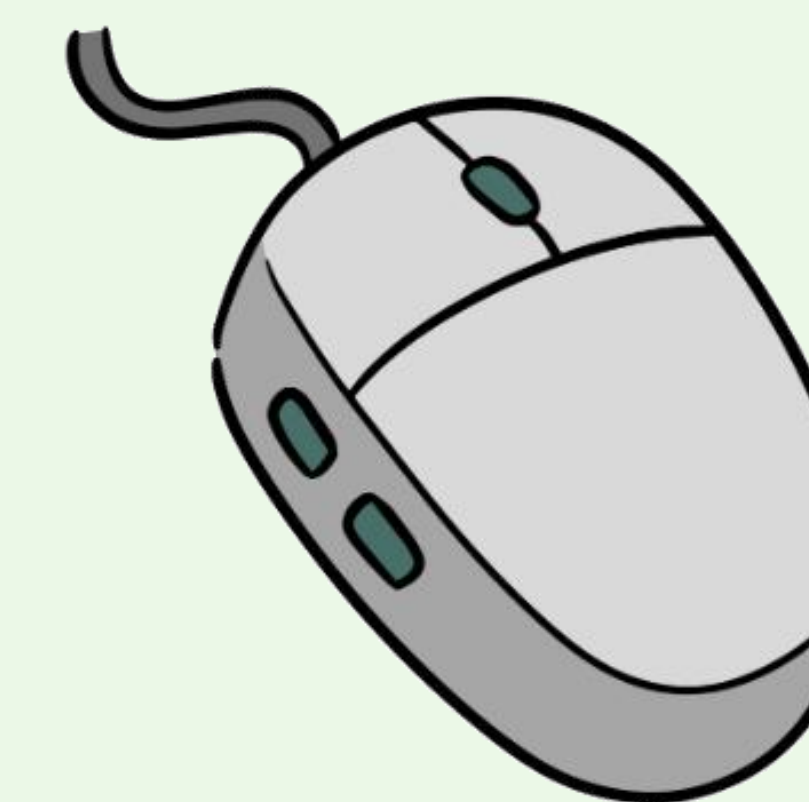




# Analyzing Computational Thinking Gameplay

## Identifying Struggles and the Role of Experience



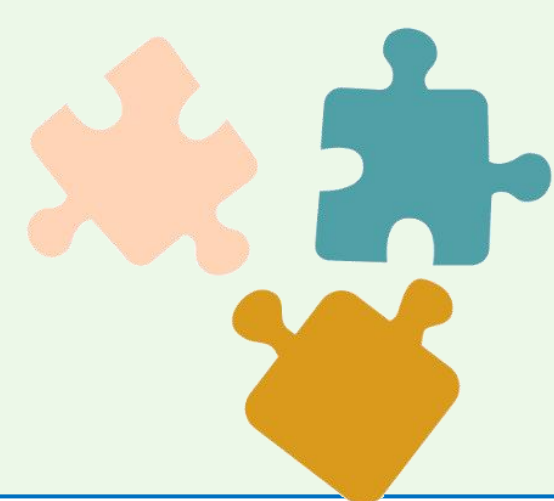
### Introduction

- Computational Thinking (CT) is an essential skill for the digital world, but students often struggle with abstraction, debugging, and spatial reasoning.
- Traditional assessments may miss real-time struggles, so we used multimodal approaches, combining gameplay analysis, physiological data, and student reflections to get deeper insight.
- This study analyzes novice and experienced players in a CT game, Fox and Field, to identify struggle patterns and inform better scaffolding for learning.

### Methods

#### Participants

- 15 participants (10 novice and 5 experienced programmers)
- Coding experience was captured through a pre-game survey.



