CODING – PART 3

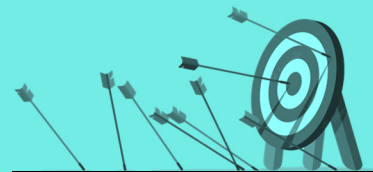**BIG IDEAS:**

- **Loops** provide an efficient way to perform repeated calculations
- *for* **loops** repeat a specified number of times
- *while* **loops** repeat as long as a specified condition is met

LEARNING GOALS AND SKILL DEVELOPMENT:
You know you have met the goals for this lesson when you can:

EMERGING

LEARNING GOALS	ANCHOR QUESTIONS	SKILL BUILDING QUESTIONS			
Predict the output of a program involving a *for* loop	1	1			
Predict the output of a program involving a *while* loop	1				
Explain the purpose of incrementing a variable in a loop	1				

EVOLVING

LEARNING GOALS	ANCHOR QUESTIONS	SKILL BUILDING QUESTIONS			
Differentiate between a *for* loop and a *while* loop	2	2	3	4	5
Write programs involving *for* loops and *while* loops	2, 4				
Write and use a program involving a loop to solve a problem	4				

EXTENDING

LEARNING GOALS	ANCHOR QUESTIONS	SKILL BUILDING QUESTIONS			
Write and use a program involving a loop to solve a problem for which an algebraic model is not provided	7	6	7		

BUILD YOUR SKILLS

1. Consider the two programs shown below.

PROGRAM A

Start loop
Use 5 consecutive integers for **x**, starting at 0.

Set **y** = 2***x** + 7

Print **y**

End loop

PROGRAM B

Set **x** = 0 and **y** = 0

Start loop
Repeat as long as **y** ≤ 20.

Set **y** = 2***x** + 7

Print **y**

Set **x** = **x** + 1

End loop
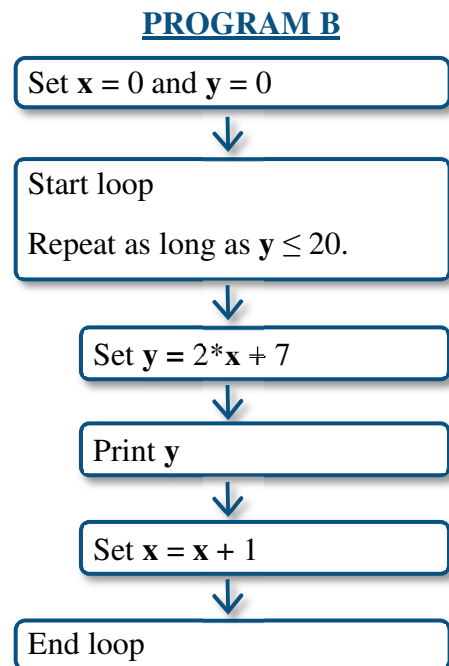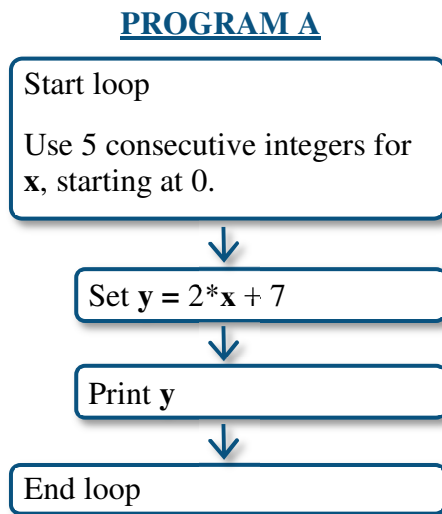
a) How many values will be printed when *Program A* is run?

b) In *Program B*, what is the purpose of the "Set **x** = **x** + 1" step?

c) Write the output of each program.

d) What would happen if the first block of *Program B* was left out? Explain.

e) What would happen if the "Set **x** = **x** + 1" step of *Program B* was omitted? Explain.

2.   a) Briefly explain the difference between a *for loop* and a *while loop*.

b) Use Python to create each program in question #1.

3. Consider the Python program shown below.

```
1   # Set initial value for sum.
2   sum=0
3
4   # Read values and update sum.
5 ▾ for x in range(10):
6       number=float(input("Please enter a number: "))
7       sum=sum+number
8
9   # Print sum.
10  print("The sum is",sum)
```

a) What is the purpose of this program?

b) What is the purpose of the variable **x**?

c) Is line #2 necessary for the program to run? Explain.

d) Explain what is happening in line #7.

