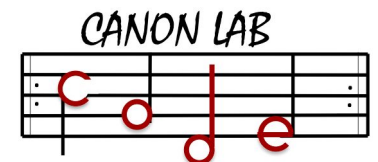# Supporting Diverse Learners in Computational Thinking with TIPP&SEE

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

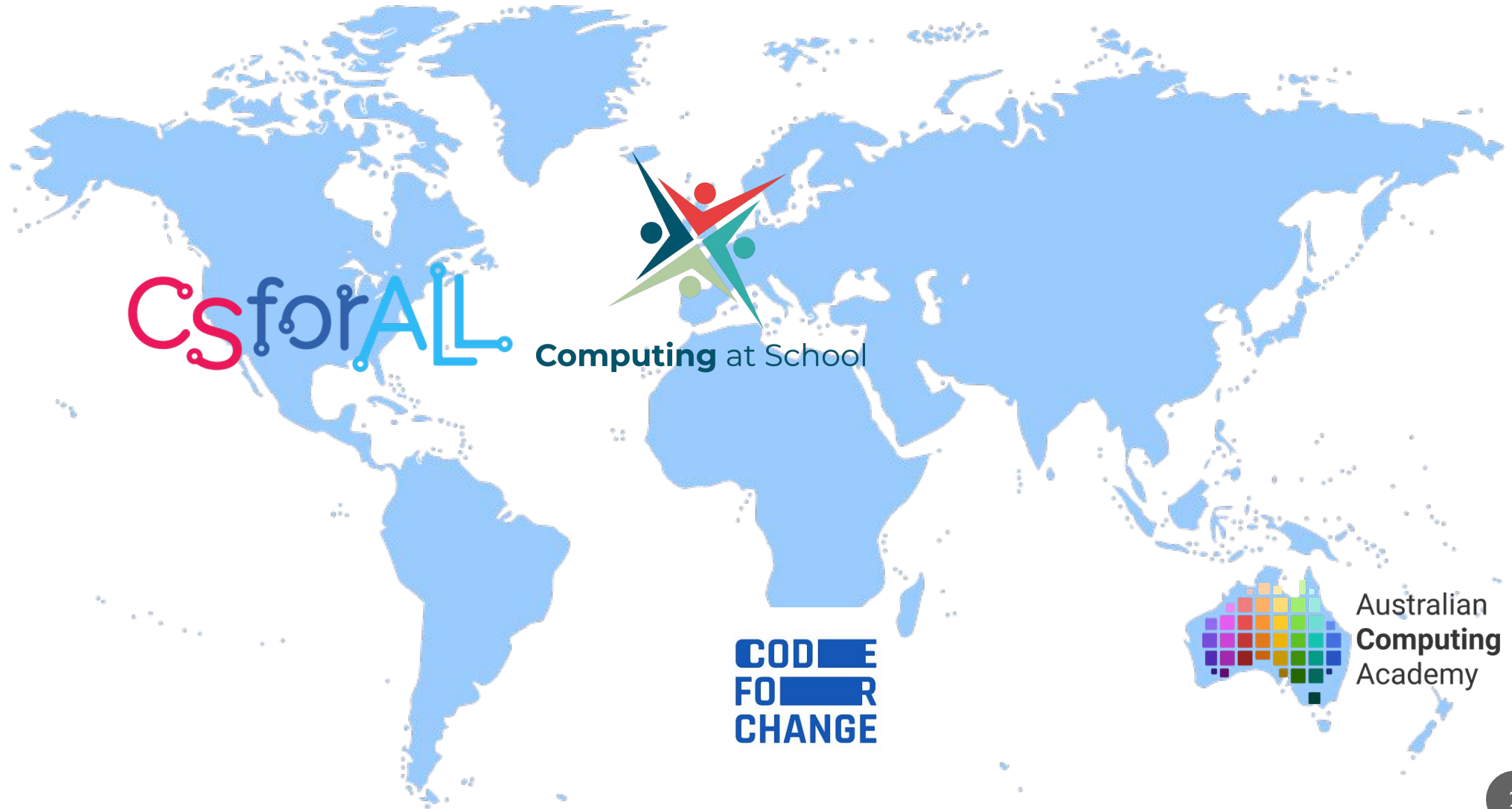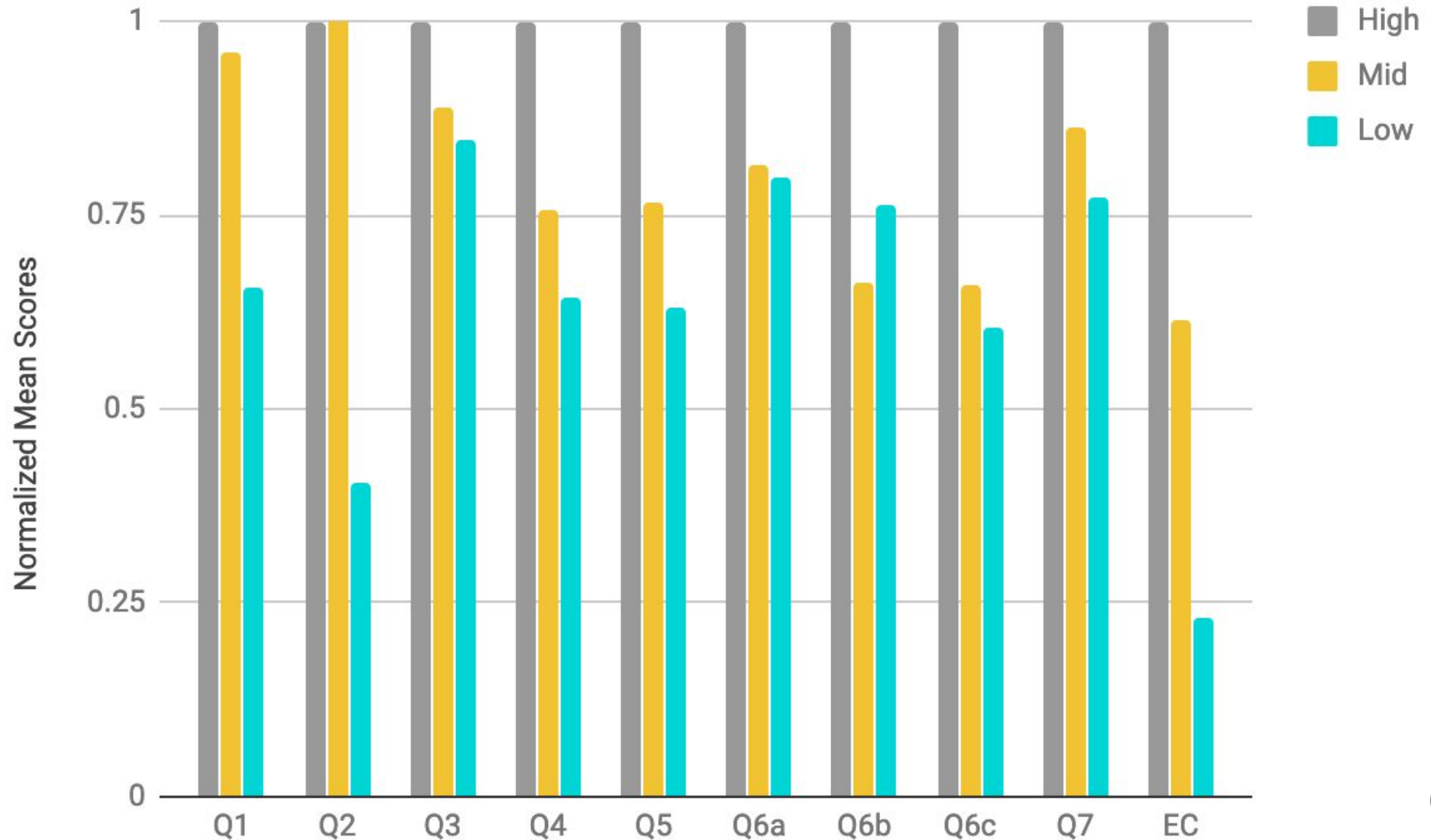University of Chicago & Texas State University

