# Designing and Refining of Questions to Assess Students' Ability to Mentally Simulate Programs and Predict Program Behavior

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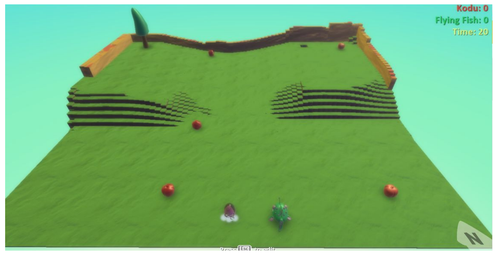
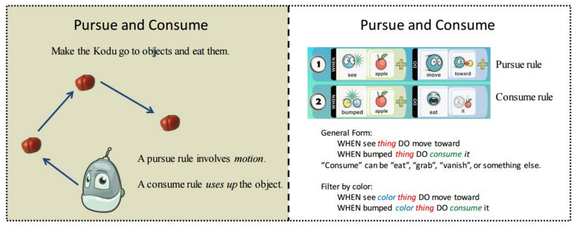
## ABSTRACT

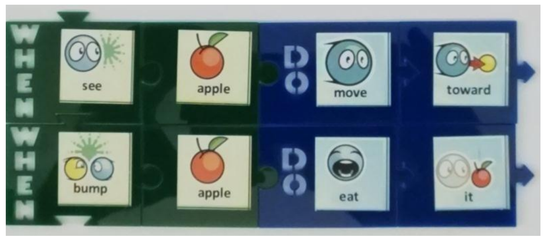
- **Mental simulation** is an important skill for program understanding and prediction of program behavior.
- This poster presents an iterative design and refinement process for assessing students' ability to mentally simulate and predict code behavior using a novel introductory computational thinking curriculum for Microsoft's Kodu Game Lab.
- The research is from three studies conducted on students of rising 3rd to 6th grade.
- Analysis of student responses indicate how different types of instructions can be used to identify **misconceptions**, **misinterpretation** and **ability** to answer a question correctly.
- Our findings suggest that excessive rule breakdown of the instructions might create confusion and it is preferred that scaffolding techniques should be coherent and consistent.

## KODU GAME LAB




## TILES AND FLASHCARDS

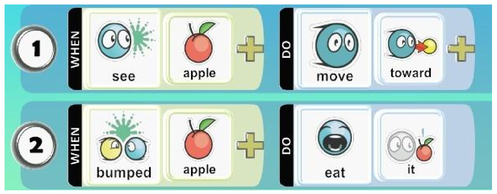



These items are available at the Kodu Resources for Teachers web page at http://www.cs.emu.edu/~dst

## TASK

**The students are expected to label the apples from 1 to 5 and it is scaffolded by a technique aimed at making the student understand about the dynamic positioning of Kodu.**



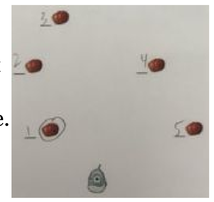

## ANALYSIS OF DIFFERENT INSTRUCTION

### Type- I - Label Path & Circle Next Position & Label Path

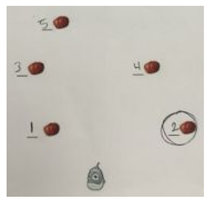
**Here is a map showing the kodu and five apples.**

- Which apple will it go and eat first? Write the number 1 to next to that apple.
- Draw a circle to show where the kodu will be *after* it eats its first apple.
- Write the numbers 2 through 5 next to the remaining apples to show the order in which the Kodu will go to and eat them.

