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Methods for Teaching Computer Science
Portfolio Lesson #2 of 2
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Summer 2021

Lesson #2 of 2: Iteration in AP-style Pseudocode

loop	condition	i	sum
pre-loop	Repeat until i=4	0	0
1	Repeat until i=4 0=4 is false, keep looping	i=1 i=i+1=1+1=2	sum= sum+ 1=0+ 1=1
2	Repeat until i=4 2=4 is false, keep looping	i=1 i=i+1=1+1=2	sum= sum+ 1=1+ 1=2
3	Repeat until i=4 2=4 is false,	i=1 i=i+1=1+1=2	sum= sum+ 1=2+ 1=3

Intended Audience: 12th Grade AP Computer Science Principles students in a selective arts school. Students in the class have passed Algebra 2.

Pedagogical Technique #1: Code Tracing

Pedagogical Technique #2: Debugging Strategies: Diagramming, Print Statements

New York State K-12 Computer Science and Digital Fluency Learning Standards - 9-12:

- 9-12.CT.8 Develop a program that effectively uses control structures in order to create a computer program for practical intent, personal expression, or to address a societal issue.
- Clarifying Statement The focus is on combining different forms of repetition and conditionals, including conditionals with complex Boolean expressions.

Aim: How can I use code tracing to track the changing values of variables as a loop executes, and how can this be useful when debugging my own code?

Warm up Look at the code segment below in AP-style pseudocode, and answer the following questions.

```
int counter=0;
    while (counter<5)
{
    print (counter)
    counter=counter+1
}
```

- 1) What is a Boolean expression?
Cold Calling - Student Answer: A Boolean expression is a statement that evaluates to true or false. Follow up: Example? Another example?
- 2) What is iteration?
Cold Calling - Student Answer: Repetition of code. Continuation of the loop is often contingent upon the value of a Boolean expression. Follow up: Example? Another example?
- 3) What is printed in this segment?
Teacher models for class with annotations - Answer: 01234
Variable counter is initialized to 0. In the Boolean expression, 0<5 is true, so the first iteration of the loop executes. Counter (0) is printed, and counter is incremented to counter+1 (1). This process continues until counter<5 is false, which happens when counter is 5.

Time: 10 minutes - 5 minutes for students to work on the task above independently in Google Classroom, and 5 minutes for students to share answers through cold calling. The teacher models code tracing through simple Zoom annotations during the explanation of #3 above in preparation for the learning ahead.

Lesson Content

Consider the following program code.

```

i ← 0
sum ← 0
REPEAT UNTIL (i = 4)
  i ← 1
  sum ← sum + i
  i ← i + 1
DISPLAY sum

```

Which of the following best describes the result of running the program code?

☐ A The number 0 is displayed.

☐ B The number 6 is displayed.

☐ C The number 10 is displayed.

☐ D Nothing is displayed; the program results in an infinite loop.

Teacher Modeling:

loop	condition	i	sum
pre-loop	Repeat until i=4	0	0
1	Repeat until i=4 0=4 is false, keep looping	i=1 i=i+1=1 +1=2	sum= sum+ 1=0+ 1=1
2	Repeat until i=4 2=4 is false, keep looping	i=1 i=i+1=1 +1=2	sum= sum+ 1=1+ 1=2
3	Repeat until i=4 2=4 is false, keep looping	i=1 i=i+1=1 +1=2	sum= sum+ 1=2+ 1=3
4	Repeat until i=4 2=4 is false, keep looping	i=1 i=i+1=1 +1=2	sum= sum+ 1=3+ 1=4
<p>Conclusion: This is an infinite loop that will cause a run-time error.</p>			

The program code on the left was created by The College Board (collegeboard.com) to prepare students for the AP Computer Science Principles Exam. All other components of this lesson were designed by the teacher.

The teacher models how we can create a Variable Value Table to track the changing values of variables in a loop as seen above. The columns of the table are loop, condition, and a separate column for each relevant variable. Students are asked to take notes during this segment of the lesson, and their notes are checked. Note: Accountability and engagement are increased during this teacher mini-lesson through regular cold-calling.

Time: 10 minutes

Lesson Activity

```

a ← true
b ← false
c ← true
REPEAT UNTIL (a AND b)
  c ← NOT c
  b ← c
DISPLAY a
DISPLAY b
DISPLAY c

```

Student Activity

loop	condition	a	b	c
pre-loop	Repeat until a=true and b=true	true	false	true
1	a=true and b=true, true=true and false=true is false, so keep looping	true	false	c=NOT c c=NOT true false
2	a=true and b=true			
3	a=true and b=true			
4	a=true and b=true			
5	a=true and b=true			
6	a=true and b=true			
7	a=true and b=true			
8	a=true and b=true			
9	a=true and b=true			
10	a=true and b=true			

This program code was created by The College Board (collegeboard.com) to prepare students for the AP Computer Science Principles Exam. All other components of the lesson were designed by the teacher.

Note that peer tutors and the teacher will circulate during this activity to offer support. Students work in pairs.

Time: 15 minutes

Closing - Three student volunteers from different groups come to the front to fill out the table for the class on the white board and talk it through. Each volunteer talks through two iterations.

We close by asking, How in the world does any of this relate to debugging our own code? How can we use this strategy on the AP Exam? What are the advantages and disadvantages to using this approach? Had any of us been using a similar system before? Does anyone have a suggestion for extending this? Student understanding of this technique is assessed on the next quiz with a problem that is structurally very similar to the one above.

Time: 10 minutes