@SaladwithaC

CANON LAB

Computing for ANyONe:
Designing for equity and inclusion

Worldwide, CS instruction is expanding to younger ages.
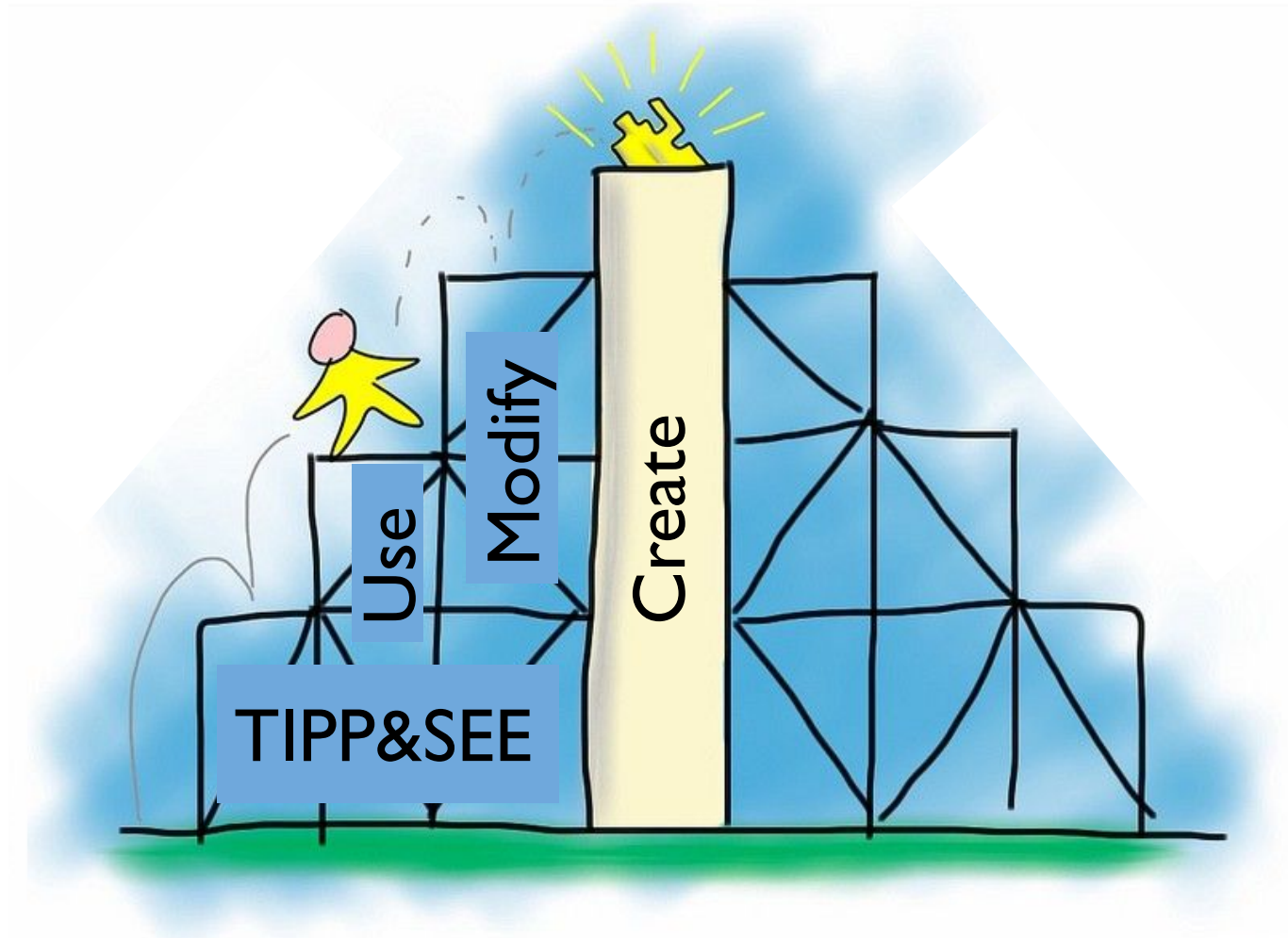
CS instruction may not work for everyone.