**SAMPLE RESPONSES**



a) Correct Response



b) Incorrect Response

| n=9 | Marked Circle Correctly | Marked Circle Incorrectly | Omitted Marking Circle | *Total* |
|---|---|---|---|---|
| Correct Labeling | 1 | 1 | 3 | ***5*** |
| Incorrect Labeling | 1 | 2 | 1 | ***4*** |
| *Total* | ***2*** | ***3*** | ***4*** | ***9*** |

**OBSERVATION**

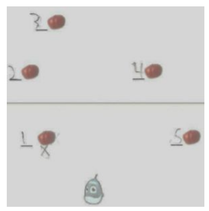
- **55% of students (n=5) correctly labeled kodu's path and only one student marked the circle currectly.**
- **55% of students (n=5) mark the circle and out of those students only 40 % (n=2) mark circle correctly.**
- **33%of students (n=3) did not mark circle still got the correct answer.**

### Type- II - Label Path & Mark "X" on Current Position & Label Path

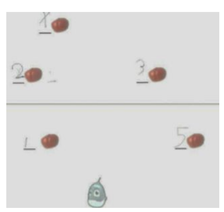
Here is a map showing the kodu and five apples. Read the following instructions carefully:

a) Which apple will the kodu go to first? Write the number 1 next to that apple.
b) Draw an "X" to show where the kodu will be after it eats that first apple.
c) Once the kodu eats its first apple, which apple will it go to next? Write a 2 next to that apple, but don't draw any more "X" marks.
d) Write the numbers 3 through 5 next to the remaining apples to show the order in which the kodu will go to eat them.

**SAMPLE RESPONSES**



a) Correct Response



b) Incorrect Response

| n=37 | Marked "X" Correctly | Marked "X" Incorrectly | Omitted Marking | *Total* |
|---|---|---|---|---|
| Correct Labeling | 10 | 8 | 8 | ***26*** |
| Incorrect Labeling | 2 | 6 | 3 | ***11*** |
| *Total* | ***12*** | ***14*** | ***11*** | ***37*** |

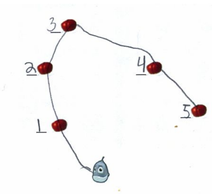
**OBSERVATION**

- **70% students (n=26) correctly labeled kodu's path and out of those students 38% (n=10) correctly marked "X" on current position.**
- **70% of students (n=26) marked "X"on Kodu's current position and out of those only 46% (n=12) marked "X" correctly.**
- **21% students (n=8) did not mark "X"but still correcly labeled Kodu' s path**

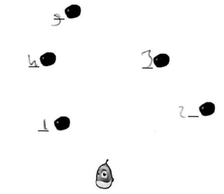
### Type- III - Trace Path & Label Path

**Here is a map showing the kodu and five apples. Based on your understanding of how the kodu moves, draw the path the kodu will take to eat all the apples. Start by drawing a line from the kodu to the first apple, then extend the line to the next apple, and so on. Finally, write the numbers 1 through 5 next to the apples to show the order in which they are eaten.**

**SAMPLE RESPONSES**



a) Correct Response



b) Incorrect Response

| n=34 | Correct Tracing | Incorrect Tracing | Omitted Tracing | *Total* |
|---|---|---|---|---|
| Correct Labeling | 22 | 0 | 10 | ***32*** |
| Incorrect Labeling | 0 | 0 | 2 | ***2*** |
| *Total* | ***22*** | ***0*** | ***12*** | ***34*** |

**OBSERVATION**

- **94% students (n=32) correctly labeled kodu"s path and out of those 68% (n=22) traced the path correctly.**
- **64% students(n=22) traced the path and 100% of those students traced the path correctly.**
- **29% students did not trace path but still correctly labeled Kodu's path.**

## CONCLUSION

1. Excessive rule breakdown does not always help, rather it can create confusion.

Suggestion: use clear and easy to comprehend instructions.

2. Minimize ambiguity in instructions and scope of instruction interpretation.

Ex. Scaffolding Mental Code Simulation: Choose a coherent and consistent technique (like tracing here), which encompasses the entire question and is not limited to only part of the task scope ( mark "X" or circle on just the first one).

## ACKNOWLEDGEMENT

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