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Integrated Lesson (CS and Math)

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Integrated Lesson (CS and Math)

January 2022

Fifth-Grade Computer Science Lessons

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Continuation of Looping with Exponents

****Note:** this activity does **not** require students to log into their Scratch account.**

Have the students log in to their computers.

Use GoGuardian to have the students turn their attention to the front of the room.

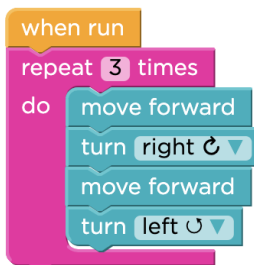
This lesson builds on what students did in Course E in code.org and extends it to Scratch. The goal is for them to review repeat loops and see the difference in what they may look like in code.org and Scratch.

[Click here to view the slide presentation that goes with this unit.](#)

Say: *Do you remember what a repeat loop does?*

<Answer: Repeats the commands that are in the middle a specific number of times.>

Show Slide 1 in the presentation, which is shown below:



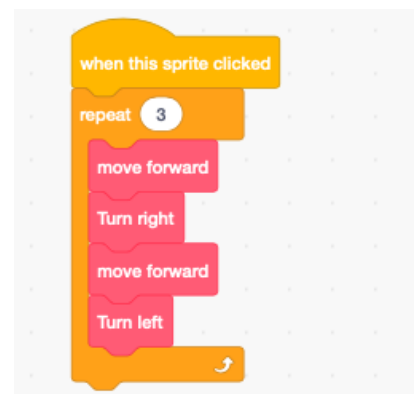
Say: *This code is from one of the puzzles in Code.org. What does this code do?*

<Suggested answers: Move in a diagonal direction three times.>

Show Slide 2 in the presentation, which is shown on the right.

Say: *This is the same repeat loop but this is what it looks like in Scratch.*

Say: *The coding blocks and the output interface look different in Code.org and Scratch but they do similar things.*



INTRODUCE Math and CS Integration

In this section we are going to explain to the students that computer programming and math have some concepts in common.

Say: There are often things we do in coding that we also do in math and vice versa. For example, In coding, we use repeat blocks to repeat sections of code and in math, we repeat operations like addition and subtraction and multiplication. We may call it something different in Math, but it is still just repeating.

Say: As you already know, multiplication is really repeated addition. You are just adding the same number a specific number of times. When we multiply two numbers, the two numbers are called factors – factor 1 and factor 2. We add factor 1 to itself factor 2 number of times, factor 2 tells us how many times factor 1 is added to itself. We repeat addition factor 2 number of times.

Show slide 3 in the slide show and read through the slide.

E.g., $4 \times 3 = 4 + 4 + 4 = 12$. In this example, we add 4 to itself three times.

Say: In math class, you are learning about exponents right now. Exponents are a more efficient way to show 4 to the power of 3. Exponents are similar to multiplication, but instead of repeated addition, we are dealing with repeated multiplication. The base is the starting value and the exponent is the number of times the base is multiplied to itself. We repeat the multiplication “the exponent” number of times.

Show slide 4 in the slide show and read through the slide.

E.g., $4^3 = 4 \times 4 \times 4 = 64$. In this example, we multiply 4 by itself 3 times.

An exponent is a more efficient way to represent 4 to the 3rd. A repeat loop is a more efficient way to code.

Say: We will be coding repeat loops in Scratch to represent how multiplication and exponents work. We’ll also see how repeated bases in exponents are different from repeated factors in multiplication.

Activity 1: Repeated Addition and Repeated Multiplication

In this activity, you will show students the Scratch code that has both repeated addition and repeated multiplication.

Teacher Tasks:

Click on the following link to open the “Activity 1 Example 1” Scratch program:

<https://scratch.mit.edu/projects/557057037>

Click on the blue “See inside” button on the top right to view code.

Click on the = button in the code window to center the code. ----->



Note that each sprite has its own set of code. Also, there is additional code not shown that helps these programs work. But it is hidden off to the side to avoid confusion.