TIPP&SEE scaffolds learning in the Use → Modify step, narrowing the performance gap.

Title
I nstructions
Purpose
Play

Sprites
Events
Explore

Does TIPP&SEE support students with challenges?

- Students using TIPP&SEE performed better on computational thinking assessments. (Salac et al. 2020)
- Students using TIPP&SEE had more complex Scratch projects. (Franklin et al., 2020)

Outline

Motivation

Task

TIPP&SEE

Related Work

Theoretical Framework

Study Design

Results

Open-Ended Exploration or Direct Instruction?

Open-Ended Learning

+ Constructionism: Students learn best when expressing themselves (Harel & Papert, 1991)

- No guarantee of comprehension of underlying concepts (Biggs & Collis, 2014; Lee & Ko, 2015)

Direct Instruction

+ More immediate comprehension of underlying concepts

- Discouragement from future instruction (Webb et al, 2012)

Happy Medium:
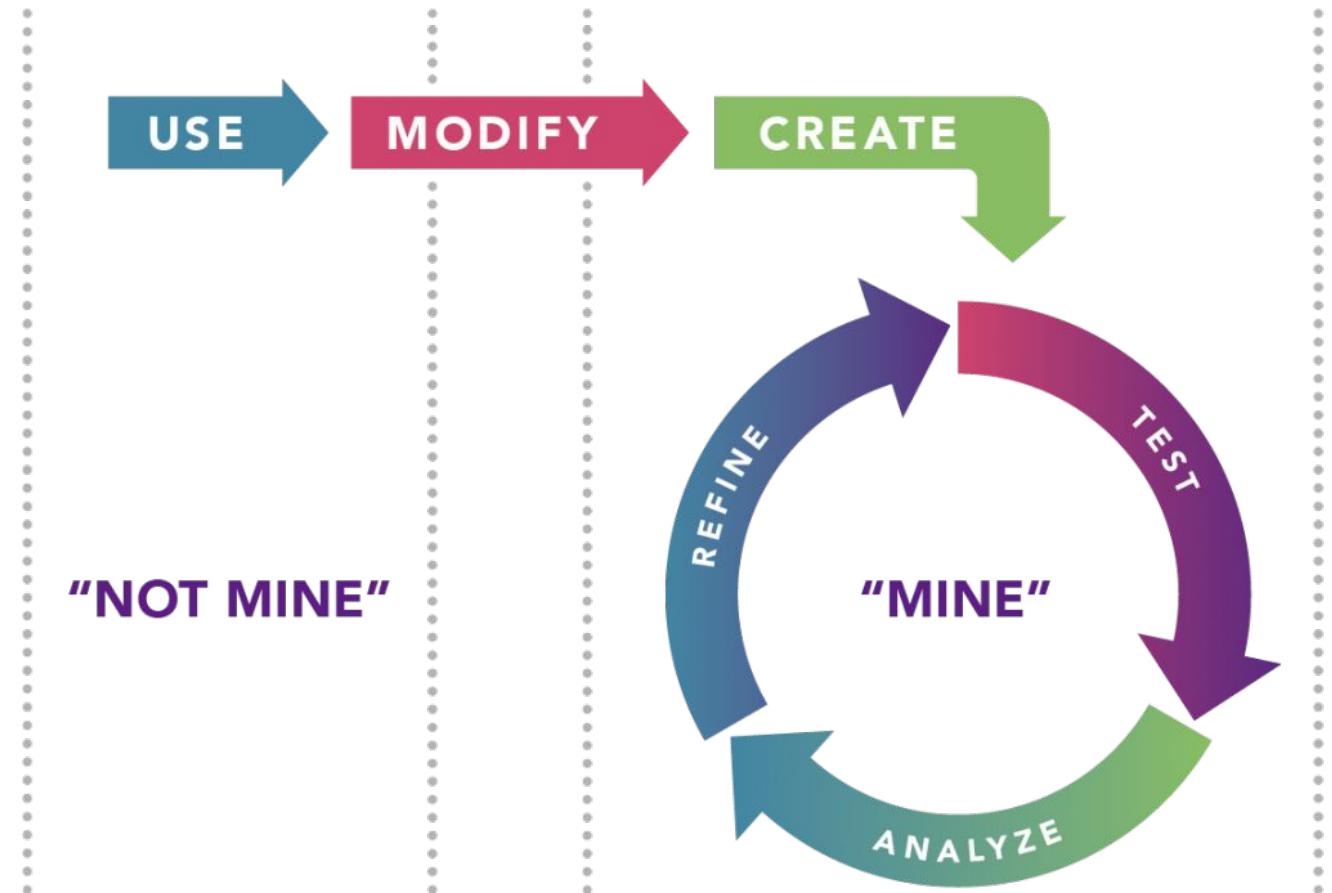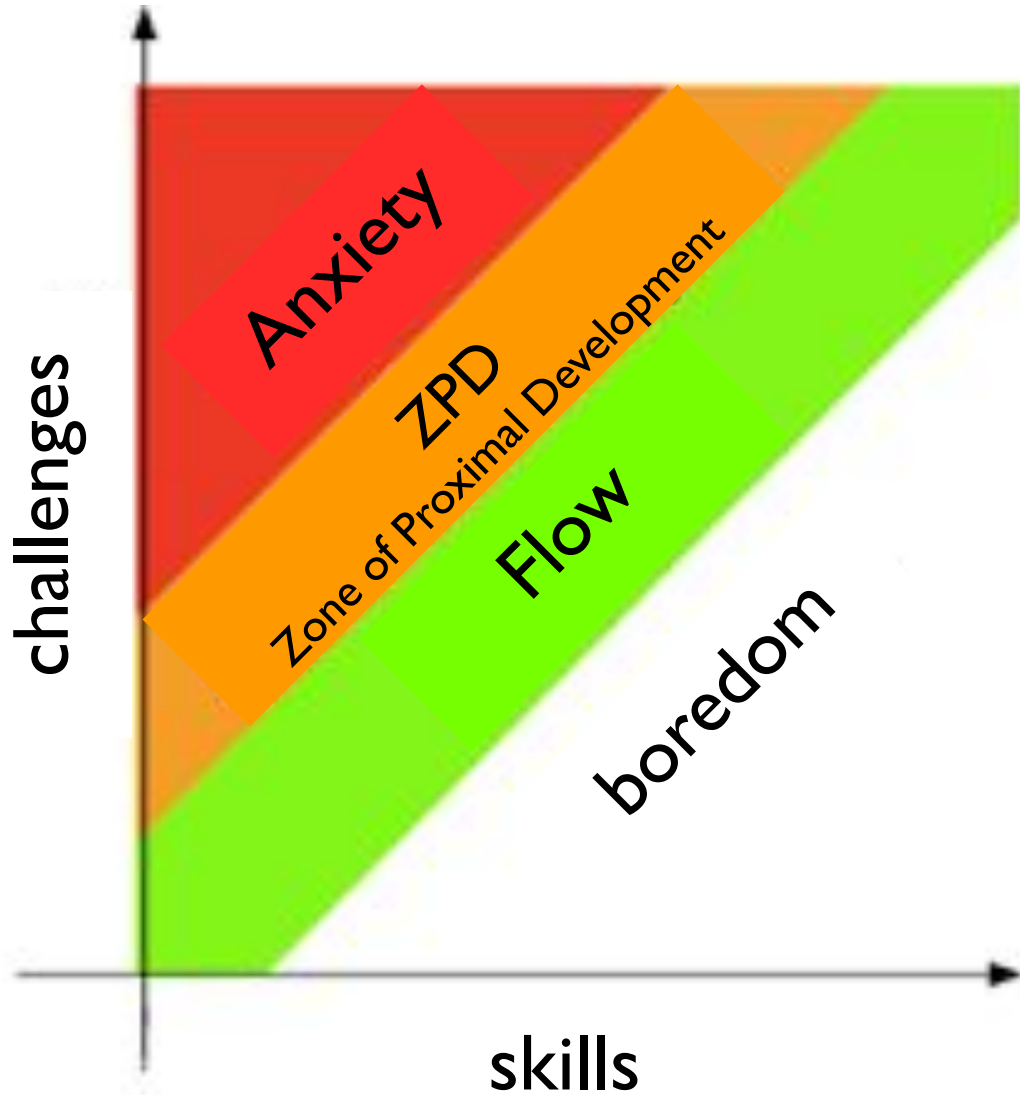# Zone of Proximal Flow & Use→Modify→Create

