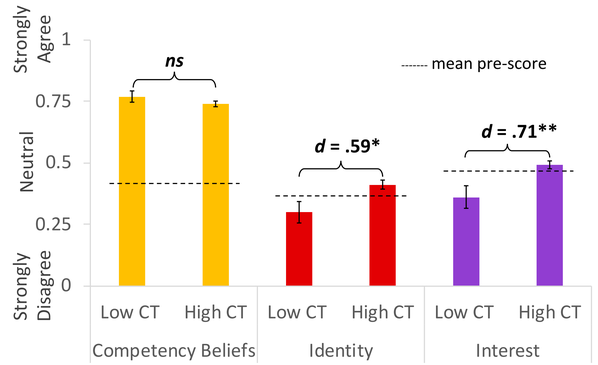
Computational Thinking Assessment

- Students with teachers who highly endorsed CT goals scored significantly higher on a post-test.
- Smaller effects remained when controlling for pre-test scores, age and prior experience.



Attitudinal Surveys

- Students with teachers who highly endorsed CT goals showed higher Programming Interest and Programming Identity at post.
- No significant differences in Competency Beliefs



ns = not significant; ~p<.10, * p<.05, ** p<.01

References

[1] Barr, V. & Stephenson, C. (2011) "Bringing Computational Thinking to K-12." *ACM Inroads 2*(1).
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[6] Hiebert, J., Morris, A.K. and Spitzer, S.M. (2017), "Diagnosing Learning Goals: An Often-Overlooked Teaching Competency", in Lueders, T., Philipp, K. and Lueders, J. (Eds.), *Diagnostic Competence of Mathematics Teachers*, 11th ed., Springer International, Cham, Switzerland, pp. 193–206.
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