A LEARNING STRATEGY FOR USE → MODIFY SCRATCH ACTIVITIES

Jean Salac, Cathy Thomas, Chloe Butler, Ashley Sanchez, & Diana Franklin

University of Chicago & Texas State University

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When you read some incredibly bad code, thinking "What moron wrote this...", but halfway through it starts to become familiar.

Open-ended designs for informal learning may not translate well to the formal setting.

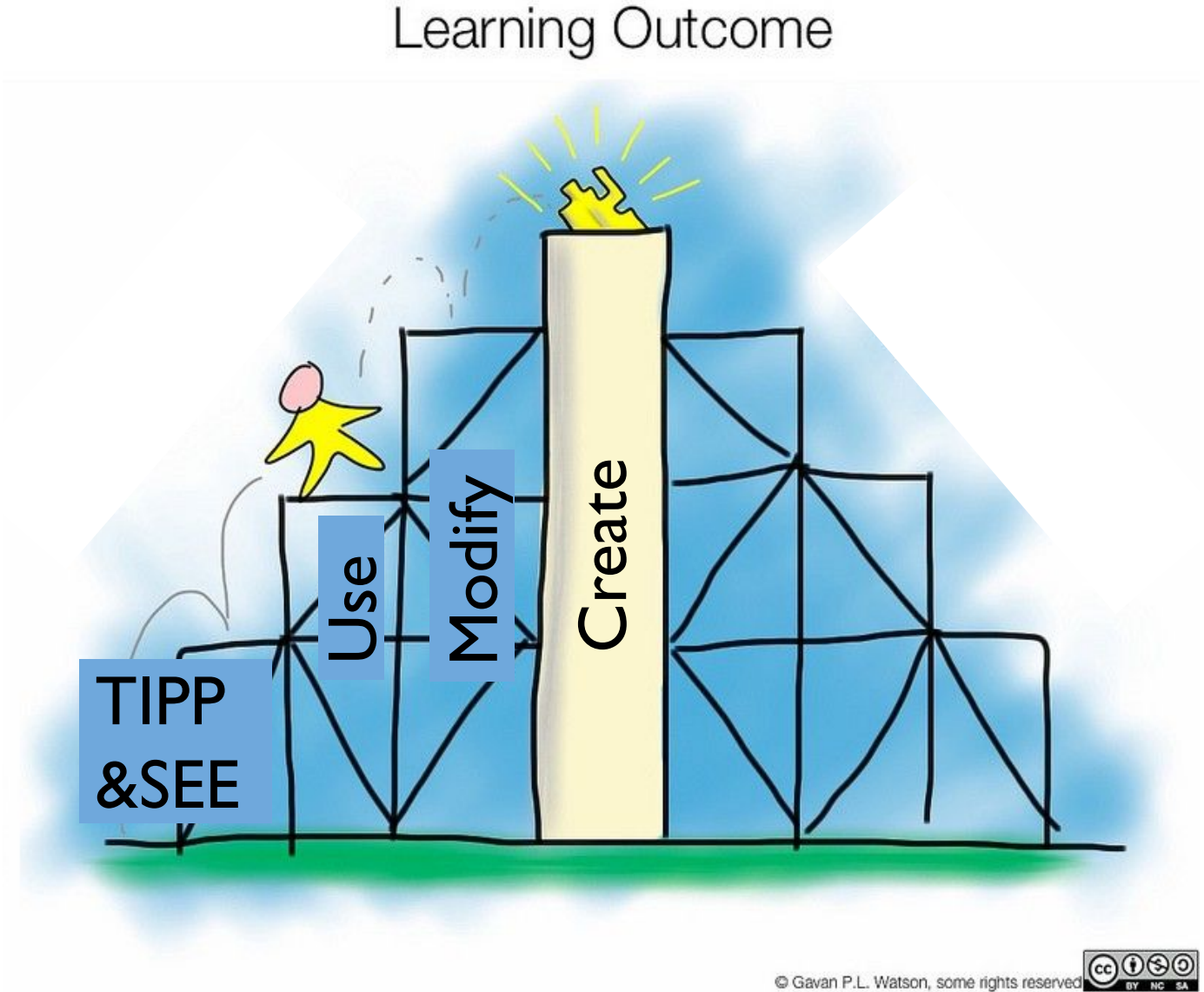
Students may face academic challenges that interfere with their success in a programming curriculum.

School performance has been tied to student learning in CS. (Salac et al., 2019)

Creative Computing Curriculum

Images from scratch.mit.edu & creativecomputing.gse.harvard.edu

TIPP&SEE scaffolds learning in the Use → Modify step, leading to improved performance.



Outline

Motivation

Task

TIPP&SEE

Related Work

Theoretical Framework

Study Design

Results

Most learning strategies for CS are at the university-level.

University-level strategies include:

- Reading, tracing, & explaining **before** writing code (Lister et al. 2004-9)
- Diagramming & design (Falkner et al. 2014)
- Game development (Barnes et al. 2007)

The K-12 strategies that do exist include:

- PRIMM (Sentance et al. 2019)
  - Use → Modify → Create (Lee et al. 2011)

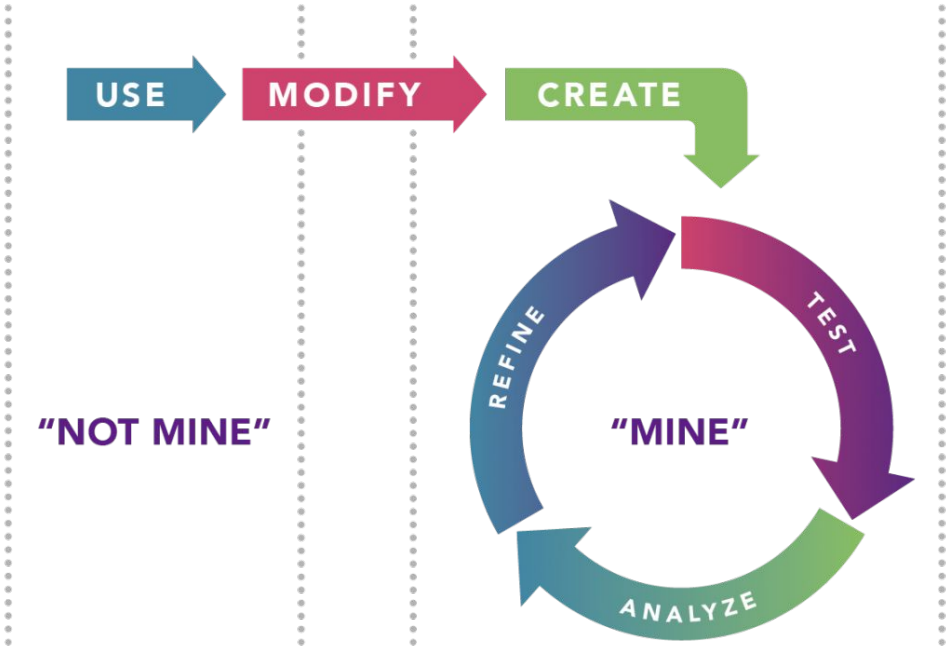


Image from K12cs.org

There are reading comprehension strategies that may have ties to programming.