Image from Basawapatna et al.

CS instruction is not always equitable.

Opportunity: Informal CS Learning for All

- Lack of CS vocabulary hinders parents from finding opportunities.

  (DiSalvo et al., 2014)

Access: In-School Instruction for All

- Inequities in school support, demographics, math & literacy persist.

  (Century et al., 2020; Fancsali et al., 2018; Margolis et al., 2010, Salac et al., 2019)

Outcomes: Learning for All

- Goal of TIPP&SEE learning strategy

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Theories of metacognition guide our strategy design.

- Metacognition: Self-regulation & Motivation

- Expert learners are metacognitive & strategic

- Strategic learning is internal & covert

- Learning strategies make these implicit processes explicit

- Learning strategies enable a student to learn, solve problems, and to complete tasks independently

"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 🚩 ?

Catrina	Left	Middle	Right

2. Who talks when I press spacebar?

Catrina	Left	Middle	Right

"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?

change size by `100`   say `I am Grandpa John.` for `2` seconds   change size by `-100`

5. Which block makes the sprite smaller?

change size by `100`   say `I am Grandpa John.` for `2` seconds   change size by `-100`

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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.

- Cronbach's alpha was calculated for internal reliability.

Exploratory Factor Analysis to Match Questions to Concepts

	Remember	**Understand**
Scratch Basics	Events & Sequence Assessment: Q2 & Q3	---
Events	---	Events & Sequence Assessment: Q4a & Q4b
Sequence	---	Events & Sequence: Q6 & Q7b Loops: Q5a, b, c
Loops	---	Loops Assessment: Q1, Q2, Q4, Q5a, b, c

We identified students facing academic challenges.

- Economic challenges identified through free or reduced lunch

- Disabilities & Limited English Proficiency identified through district-provided demographic data

- Below Grade Level Reading and Math proficiency identified through state testing

Scores were analyzed by student category.

