Loops and Iteration

Computers are often used to perform repetitive tasks. Running the same statements over and over again, without making any mistakes, is something that computers do very well.

Manager:	Recorder:
Presenter:	Reflector:

Content Learning Objectives

After completing this activity, students should be able to:

- Explain what happens when re-assigning a variable.
- Identify the three main components of a while loop.
- Rewrite a while loop as a for loop (and vice versa).

Process Skill Goals

During the activity, students should make progress toward:

- Tracing the execution of while/for loops and predict their final output. (Critical Thinking)

Model 1 Assignment

Consider the following Java statements. What is the resulting value of each variable?

A:

```java
int x, y;
x = 1;
y = 2;
y = x;
x = y;
```

Value of x:

Value of y:

B:

```java
int x, y, z;
x = 1;
y = 2;
z = y;
y = x;
x = z;
```

Value of x:

Value of y:

Value of z:

C:

```java
int z, y;
z = 2;
z = z + 1;
z = z + 1;
y = y + 1;
```

Value of z:

Value of y:

Questions (15 min)

Start time:

1. In program A, why is the value of x not 2?

2. In program B, what happens to the values of x and y?

3. In program B, what is the purpose of the variable z?

4. If program C runs, what happens to the value of z?

5. In program C, why is it possible to increment z but not y?

6. Because ***increment*** and ***decrement*** are so common in algorithms, Java provides the operators `++` and `--`. For example, `x++` is the same as `x = x + 1`, and `y--` is the same as `y = y - 1`. Write the value of `x` and `y` next to each statement below.

```
int x = 5;
x--;
x--;
```

```
int y = -10;
y++;
y++;
```

7. Like the assignment operator, the `++` and `--` operators replace the value of a variable. Java also has ***compound assignment*** operators for convenience. For example, the statement `x = x + 2` can be rewritten as `x += 2`. Simplify the following assignment statements.

```
step = step + 5;
size = size - 3;
total = total * 2;
change = change / 10;
hours = hours % 24;
```

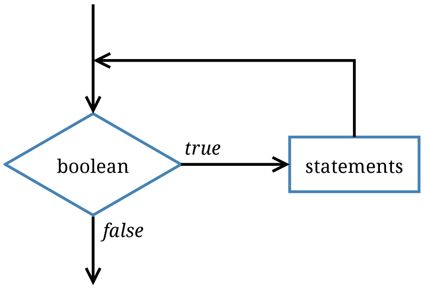
8. Which of the following assignment statements can also be rewritten like the ones in #7?

```
step = 5 + step;
size = 3 - size;
total = 2 * total;
change = 10 / change;
hours = 24 % hours;
```

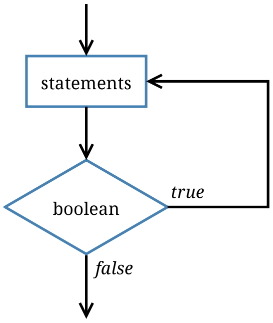
Model 2 While Loops

A loop is a set of instructions that are to be repeated. All loops have three main components: ***initialize***, ***test***, and ***update***. Identify these components in each of the examples below.

```
// pre-test loop
number = 1;
while (number <= 10) {
    System.out.println(number);
    number++;
}
```



```
// post-test loop
number = 1;
do {
    System.out.println(number);
    number++;
} while (number <= 10);
```



Questions (20 min) Start time:

9. Which loop component always happens first? Why?

10. Explain why the `while` loop is called a ***pre-test*** and the `do while` loop is called a ***post-test***.

11. What is output to the screen by each loop? Predict the output first, and then run the code to check your answer.

12. What is the final value of `number` at the end of each loop? Make a prediction first, and then add print statements to the code to check your answer.

13. How does the output change if you swap the `println` and `number++` statements?

14. What is the output to the screen if you remove the `number++` statement?

15. What is the difference between a `while` statement and an `if` statement?

16. What is output by the following loop? Explain how the code works.

```
number = 99;
do {
    System.out.println(number);
    number++;
} while (number <= 10);
System.out.println(number);
```

17. What is output by the following loop? And what mistake was made?

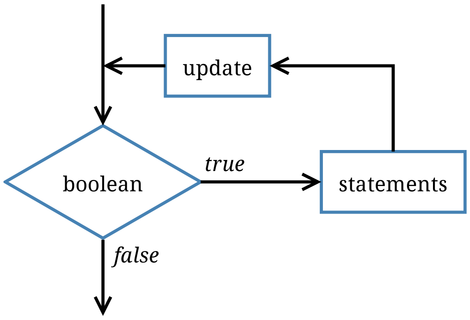
```
int i = 0;
while (i < 3)
    System.out.println("i = " + i);
    i = i + 1;
```

Model 3 For Loops

The `for` loop combines ***initialize***, ***test***, and ***update*** into one line of code.

```
// Loop A: count forwards
for (i = 1; i <= 10; i++) {
    System.out.println(i);
}

// Loop B: count backwards
for (i = 10; i >= 1; i--) {
    System.out.println(i);
}
```



Questions (10 min) Start time:

18. Identify the components of each `for` loop.

Loop A:

a) initialize

b) test

c) update

Loop B:

a) initialize

b) test

c) update

19. Rewrite each for loop as a while loop.

Loop A: **Loop B:**

20. What do each of the for loops output to the screen? Be specific.

21. Describe how to change the for loops to print even numbers only (i.e., the output should be 2 4 6 8 10 and 10 8 6 4 2).

22. In mathematics, the factorial of an integer n (denoted by $n!$) is the product of all positive integers less than or equal to n. For example, the factorial of 5 is:

$$5! = 5 * 4 * 3 * 2 * 1 = 120$$

The following code computes the factorial of 5:

```
fact = 1;
i = 5;
while (i > 1) {
    fact *= i;
    i--
}
```

a) Rewrite the code above using a for loop instead of a while loop.

b) How would you change the code to compute the factorial of 12?