



Carnegie Mellon University

This material is based upon work supported by the National Science Foundation under Award No. 2418655 and No. 2349558.

Investigating the Efficacy of Mastery-Based Tests in Fostering Effective Self-Regulated Learning Behaviors

Joyce Gill^{1, 2}, Michael W. Asher², Paulo F. Carvalho²
Grinnell College¹, Carnegie Mellon University School of Computer Science²



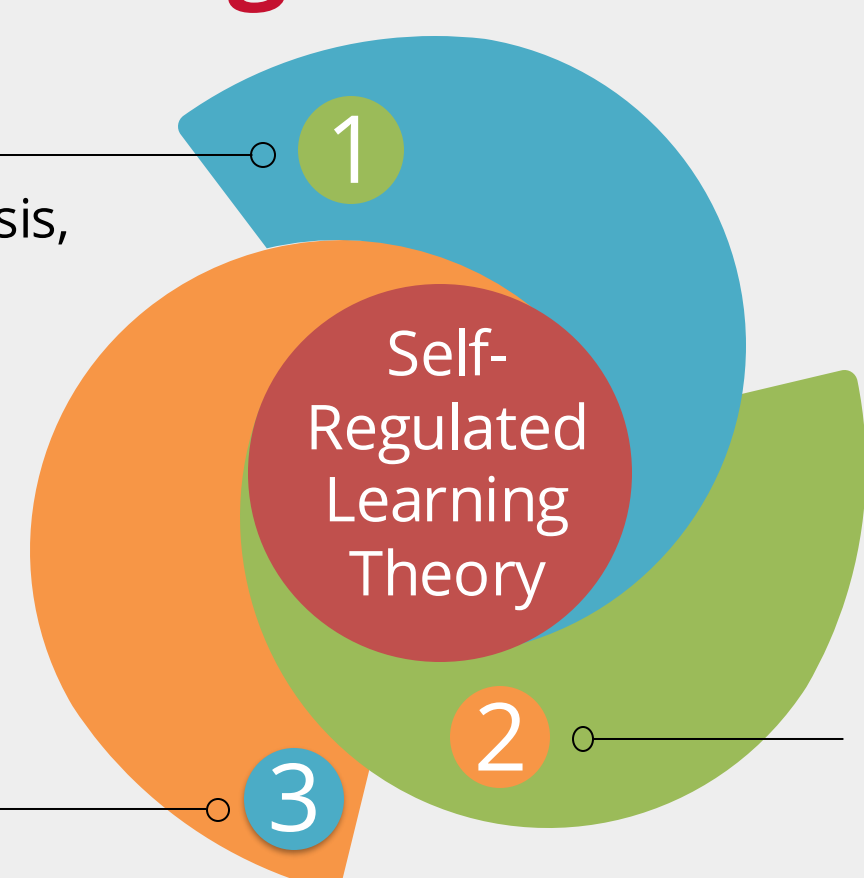
Human-Computer Interaction Institute



The Cycle of Self-Regulated Learning

Planning

Goal-Setting, Task Analysis, Strategic Planning