Previewing helps students set goals & activate their prior knowledge.(Klinger et al., 1998, Manz et al., 2002)

Text structure strategies prepare students to recognize different text structures.(Gersten et al., 2001, Williams et al., 2005)

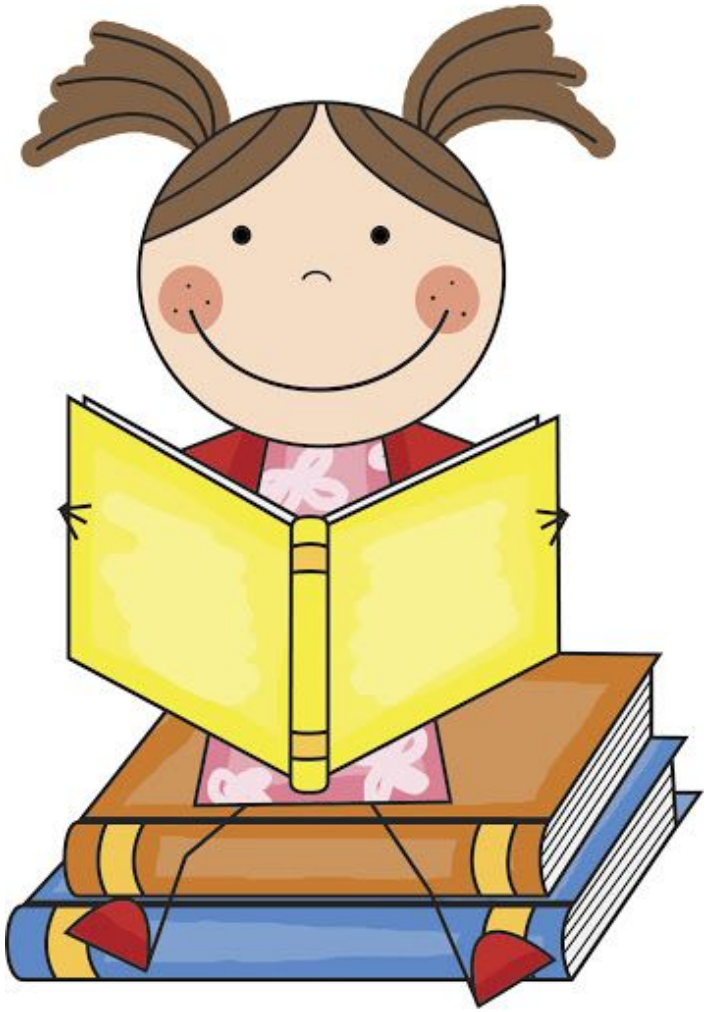


Image from Clipart library

“TIPP” was inspired by previewing strategies.

Get a TIPP from the Project Page:

Title: What is the title of the project?
Does it tell you something about the project?

Instructions: What do the instructions tell you to do?

Purpose: What is the purpose of this activity?
What will this code teach you?

Play: Run the project and see what it does!
Which sprites are doing the actions?

1. Who talks when I click  ?

2. Who talks when I press spacebar?

“SEE” was inspired by text structure strategies.

SEE Inside:

Sprites: Click on the sprite that you want to learn from or change.

Events: Look at the event blocks starting the scripts. Which scripts are most useful?

Explore: Try different changes to the scripts and observe what happens!

4. Which block makes the sprite bigger?

5. Which block makes the sprite smaller?

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Zone of Proximal Flow describes learning experiences that are not too easy & not too difficult.