Click on the red dinosaur in the sprite area to show the code for the red dinosaur (multiplisaurus).

Say: Look at this code. What do you think this code will do? Do not answer out loud, just think about it for a second. <Let the students think for 5-10 seconds.> **Let’s run the code and see what it does.**

Click on the red dinosaur to run the code.

Say: What did it do? <Answers will vary.> It sets answer to 0 and then adds 4 to answer three times which results in 4 times 3.

Click on the green dinosaur in the sprite area and show the code for the green dinosaur (t-rexponent).

Say: Look at this code. What do you think this code will do? Do not answer out loud, just think about it for a second. <Let the students think for 5-10 seconds.> **Let’s run the code and see what it does.**

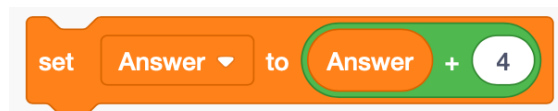
Click on the green dinosaur to run the code.

Say: What did it do? <Answers will vary> It sets answer to 1 and then multiplies 4 to answer three times which results in 4 to the power of 3.

Click on the red dinosaur in the sprite area to show the code for the red dinosaur (multiplisaurus).

Say: Let’s go back to the first example and look at the code more deeply. Do you see anything that should be repeated? Perhaps something that is coded exactly the same more than once?

Answer: Set answer to answer + 4



Say: What operation do you see? Addition or multiplication?

Answer: Addition

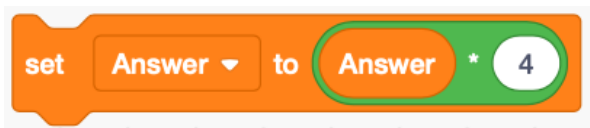
Say: How many times is it being repeated?

Answer: 3

Click on the green dinosaur in the sprite area to show the code for the green dinosaur (multiplisaurus).

Say: Let's go to the second example and look at that code more deeply. Do you see anything that should be repeated? Perhaps something that is coded exactly the same more than once?

Answer: Set answer to answer * 4



Say: Did you notice that in coding we use the * for multiplication in coding?

Say: What operation do you see? Addition or multiplication?

Answer: Multiplication

Say: How many times is it being repeated?

Answer: 3

Say: Did you notice that when we are adding the numbers we start by setting answer to 0 and when we are multiplying we start by setting answer to 1? Why do you think that is?

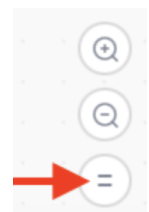
Answer: If we started multiplication out at 0 the answer would only be 0. If we started addition out at 1, our answer would be off by one. 1 is the "identity" for multiplication because it does not change the answer. 0 is the "identity" for addition because it does not change the answer.

Click on the following link to open the "Activity 1 Example 2" Scratch program:

<https://scratch.mit.edu/projects/557057846>

Click on the blue "See inside" button on the top right to view code.

Click on the = button in the code window to center the code. ----->



Click on the red dinosaur in the sprite area to show the code for the red dinosaur (multiplisaurus).

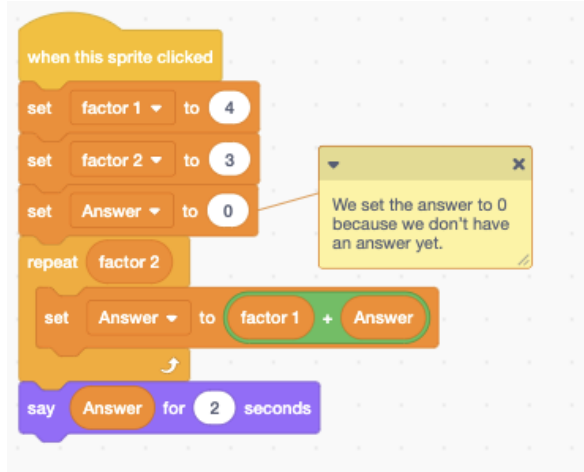
Say: Look at this code. Look at each section. At the top we have the thing we do to execute the code below it. We call this our event. Below that we have what we set factor 1 to and what we set factor 2 to. What do we set factor 1 to? <Answer: 4> What do we set factor 2 to? <Answer: 3> Next we can see

that we need to give answer a starting value. In this case, we will set it to 0. We will see why in a minute.