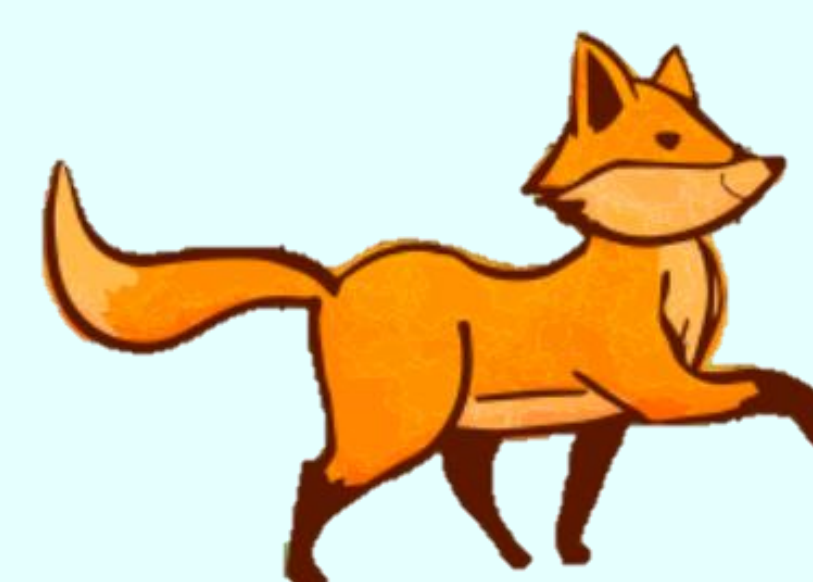
#### Gameplay Level 412



#### Analysis

- Gameplay sessions (including facial expressions) were video recorded
- Each code execution served as the unit of analysis
- Two coders performed content analysis (Cohen's kappa = 0.86)
- Heart rate continuously measured via a pulse oximeter, sampling every 116 milliseconds and synchronized with video timestamps to pinpoint struggle moments
- Post-level pop-up open-ended question, "How did you solve the level?" captured players' strategies for triangulation.
- At level 412, players are already familiar with the basic mechanics from previous levels, and it provides variations to assess different aspects (i.e., debugging, using non-right-angle).

### What are students' struggle points and misconceptions in the CT game?



#### Concept of Degree Angle

Players have difficulty grasping that degrees measure rotation ( $360^\circ$  = full circle) and choosing the right angle.

5/15 participants

"It was more difficult to find the angle to get to the house, so I kept guessing until I could get to the right spot."

#### Fox Direction

Players struggle to imagine the game from the fox's perspective, leading to wrong directional choices.

8/15 participants

3/15 participants struggled more than once

#### Debugging

Players find it hard to pinpoint and correct mistakes in their code, often opting to restart rather than identify the exact problem.

5/15 participants

Luna Time Spent 20+ mins Attempt 40 attempts Heart Rate 70 → 100 bpm

"I thought the problem was the angle, and I was traveling from lily pads to the house. The actual problem was the mushroom. I did not notice that until..."

### How do these struggles vary by programming experience?

#### Overall

On average, the experienced programmers performed better than novice programmers.

8.9min (SD = 8.1)  
12.3 attempts (SD = 19.4)  
All used non-right angle



4.8min (SD = 1.9)  
3.4 attempt (SD = 3.4)  
4/5 used right angle

#### Concept of Degree Angle

536.1s (SD = 484.5)  
13.9 attempts (SD = 19.4)  
110-20 bpm



291.8s (SD = 117.7)  
3.2 attempts (SD = 3.8)  
No sig. change

#### Fox Direction

4/10 misjudged the direction more than once & took around 4 minutes on average to resolve



No Struggle

#### Debugging

5/10 participants



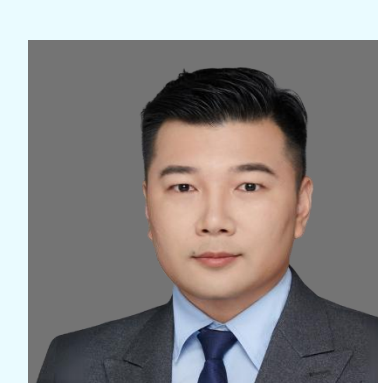
1-2 attempts  
No sig. change

### Discussion

- Struggles with degree angle and fox's perspective align with **abstraction** and **spatial reasoning**.
- Debugging** is a common struggle for novices as code complexity increases.
- Prior programming experience may enhance spatial reasoning, but limited research supports this.



**SOTHEARA VENG**  
PhD Student  
University of Delaware



**DR. YIFAN ZHANG**  
Postdoctoral Researcher  
Beijing Normal University



**EKATERINA BERGWALL**  
PhD Student  
University of Delaware



**DR. TEOMARA RUTHERFORD**  
Associate Professor  
University of Delaware



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