- Aligned Rank Transform on data for non-parametric factorial analyses prior to ANOVA F-test

- Non-parametric due to small sample sizes

- Type III sum of squares for unequal sample sizes

- Estimated marginal means for post-hoc comparisons

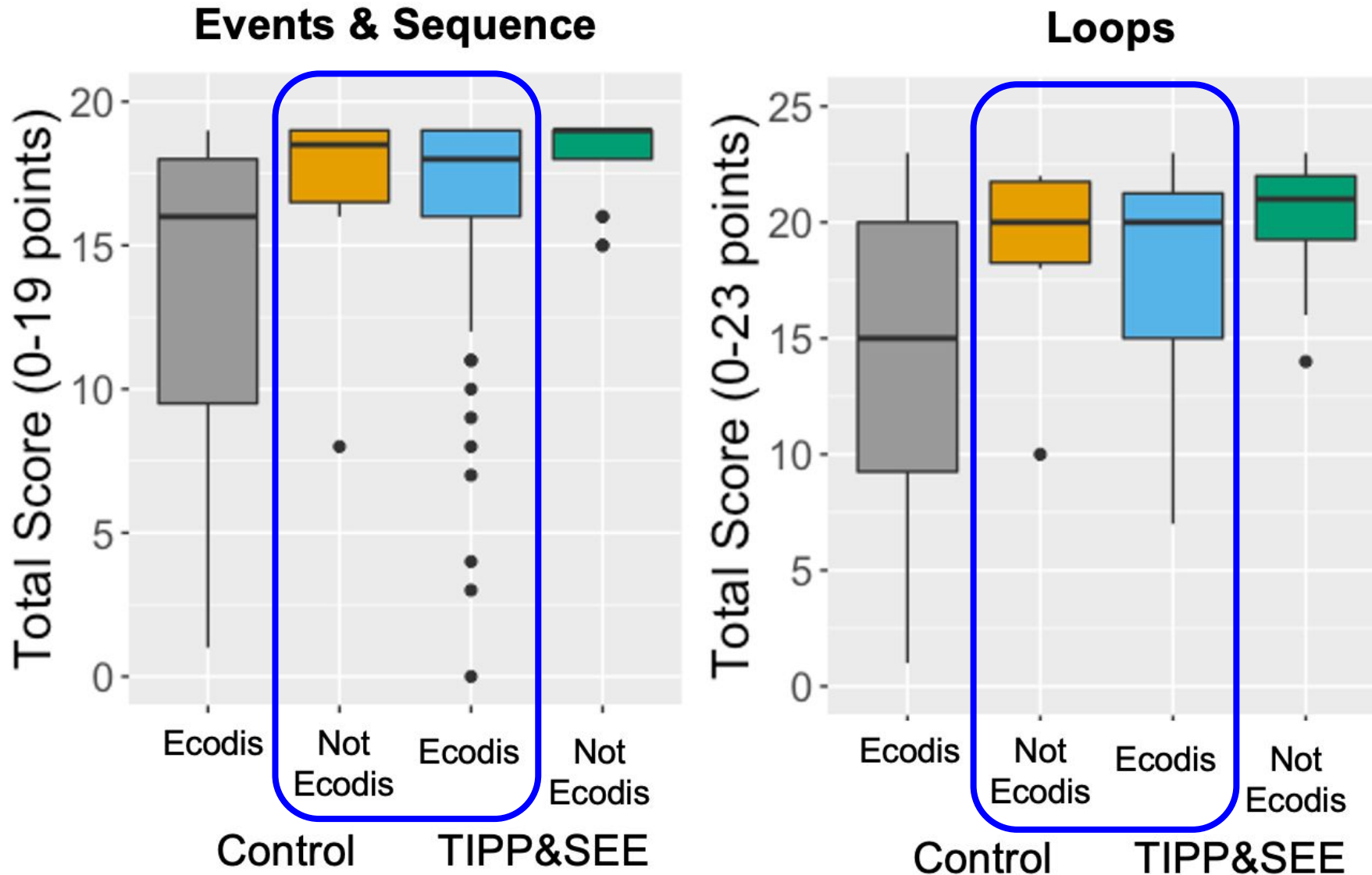# Outline