Performance

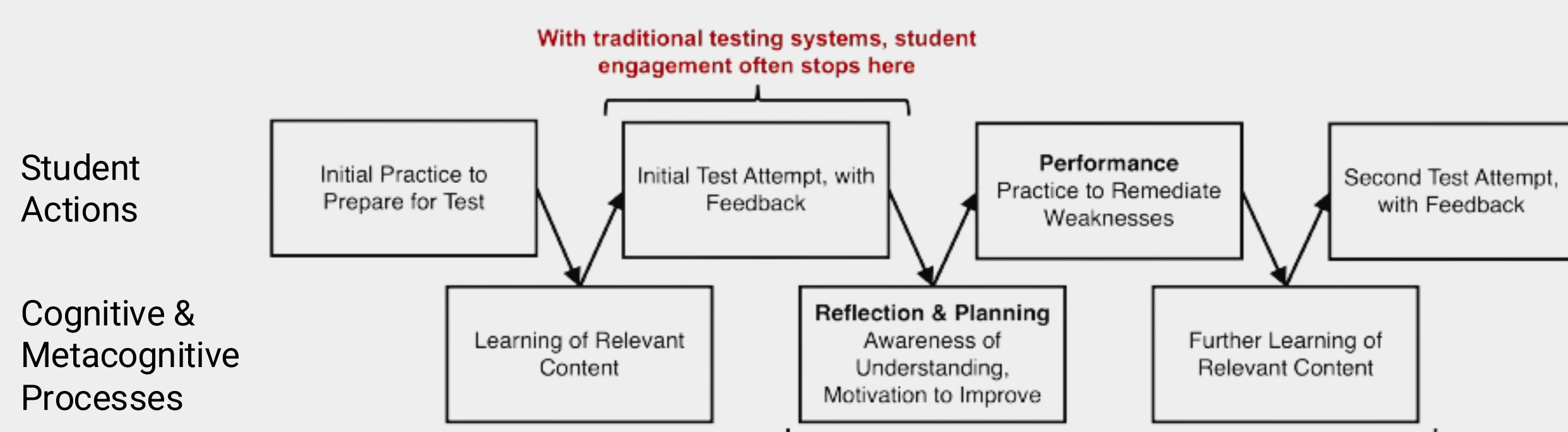
Execute Plan, Practice, Learn

Reflection

Self-Judgement, Evaluate, Adapt

(Zimmerman, 2002).

Mastery-Based Testing Model



(Asher, 2025).

Problem:

Novice learners struggle with self-regulated learning.

(Arakawa et al., 2021).

Tool:

Mastery-Based Tests (MBTs) show promise in intro CS courses.

(Sindre & Hansen, 2024).

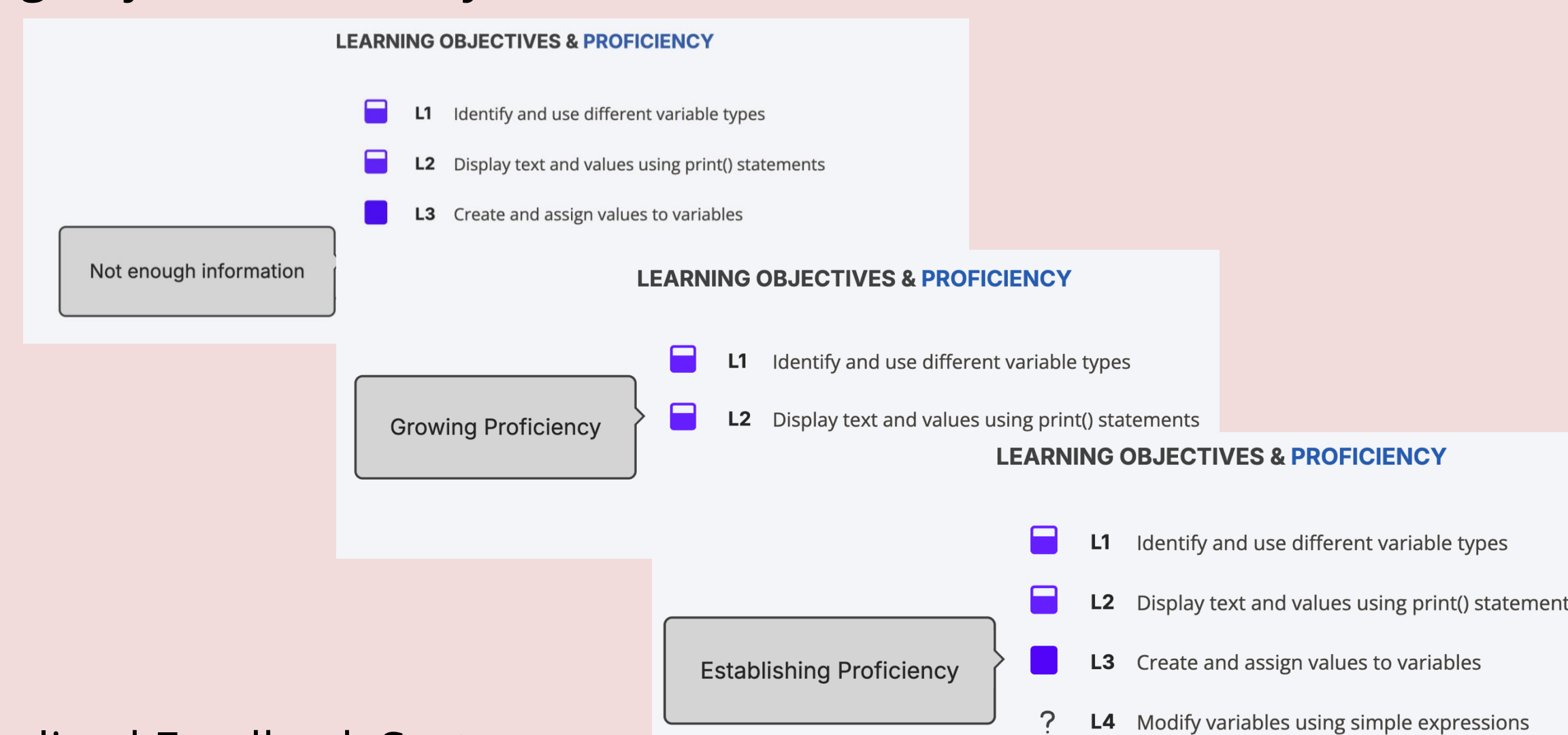
Potential Solution: Use MBTs as an external metacognitive scaffold to help students foster efficient self-regulated learning behaviors.