Say: On the left we can see a repeat loop that is repeating something factor 2 number of times. On the right we can see our math. What is the math that we are doing? <Answer: Adding factor 1 to answer and having that be the new answer.> Then the purple block has the dinosaur say the value of Answer.

Say: Our goal is to connect the block to each other so that they work.

Using the text and actions below, demonstrate what needs to be done and then the students will do it after.

Say	Do
<p>Let's first connect the setting of the starting values to the event block.</p>	<p>Drag the set factor 1 and set factor 2 blocks to the event block. Drag the set answer block to the bottom of the event block.</p>
<p>Next, let's look at the repeat loop. We are repeating factor 2 times. But what do we want to repeat? <Answer: set answer to factor 1 + answer></p> <p>This means we are adding factor 1 to answer factor 2 number of times. And you can now see why we set answer to 0 because we are adding.</p>	<p>Drag the set answer block inside of the repeat block.</p> <p>Drag the repeat block to the bottom of the event block.</p>
<p>And now, let's drag the say block to the bottom so we can have the dinosaur give us the value of answer when we are done.</p>	<p>Drag the say block to the bottom of the event block.</p>
<p>Now that we have it all connected, let's read through the code and determine what it will do before we run it. <Read through the code.></p> <p>Let's click the sprite and see what happens.</p> <p>The dinosaur said 12. Yay. That means 4 added three times is 12. This is repeated addition. Repeated addition is really multiplication so we are calculating 4 times 3 which is 12.</p>	<p>Your code should look like this:</p> 

Say: Now it is time for you to give it a try:

Push out this link to the students via GoGuardian. <https://scratch.mit.edu/projects/557057846>

Say: Click on the blue “see inside” button to see the code. Click on the = in the code area to center the code so you can see it properly.



Say: Now you can try it with the red dinosaur. When you think you have it figured out, click on the green dinosaur in the sprite area and see if you can connect up that code as well. Notice the math change with the green dinosaur. The green dinosaur is doing multiplication.

Let them work for a minute.

Say: Did you all notice that the green dinosaur was repeating multiplication? Repeated multiplication is what exponents are so we are calculating 4 to the 3rd power which is 64.

Activity 2: Visualizing growth by multiplication

In this activity, students should be able to visualize multiplication as a repeated addition.

Bring the students attention to you. Use GoGuardian to lock the computers, if needed.

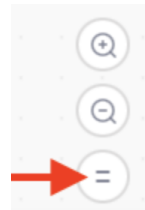
Say: *In the previous activity, we saw how we can use repeat loops when coding repeated addition and repeated multiplication in Scratch. In our next activity, we will look at a similar code for multiplication that shows growth in numbers when we are multiplying numbers -- also known as repeated addition.*

Click on the following link to open the “Activity 2 Example 1” Scratch program:

<https://scratch.mit.edu/projects/565324395/>

Click the ‘See inside’ button to view code.

Click on the = button in the code window to center the code. ----->



Say: *You can see that in this code we are setting factor 1 to 4 and factor 2 to 3 and answer to 0. Factor 1 is the number we are adding to answer and we can see that code inside the repeat loop. In this example factor 1 is 4. The value of factor 2 is the number of how many times factor 1 addition is being repeated. It is the value for our repeat loop. In this example factor 2 is 3. Inside our repeat loop is some magic code that will put cats on the screen to show the result of the math. At the end, our cats will say the answer. In this case, what is the result of the math? How many cats do you think will appear on the screen when we click the green flag?*

Answer: 12

Click on the green flag to demonstrate the code. (It has a wait of 2 seconds between each line so give it a bit to run.)