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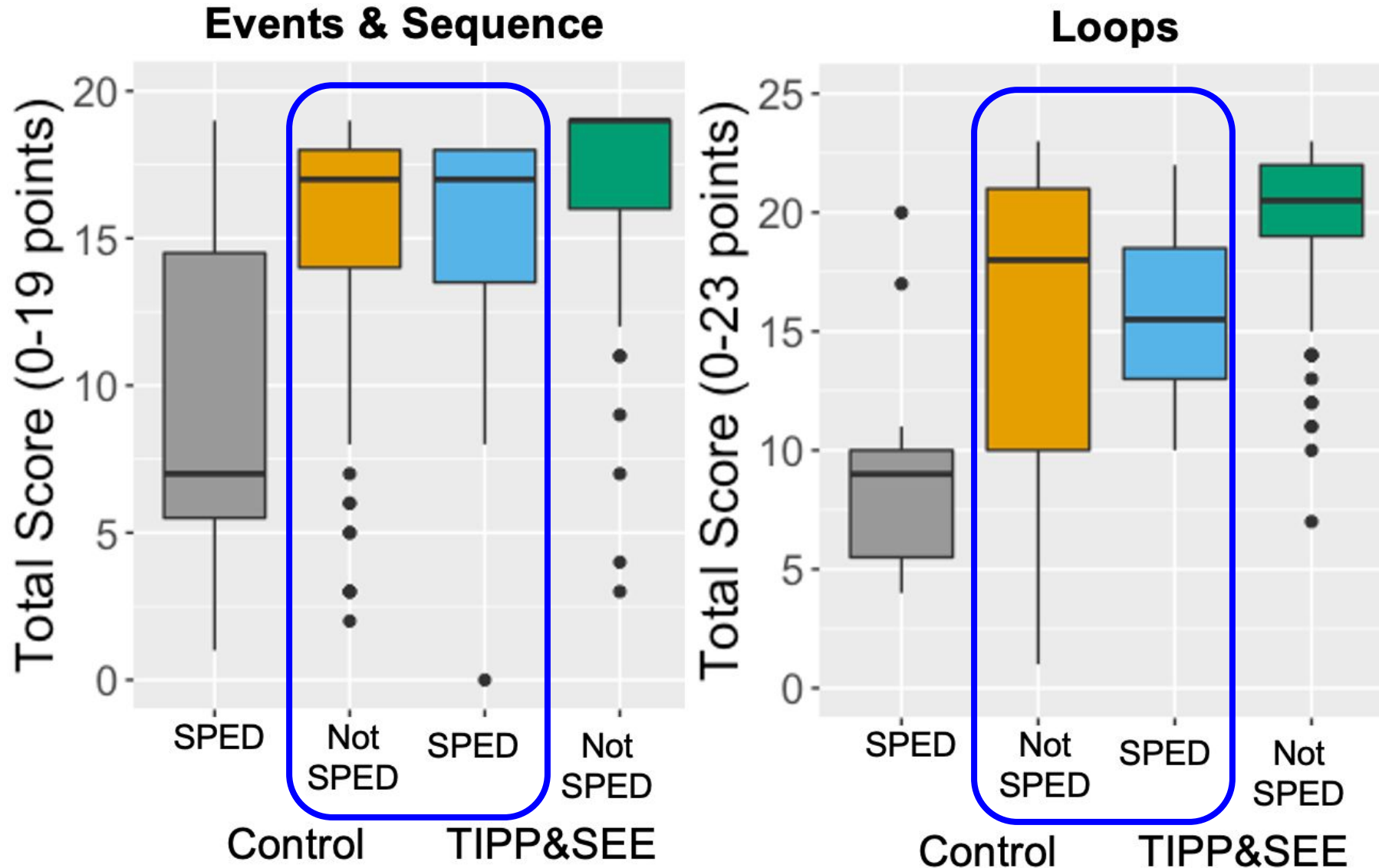TIPP&SEE

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Gap between Students with & without Challenges Narrowed when using TIPP&SEE.
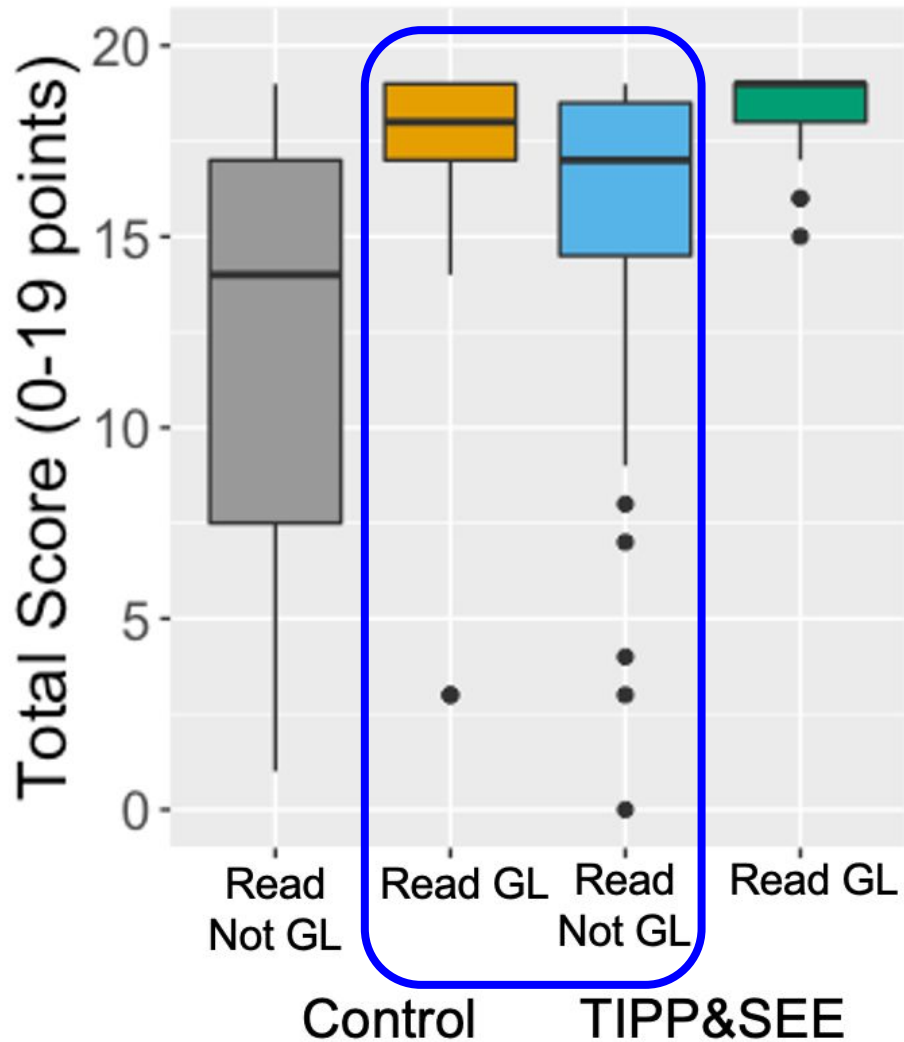