Predicted Outcome:

- (1) Study more efficiently by focusing on difficult topics.
- (2) Achieve higher post-test scores.
- (3) Demonstrate more accurate metacognitive judgment.

Learning Module: "Principles of Computation: Introduction to Programming in Python"

Learning Objectives Mastery Bucket



Personalized Feedback System

Write a Python print() statement that displays the message: "5000 Forbes Ave"

```
print(5000 Forbes Ave)
```

Submit

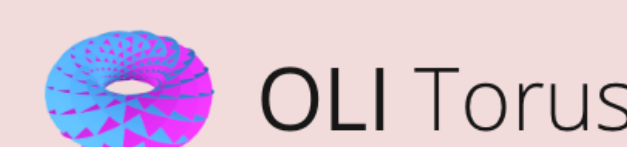
Incorrect. The correct answer is `print("5000 Forbes Ave")`. This question was testing Learning Objective 2: Display text and values using print() statements. Refer back to Displaying Text and Values with `print()` from Page 2: Interacting with the Python Interpreter.

Practice Questions By Learning Objective

Learning Objective #3: Create and assign values to variables

Create a variable named "age" and assign it the integer value 21.

Submit



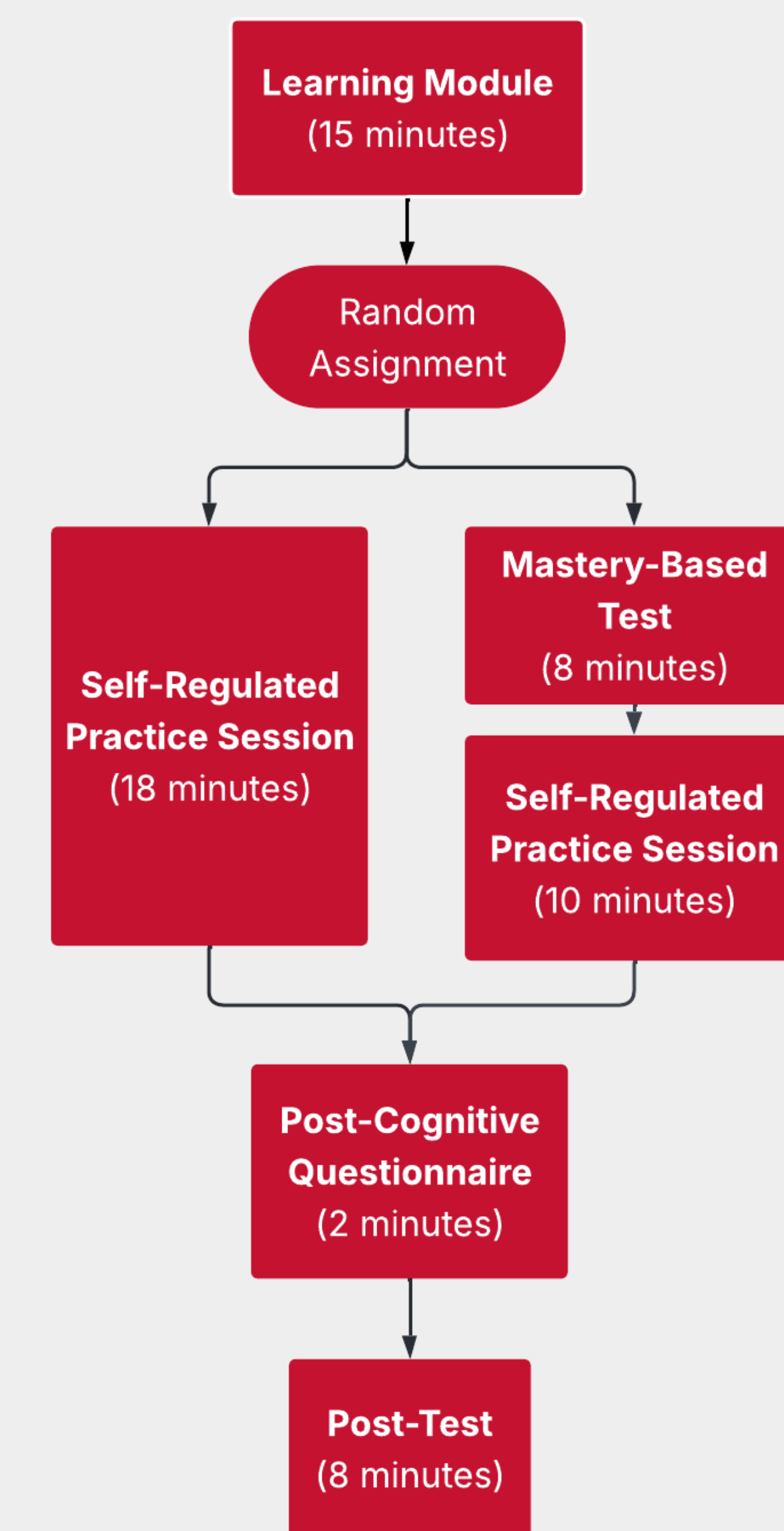
Control Group



Experimental Group

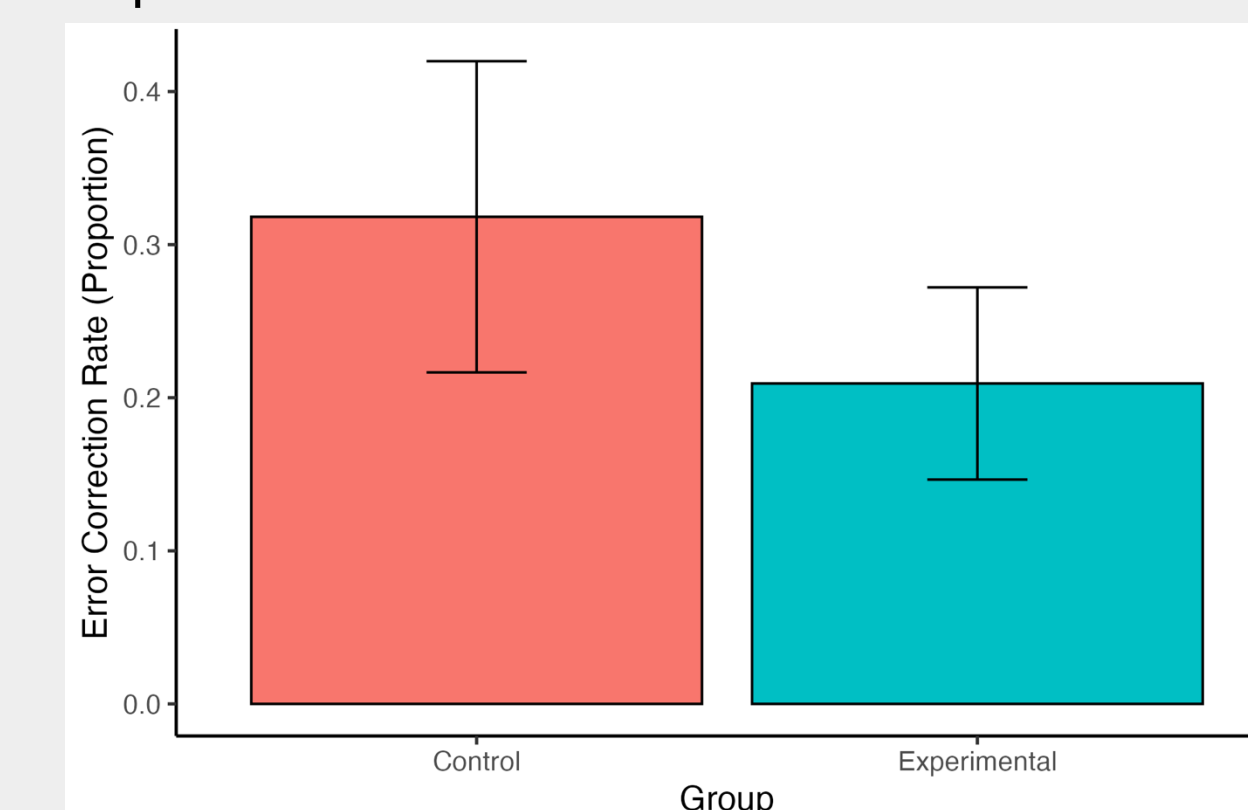
Experimental Study Design

Between-Subjects Design (N = 6)