Say: *What did you notice about the rows?*

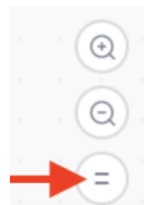
How many rows were there? <Answer: 3>

How many cats per row? <Answer: 4>

Have students go to the Scratch program: <https://scratch.mit.edu/projects/565324395/>

You can push out the link via GoGuardian.

Say: *Click on the blue “see inside” button to see the code. Click on the = in the code area to center the code so you can see it properly.*



NOTE: There is other code off to the side of what the students see. Please do not show them that code or have them click on it. It is what is needed to make the code they see run properly. It is the “magic coding.”

Say: Let’s play around with this for just a minute. First, click the green flag and see that we can get three rows of four cats.

Say: Now let’s change the numbers. Change factor 1 to 6 and factor 2 to 4. Click the green flag. What happens? <Answer: Cats go on the screen> How many cats appeared? <Answer: 24> How many rows were there? <Answer: 4> How many cats per row? <Answer: 6>

Say: Now let’s swap the numbers. Change factor 1 to 4 and factor 2 to 6. Click the green flag. What happens? <Answer: Same number of cats, different rows and numbers per row> How many cats appeared? <Answer: 24> How many rows were there? <Answer: 6> How many cats per row? <Answer: 4> We still get 24, but it is a different layout of 24.

Activity 3: Visualizing exponential growth

In this activity, students should be able to visualize exponentiation as a repeated multiplication.

Bring the students attention to you. Use GoGuardian to lock the computers, if needed.

Say: In the previous activity, we saw a program demonstrating repeated addition - also known as multiplication - and we were able to visualize the answer. We also changed the values of numbers in the multiplication operation. In this activity, we will look at a similar code that shows exponential growth in numbers of a Sprite on the screen. This will help you visualize exponents.

Click on this link to go to the “Activity 3 Example 1” Scratch program:

<https://scratch.mit.edu/projects/565355637/>

Click the ‘See inside’ button to view the code.

Click on the = button in the code window to center the code. ----->



Say: You can see that in this code we are setting base to 4 and exponent to 3 and answer to 1. Base is the number we are multiplying by answer and we can see that code inside the repeat loop. In this example base is 4. The value of exponent is the number of how many times base multiplication is being repeated. It is the value for our repeat loop. In this example exponent is 3. Inside our repeat loop is some magic code that will put cats on the screen to show the result of the math. At the end, our cats will say the answer. In this case, what is the result of the math? How many cats do you think will appear on the screen when we click the green flag?

Say: The value of exponent is how many times the base is multiplied by itself. It is the value for the repeat loop. Can you see how it is repeating multiplication of the base?

Click on the green flag to demonstrate the code. (It has a wait of 2 seconds between each line so give it a bit to run.)

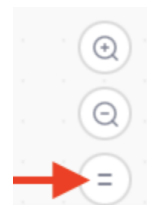
Notice what happens when I click the green flag:

- 4¹ (four to the power of 1) = 4 the first time the loop runs -- 4 cats are in the first group
- 4² (four to the power of 2) = 4 x 4 = 16 the second time the loop runs -- 16 cats are in the second group
- 4³ (four to the power of 3) = 4 x 4 x 4 = 64 the third time the loop runs -- 64 cats are in the third group

Have students go to the Scratch program: <https://scratch.mit.edu/projects/565355637/>

You can push it out via GoGuardian.

Say: Click on the blue “see inside” button to see the code. Click on the = in the code area to center the code so you can see it properly.



NOTE: There is other code off to the side of what the students see. Please do not show them that code or have them click on it. It is what is needed to make the code they see run properly. It is the “magic coding.”

Say: Let’s play around with this code for just a minute, as well. First, click the green flag and see that we can get four cats, then 16, then 64.