Students with Economic Disadvantages

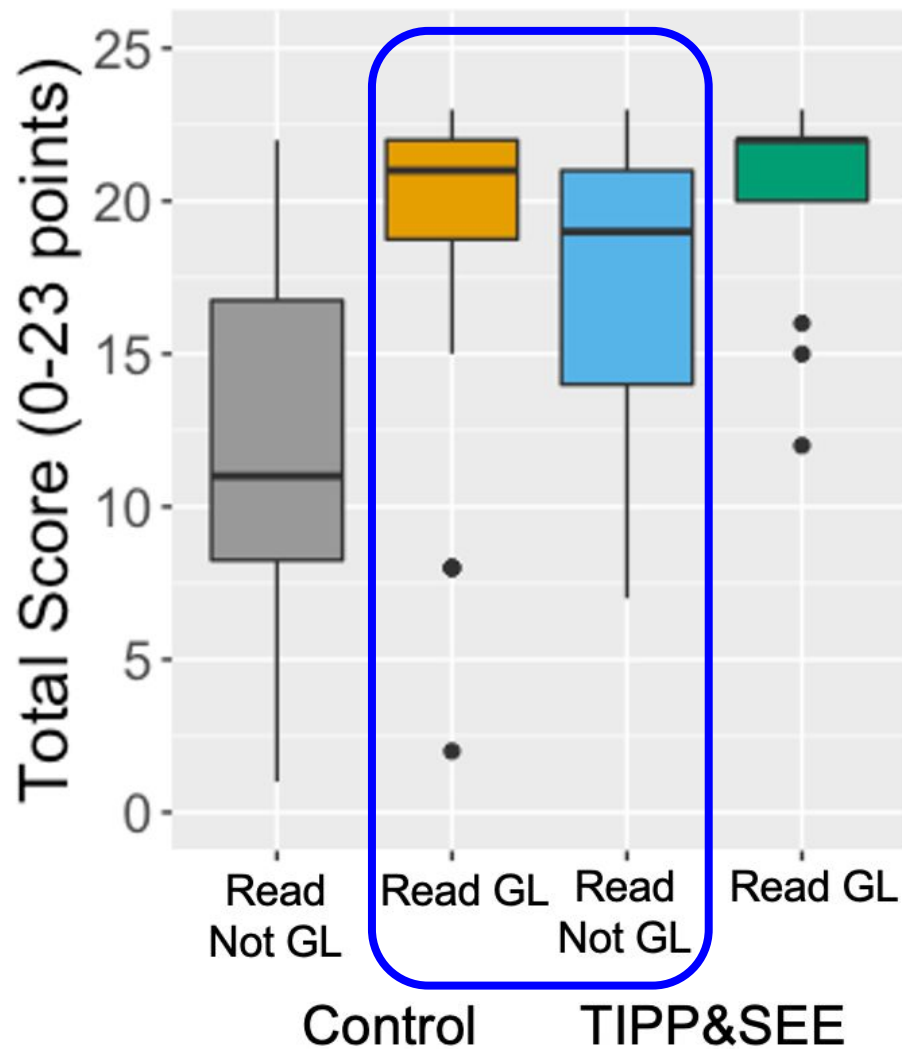# Gap between Students with & without Challenges Narrowed when using TIPP&SEE.

Students with Disabilities

Gap between Students with & without Challenges Narrowed when using TIPP&SEE.
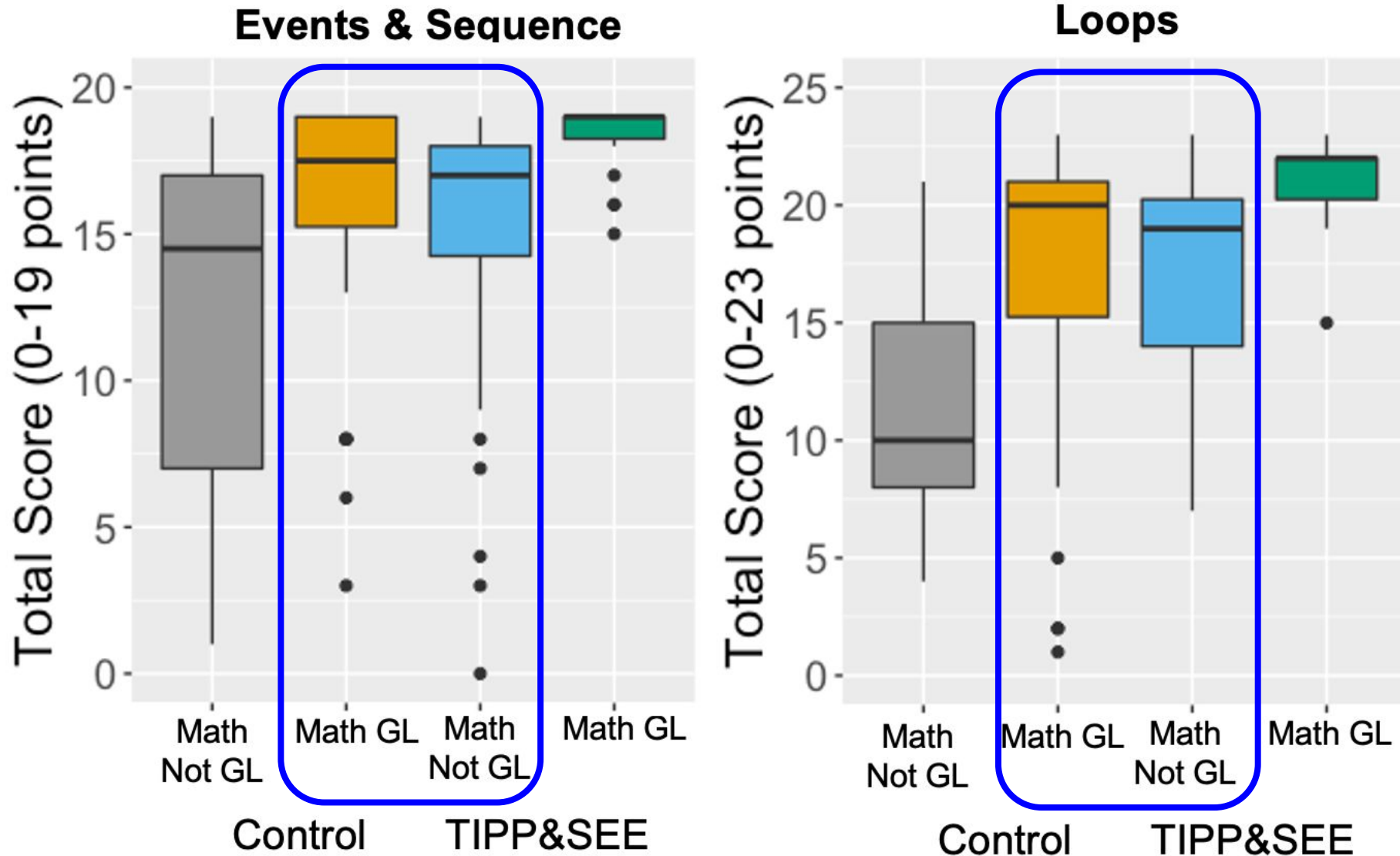