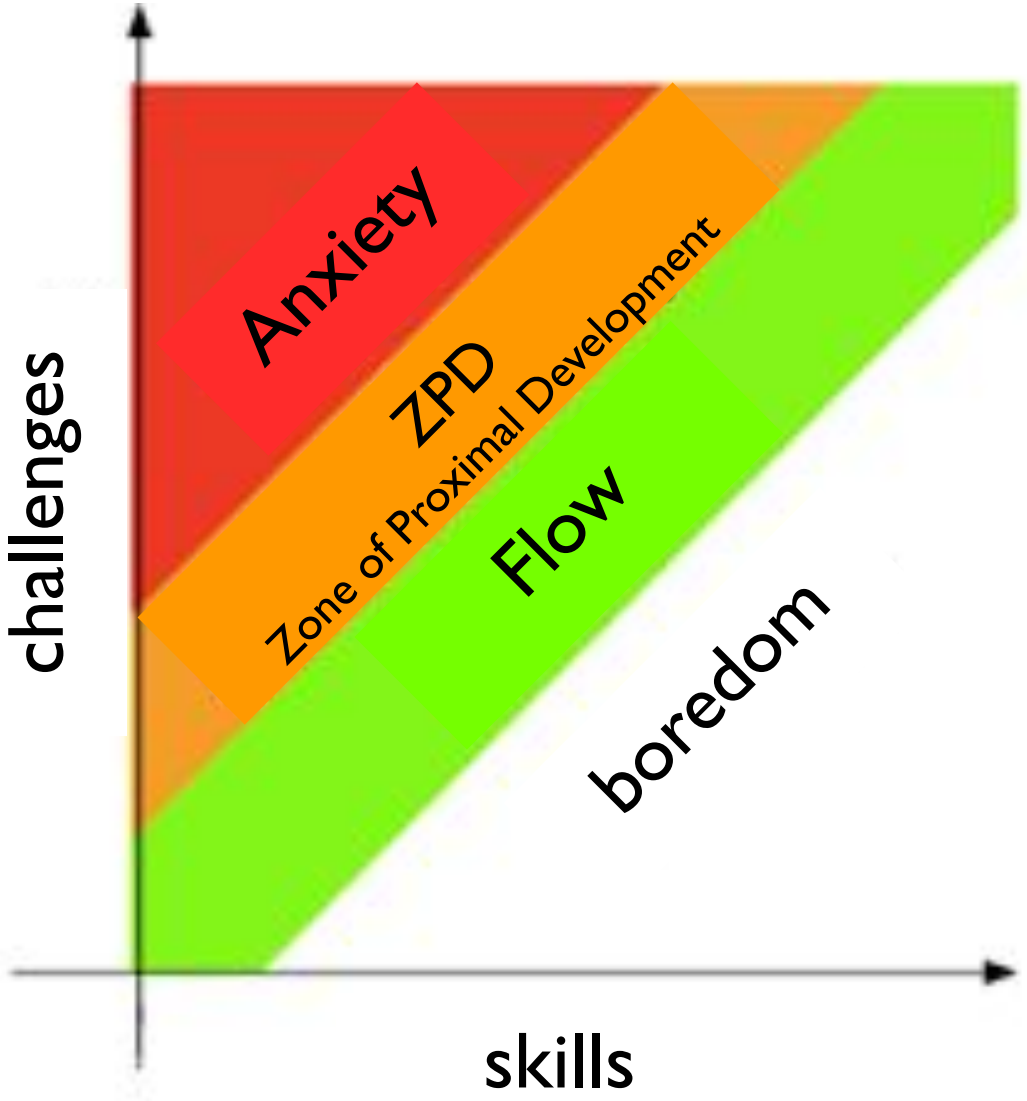

Image from Basawapatna et al.

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Our study took place in a large, urban school district.

15 teachers taught 16 classrooms, for 184 4th graders total (ages 9-10).

Classrooms were randomly assigned to TIPP&SEE or control

(5 English & 3 bilingual classrooms each).

Scratch Act 1 curriculum covered events, sequence, & loops.

Each concept was taught with Use→ Modify → Create.

All materials were available in English & Spanish.

Scratch ACT 1

Assessments were given after each module.

The Evidence-Centered Design framework guided design.

Domain analysis was informed by CS K-12 framework & K-8 learning trajectories.(Rich et al, 2017-19)

Questions were evaluated by researchers & practitioners for face validity.

Item difficulty, item discrimination, & Cronbach's alpha were also calculated.

Data analysis was performed on student assessments.

The ANOVA F-test was used to see if TIPP&SEE had an influence on assessment scores.

p-value is the probability that results are by chance.

η^2 effect size tells us how much of the variance in a dependent variable is associated with the independent variable.

Free-response questions were qualitatively coded with a Fleiss' Kappa inter-rater reliability greater than 80%.

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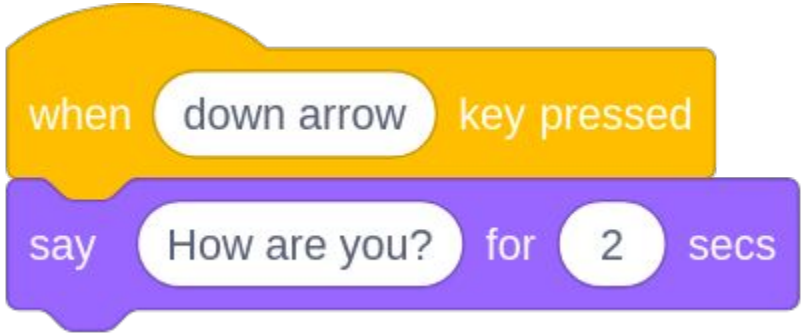
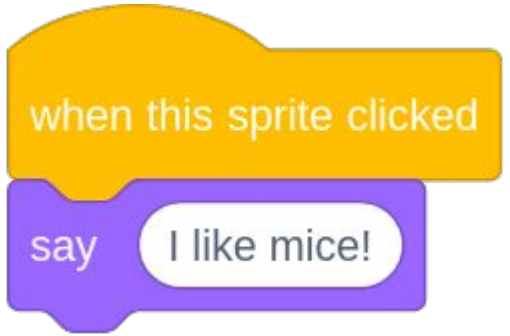
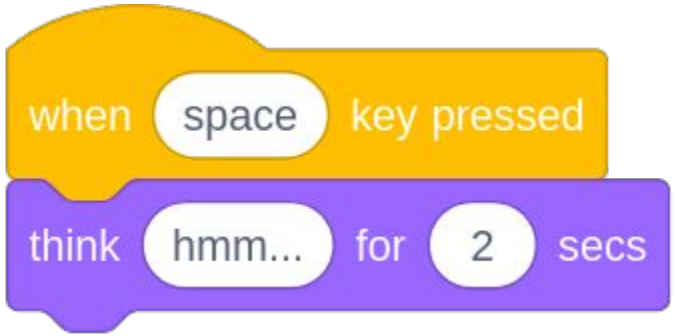
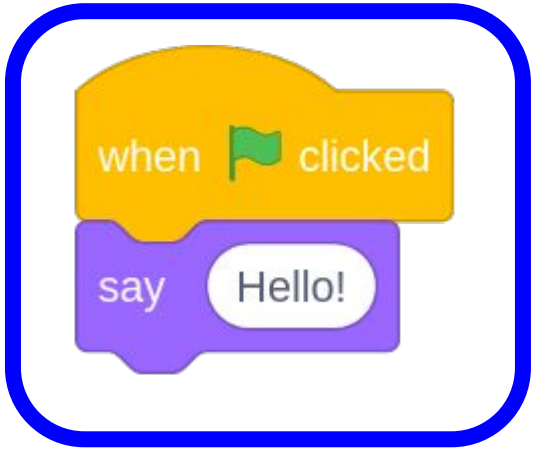
Students were asked to identify the event that makes the sprite say “Hello!” out of these scripts:

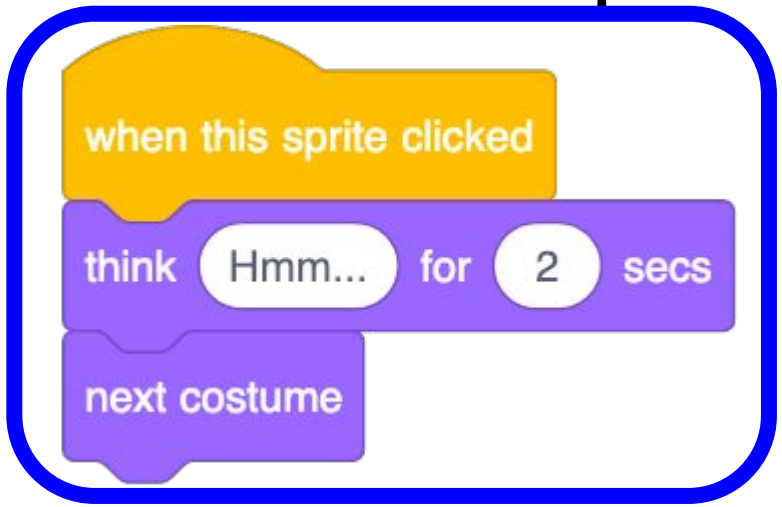


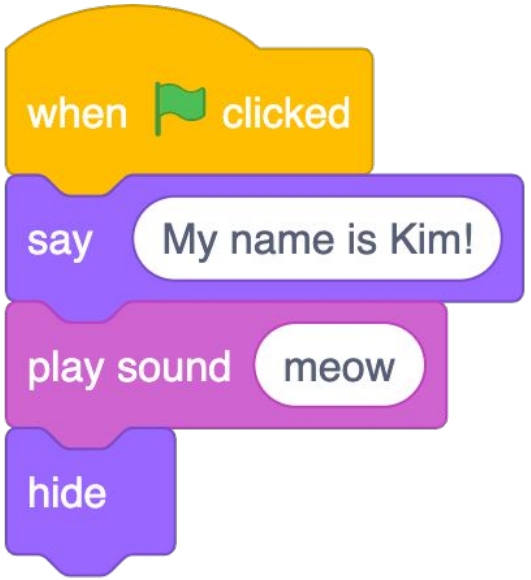




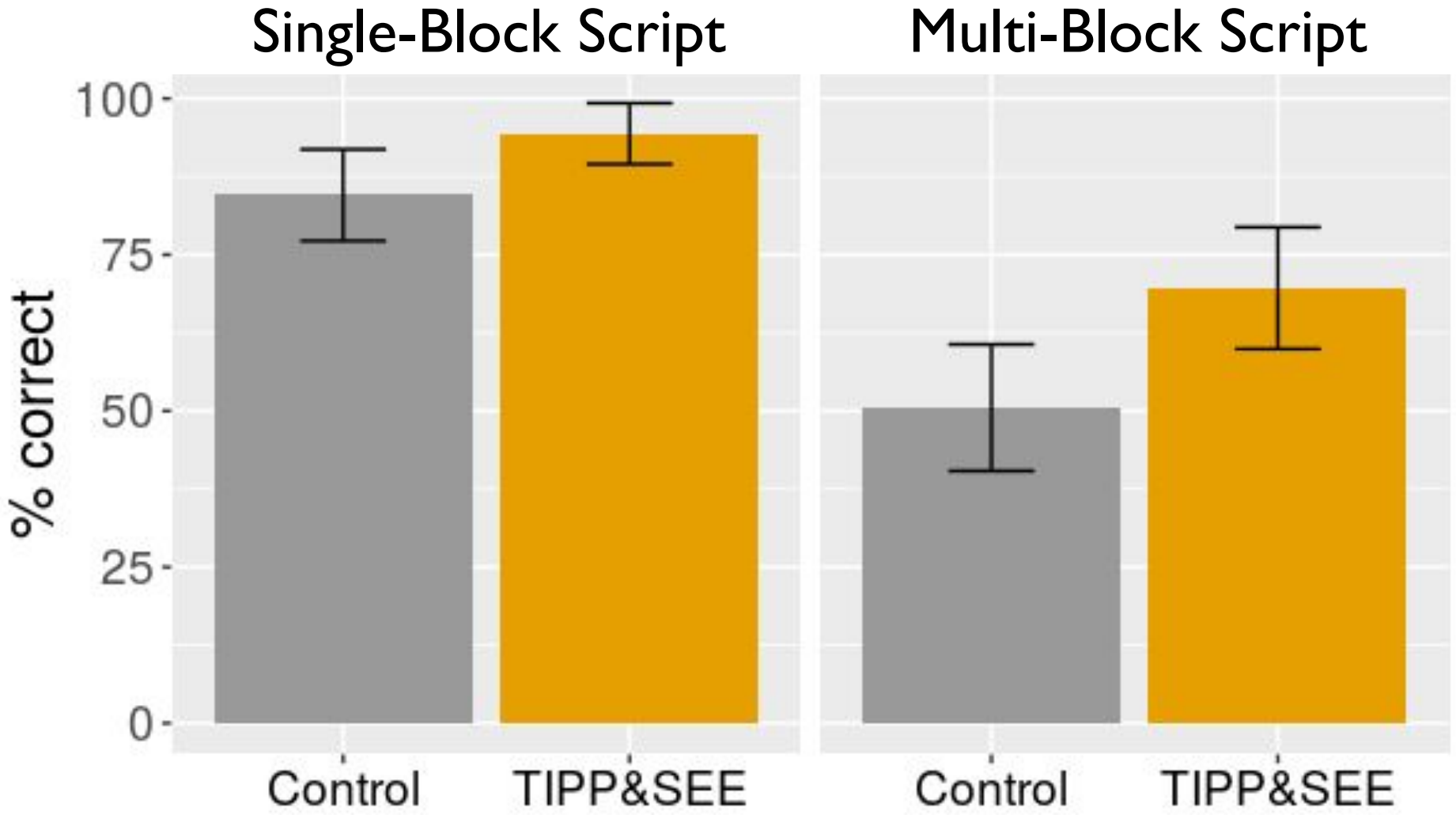


Students were asked to identify the script that runs when the sprite is clicked out of these scripts:

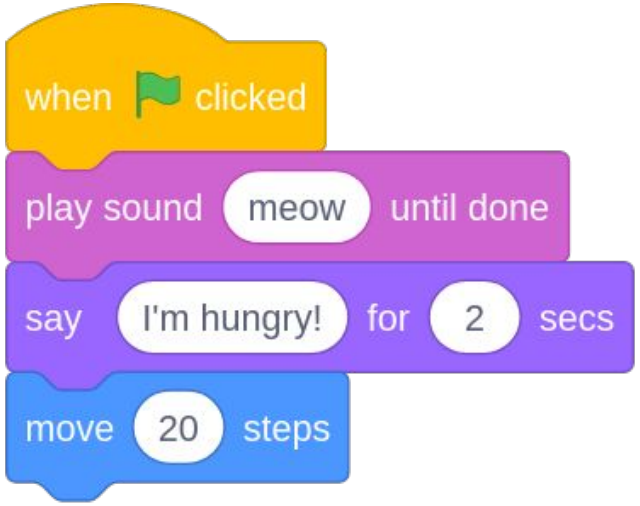




TIPP&SEE students outperformed control students in events questions.