Say: Now let’s change the numbers. Change base to 2 and exponent to 5. Click the green flag. What happens? <Answer: Cats go on the screen> How many cats appeared in the last set? <Answer: 32> How many rows were there? <Answer: 5> What is the pattern of the cats in the rows? <Answer: first row has 2 cats, then 4, then 8, then 16, then 32.> Notice that each group of cats is equal to the next power: 2^1 , 2^2 , 2^3 , 2^4 , 2^5 (2 to the power of 1, 2 to the power of 2, 2 to the power of 3, 2 to the power of 4, 2 to the power of 5)

Say: Now let’s swap the numbers. Change base to 5 and exponent to 2. Click the green flag. What happens? <Answer: Different number of cats entirely.> How many cats appeared? <Answer: 25> How many rows were there? <Answer: 2> What is the pattern of the cats in the rows? <Answer: first row has 5 cats, the second has 25.>

Say: 2^5 is NOT the same as 5^2 (2 to the power of 5 is not the same as 5 to the power of 2)

Activity 4: Comparison of growth by multiplication and exponents

In this activity, students should be able to visualize multiplication and exponentiation side by side.

Bring the students attention to you. Use GoGuardian to lock the computers, if needed.

Say: In the previous two activities, we saw Scratch code that visualizes repeated addition and code that visualizes exponential growth. We saw this by the number of cats placed on the screen. In this activity, we will look at the code for the two operations side by side.

Click on this link to go to the “Activity 4 Example 1” Scratch program:

<https://scratch.mit.edu/projects/565356276/>

Click on the blue “see inside” button.

Click on the = button in the code window to center the code. ----->



Say: This code is a bit more advanced so we will not go through it in detail. Basically we have two numbers - number 1 and number 2. We are given the multiplication answer when we multiply those two numbers and the exponent answer when number 1 is to the power of number 2. In this example, our numbers are 2 and 5. Multiplication will be 2 times 5 and exponentiation will be 2 to the power of 5. Let's see what it does.

Run the code by clicking the green flag.

Say: The orange cats demonstrate multiplication and the grey cats show how the numbers change exponentially. Both sets of cats are using the same two numbers of 2 and 5. The result of multiplication is 2 times 5 which is 10. The result of the exponent side is 2^5 (2 to the power of 5) which is 32.

Activity 5: Writing your own code for multiplication and exponent

In this activity, students will be connecting the Scratch blocks in an order that will show the operation of multiplication and exponents.

Say: *In the previous code, we saw visualizations of growth by multiplication and exponential growth, side by side. Next, we are going to have you play with some code that does this, but first I need to explain and show it to you. We will be connecting the Scratch blocks in a specific order and they will show both the operation of multiplication and the operation of exponents.*

Bring up the “Activity 5 Example 1” Scratch program:

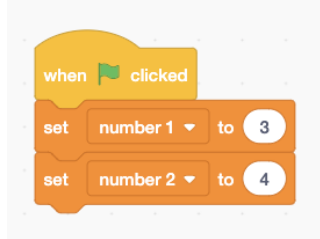
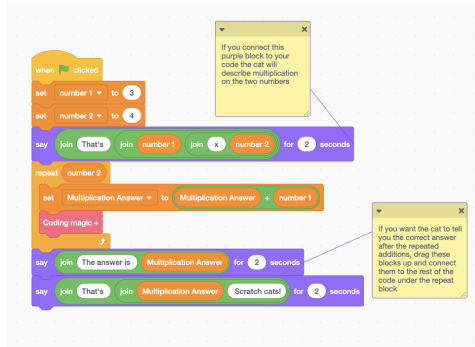
<https://scratch.mit.edu/projects/565358174/>

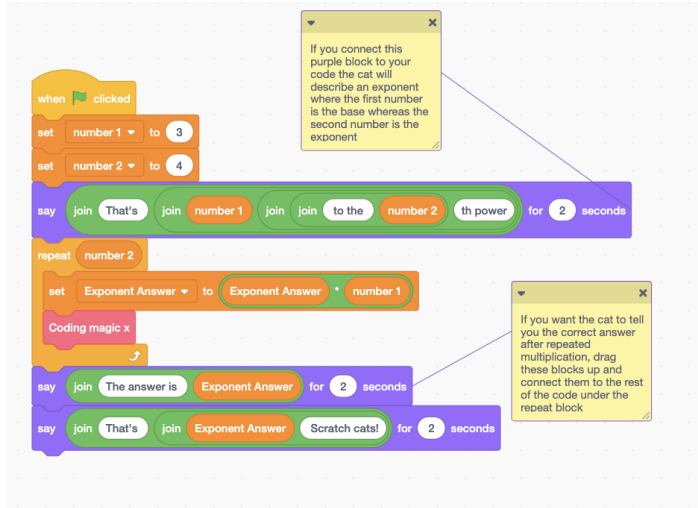
Click the ‘See inside’ button to view code.