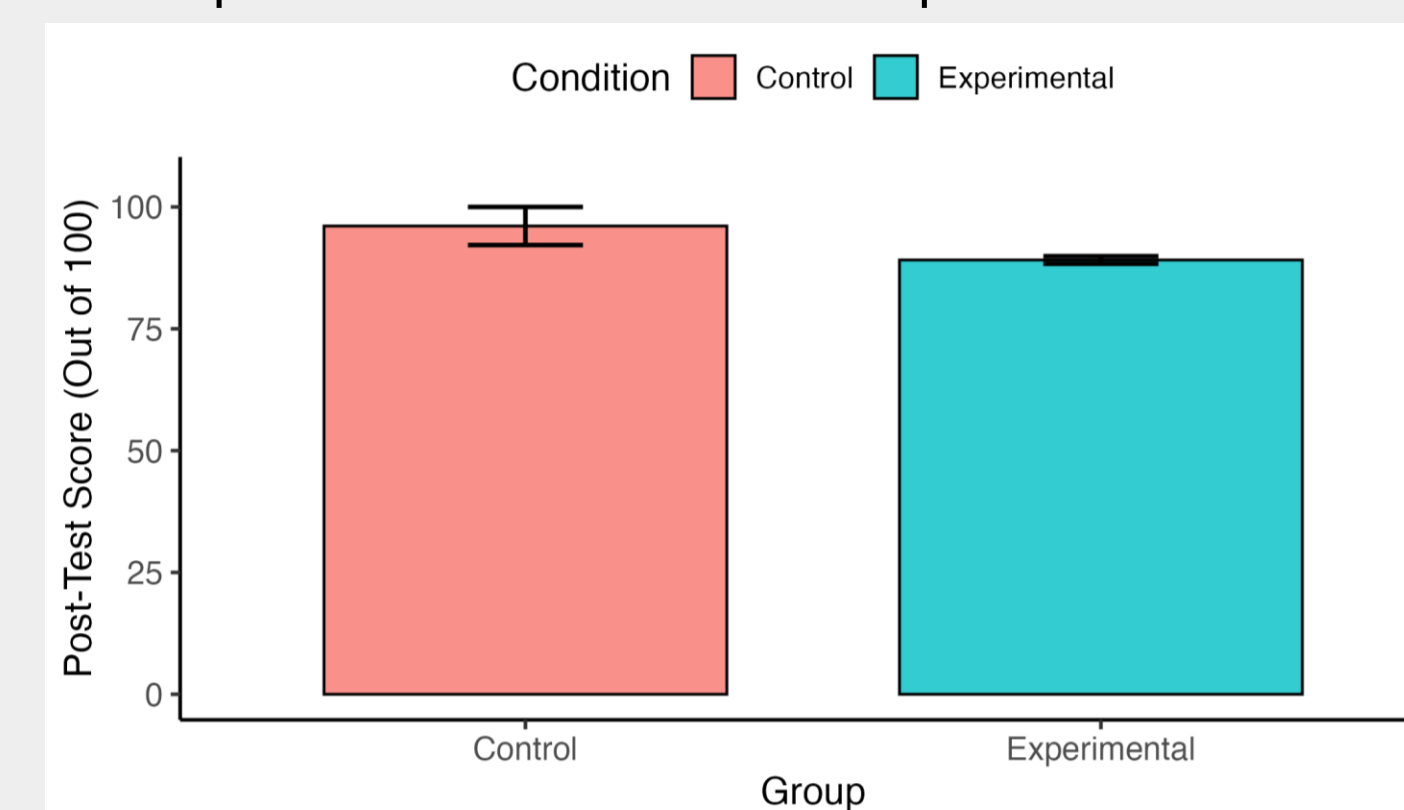


Prolific Study Results

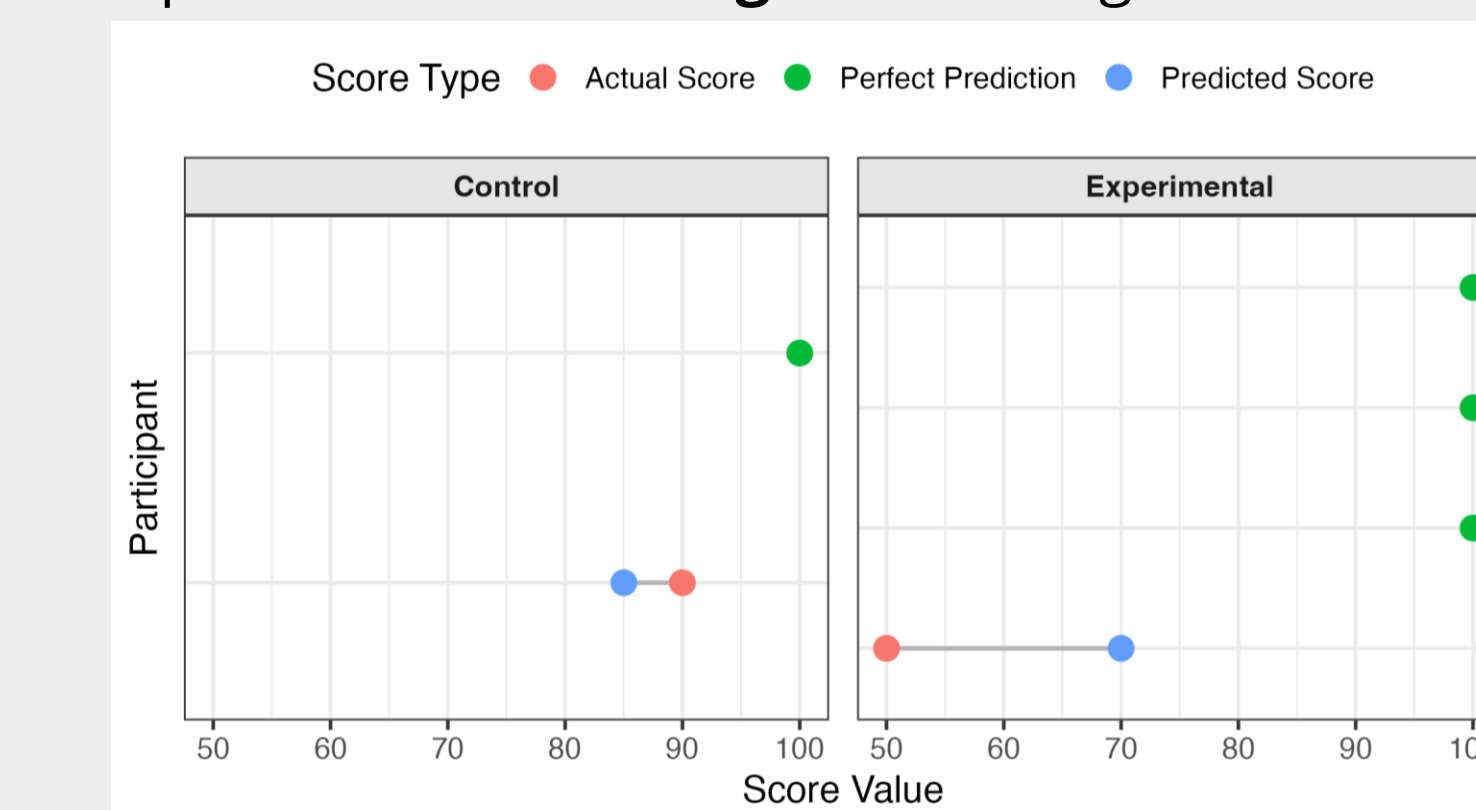
Experimental shows **lower** error correction rate



Experimental shows **lower** post-test scores



Experimental shows **higher** metacognitive accuracy



“

I used the test questions that I did not have a clue on.

- User #1 from the Experimental Group

“

I knew I needed to work on understanding modifying variables based on the feedback from the test.

- User #4 from the Experimental Group

Future Work

- Conduct a longitudinal study in an authentic classroom setting over an academic semester with a larger sample size
- Evaluate the long-term effects of the intervention on student learning behaviors and outcomes



How does externally scaffolding metacognition through MBTs reshape students' self-regulated learning behaviors?



Does this, in turn, lead to better learning outcomes?



How does this affect students' metacognitive understanding of their own learning?