Students were asked to identify the order of blocks.

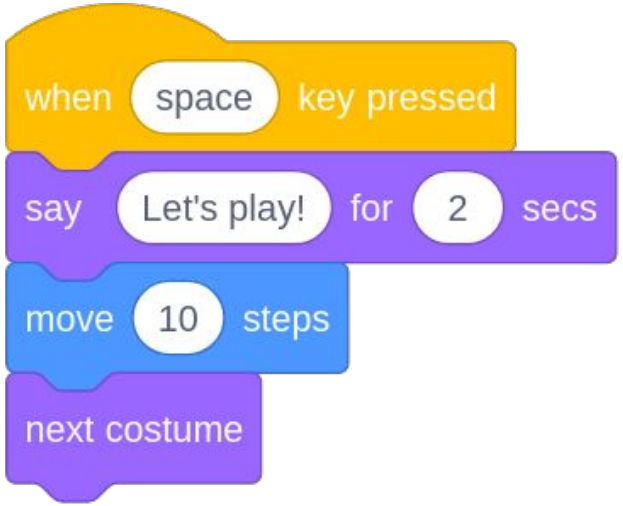


Scaffolded response structure:

First, _____

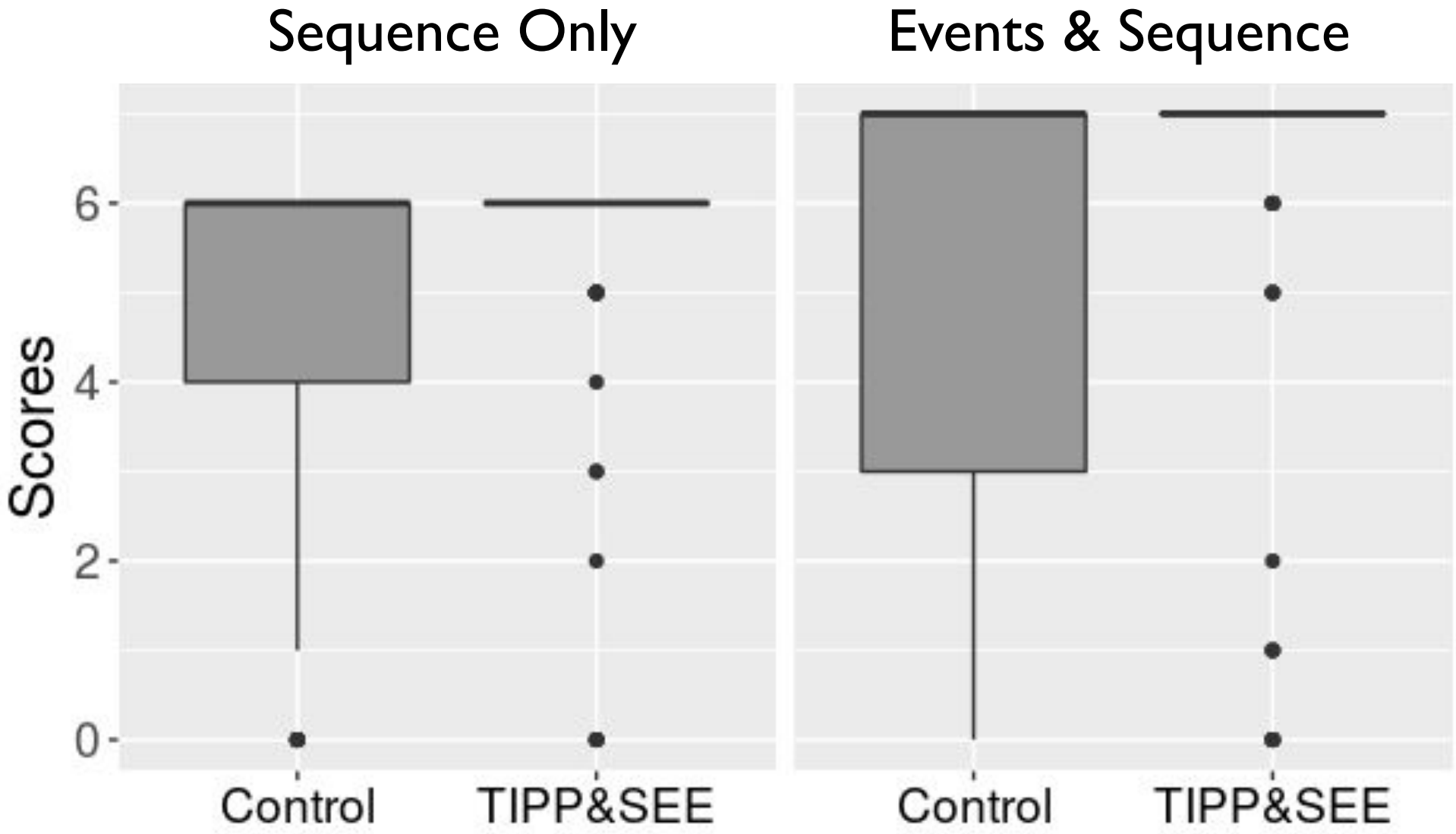
Next, _____

Last, _____



For this script, students were also asked to identify the event triggering the script.

TIPP&SEE encouraged a deeper understanding of sequence.



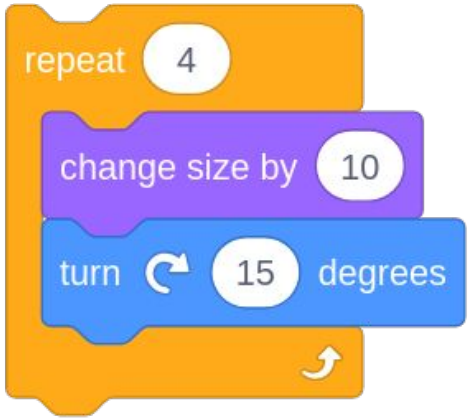
TIPP&SEE encouraged a deeper understanding of sequence.