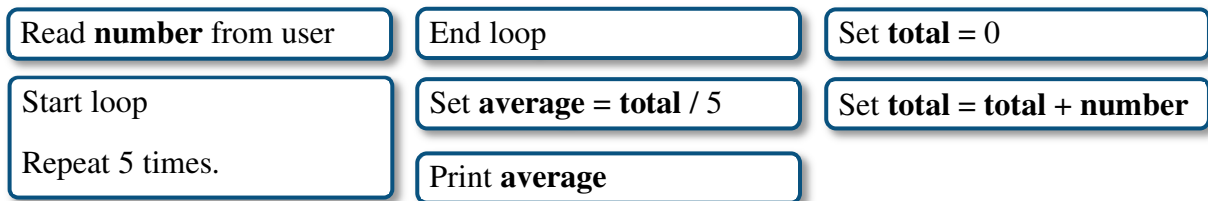e) What would happen if line #7 was omitted from the program? Explain.

4. The height of a ball (in metres), t seconds after it is thrown, is given by the equation $h = -4.9t^2 + 22.3t + 2.1$.

a) Create a Python program that uses a *for loop* to determine the height of the ball every second for $0 \le t \le 5$. Be sure to display the time values alongside the corresponding height values. Display all height values rounded to one decimal place.

b) Is the relationship between time and height linear or non-linear?

c) Using a *while loop*, modify your program from part (a) to print the height of the ball every 0.5 seconds for $0 \le t \le 5$.

d) Modify your program from part (c) to print the height of the ball every 0.1 seconds, from $t = 0$ until the time the ball hits the ground. Round the height values to two decimal places.

e) Using the output of your program from part (d), state the maximum height of the ball and the time it takes to reach that height.

5. Suppose we wish to create a Python program to solve equations of the form $ax+b=c$, where a, b and c are known values.

   a) Write a program that prompts the user to enter values for a, b and c in the above equation and then solves for x.

   b) For each of the following equations, state the values that would be entered for a, b and c in your program and then use your program to solve the equation.

   i) $4x+3=15$

   ii) $-9.2x+1285.3=-1861.1$

   iii) $x-14=-38$

   iv) $-32.5x=-825.5$

   c) Will your program work for all values of a, b and c? Explain.

6. The following blocks represent the steps of a program that averages five numbers entered by the user.

Read **number** from user	End loop	Set **total** = 0
Start loop	Set **average** = **total** / 5	Set **total** = **total** + **number**
Repeat 5 times.	Print **average**	

   a) Order the blocks in the correct sequence.

   b) Create the program in Python and use it to calculate the average of the first five natural numbers.

   c) Modify your program from part (b) such that the user first specifies how many numbers will be averaged.

7. Consider the sum $1+\dfrac{1}{2}+\dfrac{1}{4}+\dfrac{1}{8}+...$

   a) Create a Python program to evaluate the above sum for the desired number of terms (for example, the sum of the first 20 terms).

   b) As more terms are added, what happens to the value of the sum?

   c) Does the sum $1+\dfrac{1}{2}+\dfrac{1}{3}+\dfrac{1}{4}+...$ behave similarly? Explain.

CHECK YOUR UNDERSTANDING

1. a) 5   b) Increase the value of **x** by 1 for the next iteration of the loop.

    c) PROGRAM A: 7   PROGRAM B: 7

                                   9   9

                                   11   11

                                   13   13

                                   15   15

17

19

21

    d) The program would return an error since a value of **y** is needed in the condition of the loop and a value of **x** is needed for the calculation within the loop.

    e) The program would loop indefinitely, printing an output of 7 for each iteration of the loop. The value of **x** would never change and, therefore, the value of **y** would become fixed at 7 after it is first calculated in the loop. The value of **y** would never reach 20 to stop the loop.

2. a) With a *for loop*, the desired number of iterations is already known (for example, repeat the loop 20 times). With a *while loop*, the number of iterations depends on some other criteria (for example, repeat the loop as many times as needed until a calculated value reaches 0).

    b) PROGRAM A: PROGRAM B:

```
1 ▾ for x in range(5):
2       y=2*x+7
3       print(y)
```

```
1    x=0
2    y=0
3 ▾ while y<=20:
4        y=2*x+7
5        print(y)
6        x=x+1
```

3. a) The program adds ten numbers that are entered by the user.

    b) **x** is a "dummy variable" that is only used to define the loop. **x** starts with a value of 0 and increases by 1 with each iteration of the loop. The loop stops when **x** reaches 10 (it doesn't actually run for an **x**-value of 10 though).

    c) Yes. In order to use the **sum** variable in the calculation in line #7, it must already be defined. The initial value of **sum** should be 0 so that it does not affect the sum of the user-entered values.

    d) In line #7, the value of **sum** is updated by adding the number entered by the user in the current iteration of the loop. As a result, the **sum** variable is a running total of all the numbers entered by the user.

    e) The value of **sum** would not be updated and the program would ultimately output the original value of **sum**, which is 0.