Events & Sequence
Total Score (0-19 points)

Loops
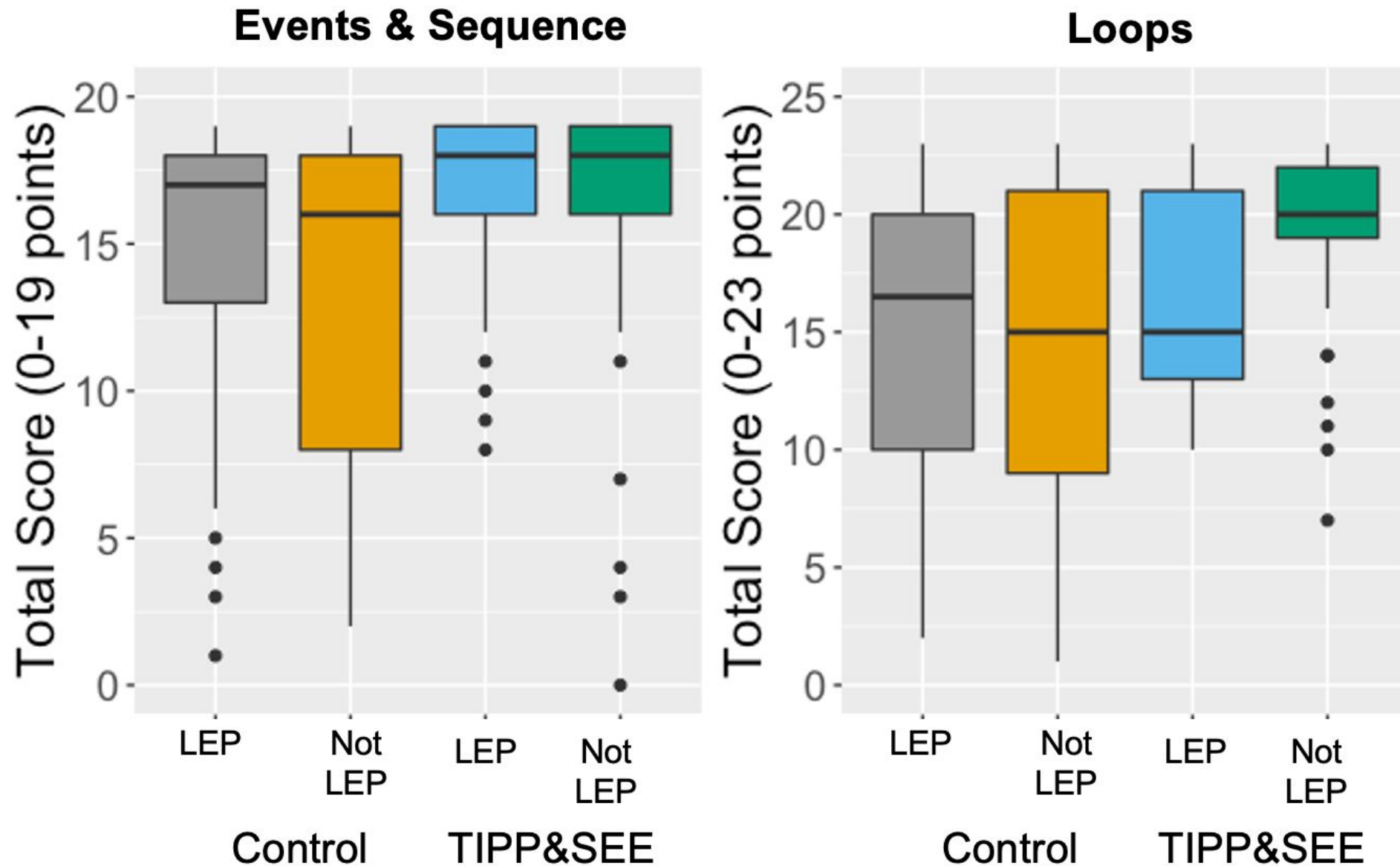Total Score (0-23 points)

Students Reading Below Grade Level

Gap between Students with & without Challenges Narrowed when using TIPP&SEE.

Students with Below Grade Level Proficiency in Math

Only exception to the trend was multilingual learners.

We can't tell (yet) if TIPP&SEE supports some concepts better than others.

- Bilingual support was sufficient for multilingual learners.

- Reading proficiency was associated with Events questions → Maybe it's a foundational skill for programming?

- Mixed results for other student categories and CT concepts

- Future Work: More questions for each CT concept & more advanced CT concepts

Supporting Diverse Learners in Computational Thinking with TIPP&SEE

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Key Contributions

- All students performed better when using TIPP&SEE

- The gap between students with and without academic challenges was narrowed with TIPP&SEE.

- Further research is needed to identify which concepts are/aren't served by TIPP&SEE.