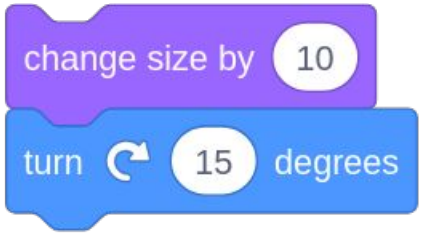
Qualitative analysis revealed that:

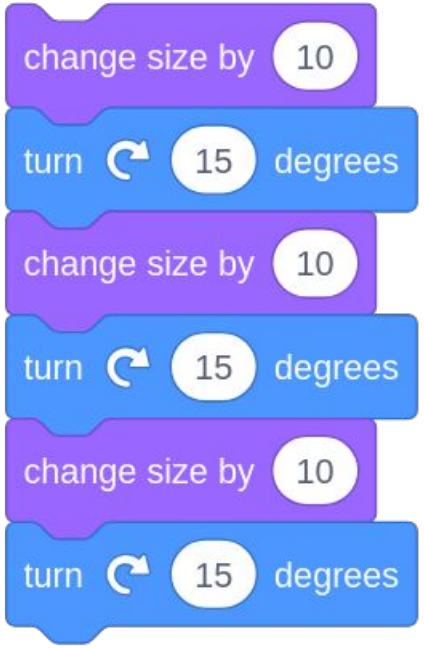
TIPP&SEE students were less likely to respond with an incorrect sequence or missing blocks.

TIPP&SEE students were more precise & were less likely to leave out block names or important parameters.

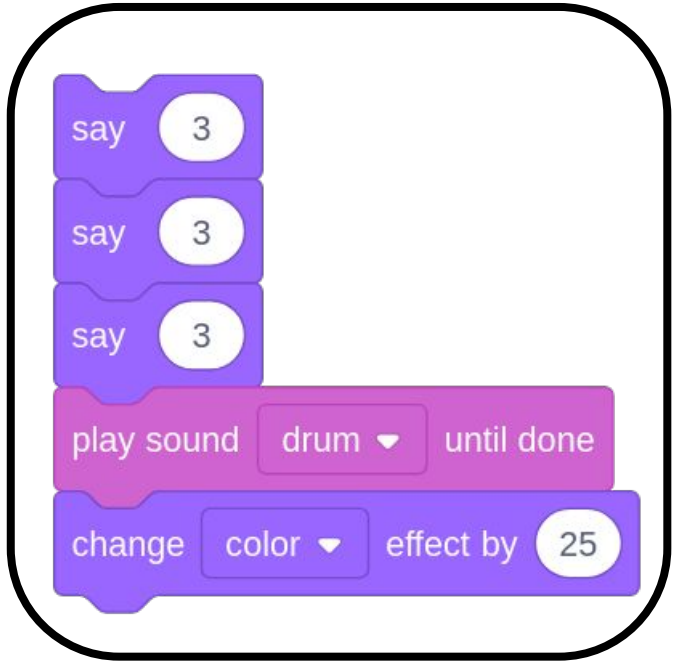
Students were asked to unroll a two-block loop, choosing from the inner blocks repeated 1-4 times.