4. a)

```
1 ▾ for t in range(6):
2         h=-4.9*t**2+22.3*t+2.1
3         h_rounded=round(h,1)
4         print(t,"---",h_rounded)
```

b) non-linear (first differences are not equal)

c)
```
1  # Set initial time value.
2  t=0
3
4 ▾ while t<=5:
5         h=-4.9*t**2+22.3*t+2.1
6         h_rounded=round(h,1)
7         print(t,"---",h_rounded)
8         t=t+0.5
```

d)
```
1   # Set initial time and height values.
2   t=0
3   h=0
4
5 ▾ while h>=0:
6         h=-4.9*t**2+22.3*t+2.1
7         h_rounded=round(h,2)
8         t_rounded=round(t,1)
9         print(t_rounded,"---",h_rounded)
10        t=t+0.1
```

*Note: **t** is rounded to one decimal place to improve the appearance of the program's output.*

e) The maximum height of the ball is approximately 27.47 m, which occurs after approximately 2.3 seconds.

5. a)

```
1   # Read user values.
2   a=float(input("Please enter a value for a: "))
3   b=float(input("Please enter a value for b: "))
4   c=float(input("Please enter a value for c: "))
5
6   # Solve for x.
7   x=(c-b)/a
8
9   # Print x.
10  print("The value of x is",x)
```
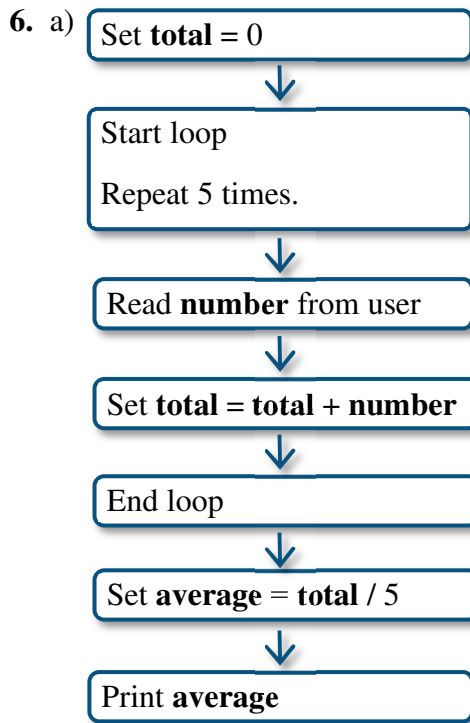
b) i) $a = 4$, $b = 3$, $c = 15$ and $x = 3$

ii) $a = -9.2$, $b = 1285.3$, $c = -1861.1$ and $x = 342$

iii) $a = 1$, $b = -14$, $c = -38$ and $x = -24$

iv) $a = -32.5$, $b = 0$, $c = -825.5$ and $x = 25.4$

c) If the program involves division by a, an a-value of 0 cannot be used, since division by 0 is undefined.

6. a)

```
Set total = 0
        ↓
Start loop

Repeat 5 times.
        ↓
Read number from user
        ↓
Set total = total + number
        ↓
End loop
        ↓
Set average = total / 5
        ↓
Print average
```

b)
```
1   # Set initial value for total.
2   total=0
3
4   # Read user values and update total.
5 ▾ for x in range(5):
6       number=float(input("Please enter a number: "))
7       total=total+number
8
9   # Calculate average.
10  average=total/5
11
12  # Print average.
13  print("The average is",average)
```

The average of the first five natural numbers is 3.

c)
```
1   # Read number of values from user.
2   values=int(input("How many values would you like to average? "))
3
4   # Set initial value for total.
5   total=0
6
7   # Read user values and update total.
8 ▾ for x in range(values):
9       number=float(input("Please enter a number: "))
10      total=total+number
11
12  # Calculate average.
13  average=total/values
14
15  # Print average.
16  print("The average is",average)
```

7. a)

```
1   # Set initial values.
2   current_number=2
3   sum=0
4
5   # Read number of terms from user.
6   terms=int(input("How many terms would you like to add? "))
7
8   # Calculate sum.
9 ▾ for x in range(terms):
10      current_number=current_number/2
11      sum=sum+current_number
12
13  # Print sum.
14  print("The sum is",sum)
```

b) As more terms are added, the value of the sum approaches 2.

c) No. As more terms are added, the value of the sum approaches infinity. A possible Python program for investigating the sum is shown below.

```
1   # Set initial values.
2   current_number=1
3   sum=0
4
5   # Read number of terms from user.
6   terms=int(input("How many terms would you like to add? "))
7
8   # Calculate sum.
9 ▾ for x in range(terms):
10      current_number=1/(x+1)
11      sum=sum+current_number
12
13  # Print sum.
14  print("The sum is",sum)
```