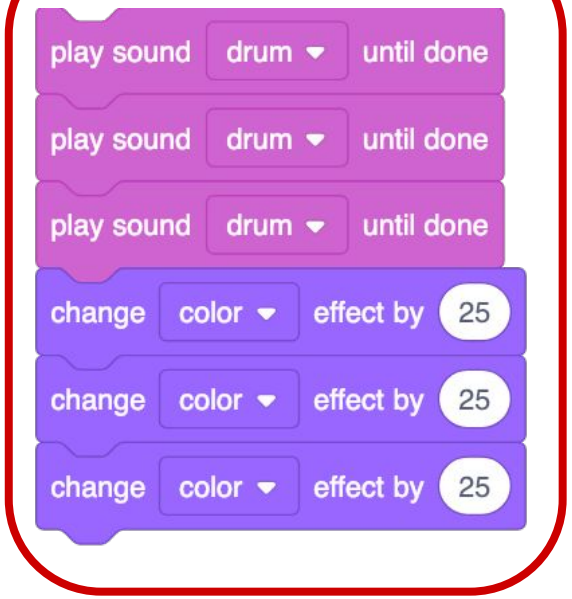


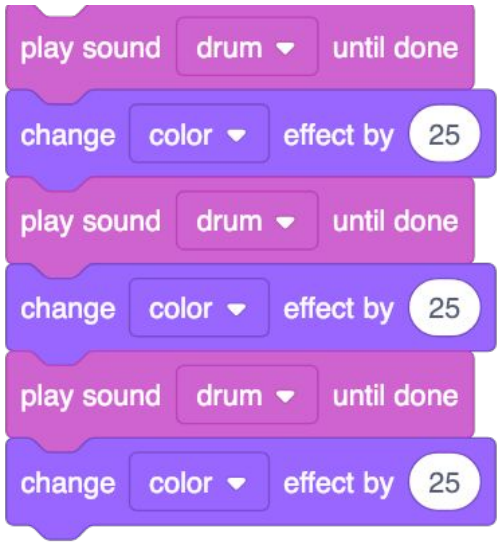




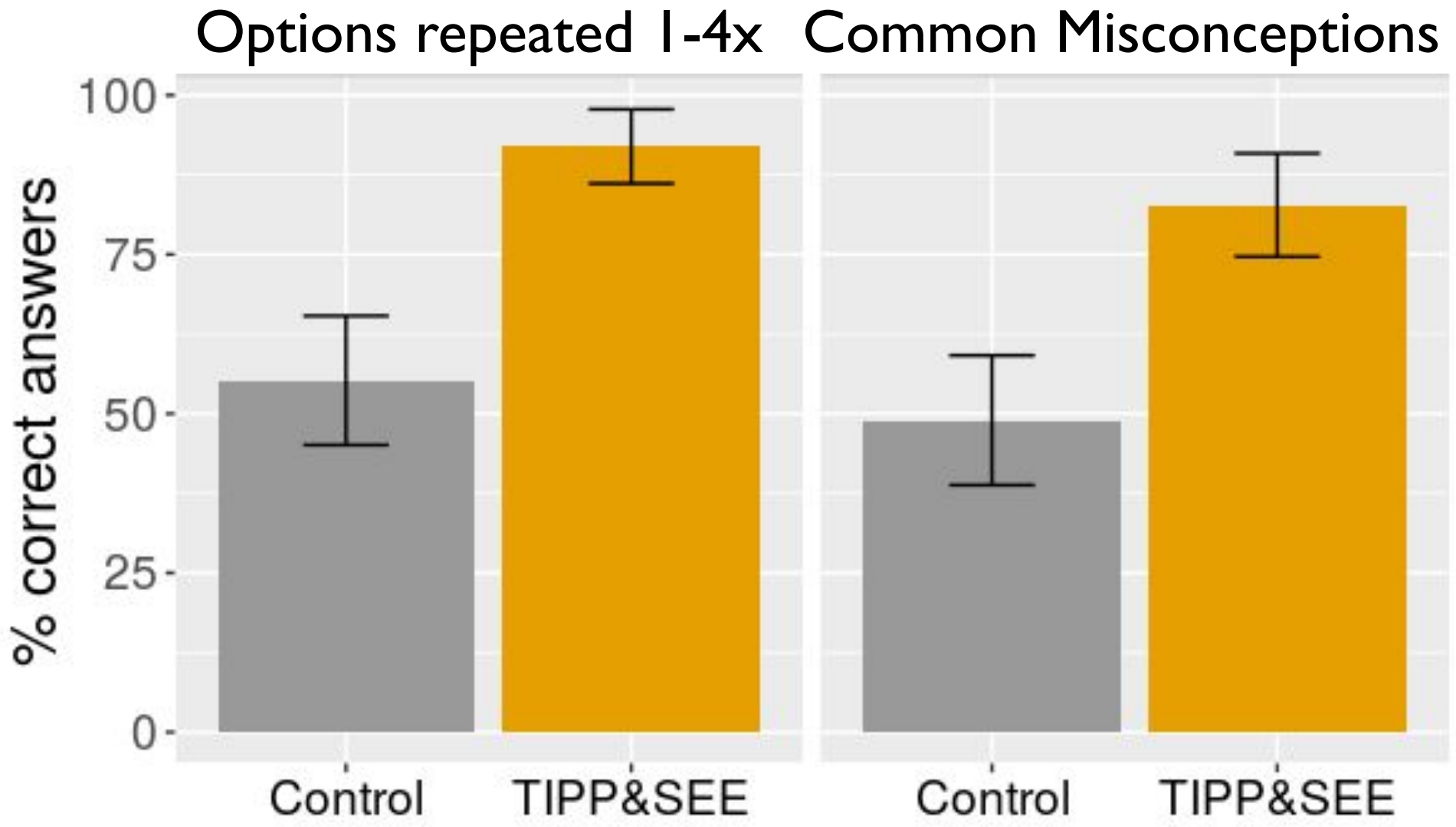
Students were asked to unroll loops, choosing from options that included common misconceptions.





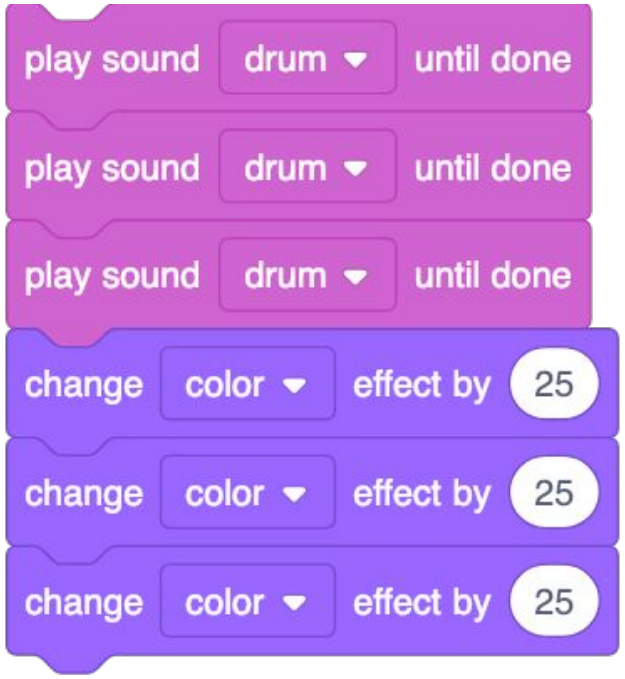


Control students displayed a more superficial understanding of loops.

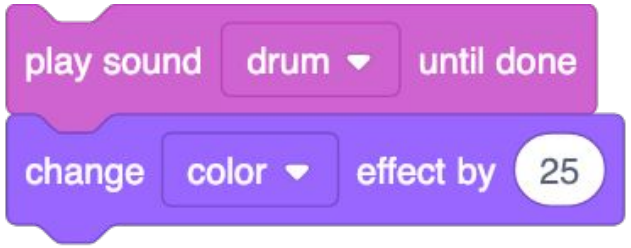


Control students displayed a more superficial understanding of loops.

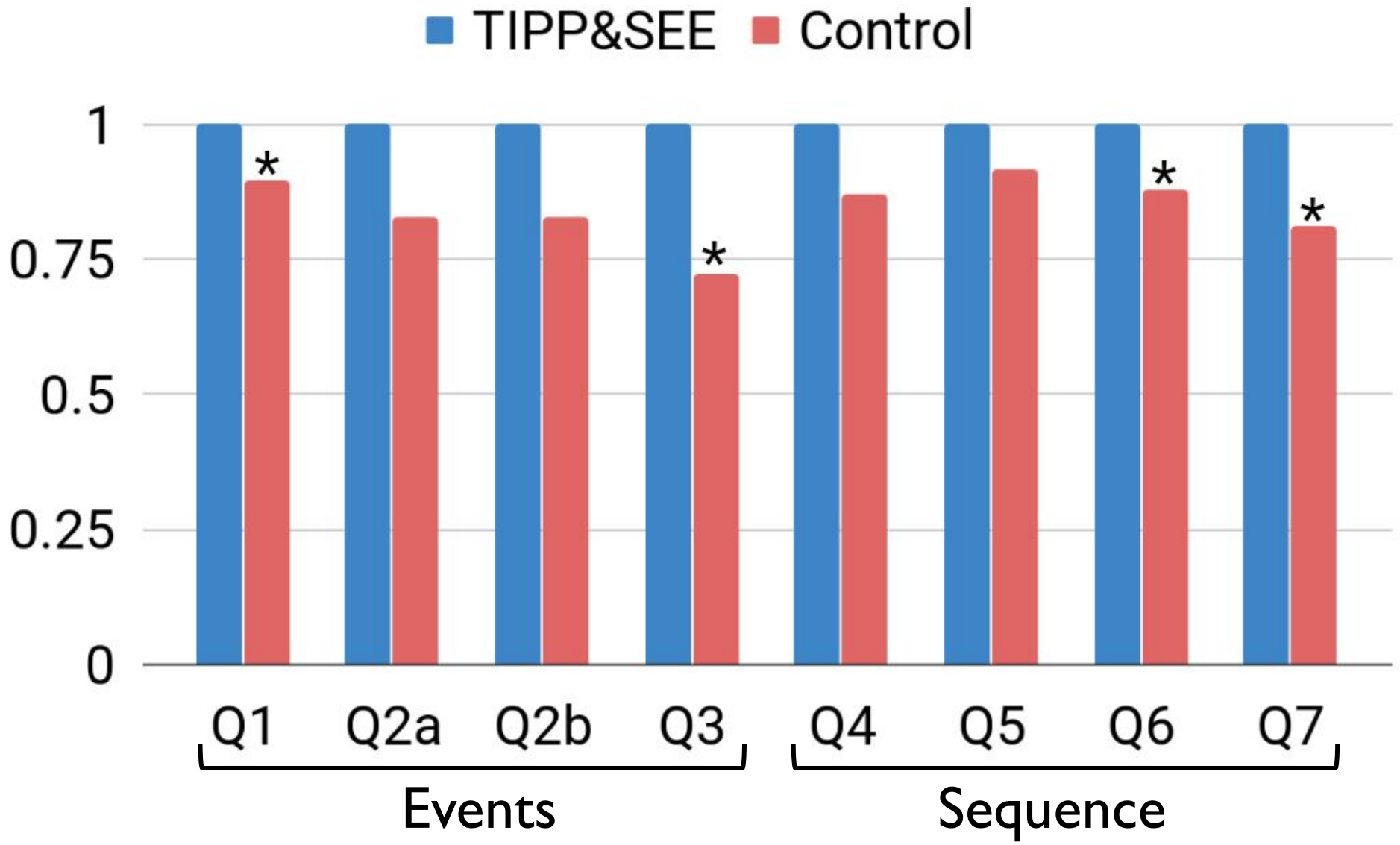
Most common mistake from TIPP&SEE students



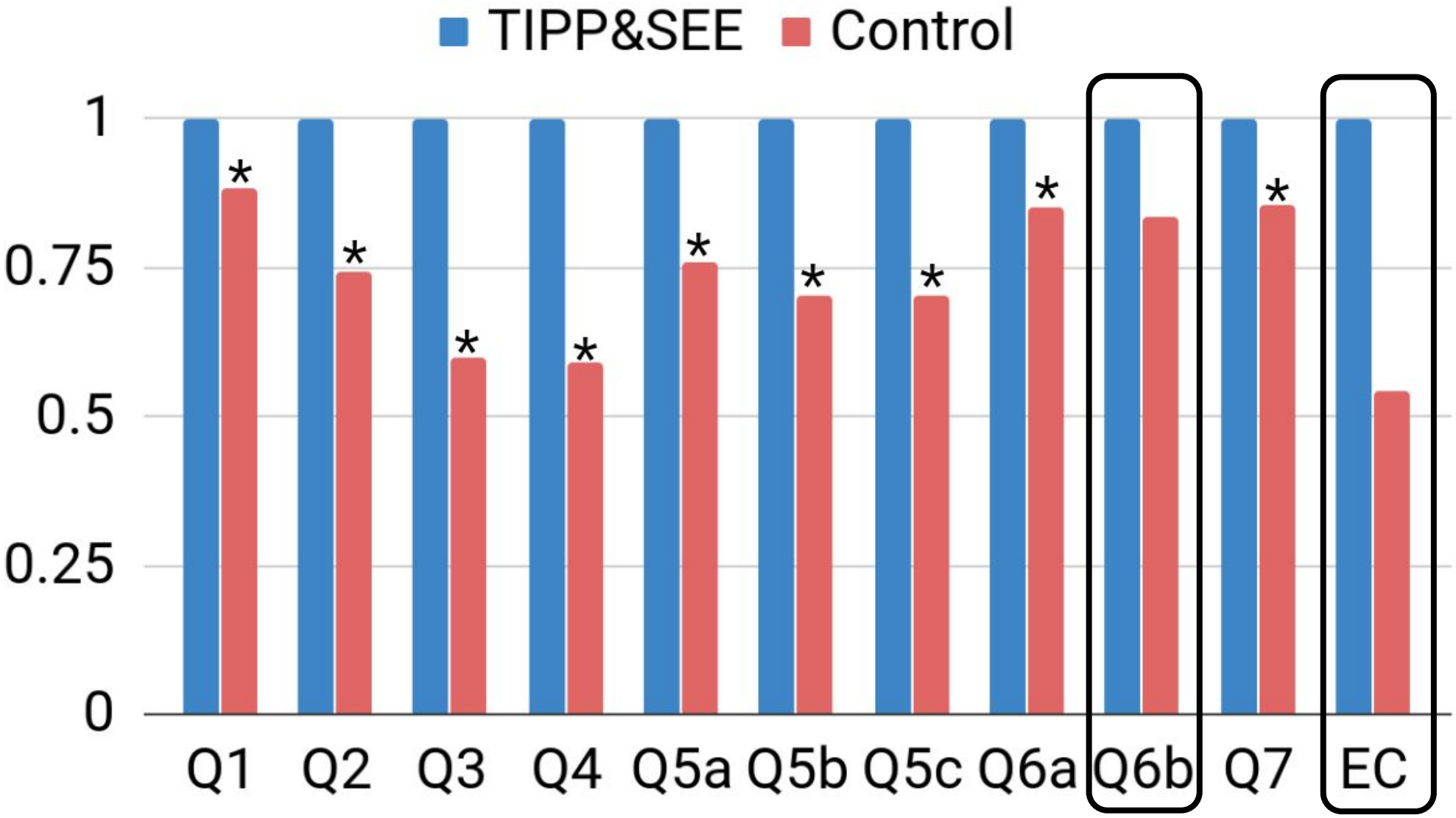
Most common mistake from control students



TIPP&SEE outperformed in more advanced questions on events & sequence.



TIPP&SEE outperformed in all but the most advanced questions on loops.



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Let's continue the conversation!
@SaladwithaC

Key Contributions:

TIPP&SEE scaffolds students in learn-by-example Scratch activities.

TIPP&SEE improved performance on questions of medium to high difficulty.