Click on the = button in the code window to center the code. ----->



Say and do the following:

Say	Do
<p>You may need to zoom out so you can see more when you bring up this code.</p>	<p>Click on the - magnifying glass to show all of the code on the screen.</p>
<p>Let's look at the top three blocks. This is our event trigger and setting our numbers to their initial values. Number 1 is set to 3 and number 2 is set to 4.</p> <p>Treat these first three lines of the code at the top middle as the main block. You will connect the other blocks to this set of blocks.</p>	<p>Point to these blocks:</p> 
<p>Connect the code blocks on the left hand side of the window together in the order that they appear to the main block.</p> <p>First, we need to connect the top say box on the left. Then we are going to connect the repeat loop that performs the repeated addition which results in multiplication. Lastly, we will connect the bottom two say boxes.</p>	<p>Build this:</p> 

<p>Let's run the program with the left side connected.</p>	<p>Click the green flag to run this set of code.</p>
<p>Did the cats grow by multiplication or exponents? (Answer Multiplication) That is because the repeat loop is repeating addition.</p>	
<p>Next, we want to do the same thing with the right side. First, we need to disconnect the code for multiplication from the main block (the first three lines).</p>	<p>Disconnect the first say box and move the top three blocks to the top middle again.</p>
<p>Connect the code blocks on the right hand side of the window together in the order that they appear to the main block.</p> <p>First, we need to connect the top say box on the right. Then we are going to connect the repeat loop that performs the repeated multiplication which results in exponentiation. Lastly, we will connect the bottom two say boxes.</p>	<p>Build this:</p>  <p>The image shows a Scratch script with the following blocks: <ul style="list-style-type: none"> when clicked set number 1 to 3 set number 2 to 4 say join That's join number 1 join join to the number 2 th power for 2 seconds repeat number 2 <ul style="list-style-type: none"> set Exponent Answer to Exponent Answer * number 1 Coding magic x say join The answer is Exponent Answer for 2 seconds say join That's join Exponent Answer Scratch cats! for 2 seconds Two callout boxes provide instructions: <ul style="list-style-type: none"> Box 1: 'If you connect this purple block to your code the cat will describe an exponent where the first number is the base whereas the second number is the exponent' (pointing to the 'th power' block). Box 2: 'If you want the cat to tell you the correct answer after repeated multiplication, drag these blocks up and connect them to the rest of the code under the repeat block' (pointing to the 'The answer is' and 'Scratch cats!' blocks). </p>
<p>Let's run this program with the right side connected.</p>	<p>Click the green flag to run this set of code.</p>
<p>Did the cats grow by multiplication or exponents? (Answer Exponents) That is because the repeat loop is repeating multiplication.</p>	
<p>Now let's see if we can do both at the same time.</p> <p>Let's take the left side that we disconnected and add it to the bottom of our exponents code.</p>	<p>Connect the blocks on the left side of the window right below all the blocks.</p>

The code block contains the following logic:

```

when clicked
  set number 1 to 3
  set number 2 to 4
  say join That's join number 1 join join to the number 2 th power for 2 seconds
  repeat number 2
    set Exponent Answer to Exponent Answer * number 1
    Coding magic x
    say join The answer is Exponent Answer for 2 seconds
    say join That's join Exponent Answer Scratch cats! for 2 seconds
    say join That's join number 1 join x number 2 for 2 seconds
  repeat number 2
    set Multiplication Answer to Multiplication Answer + number 1
    Coding magic +
    say join The answer is Multiplication Answer for 2 seconds
    say join That's join Multiplication Answer Scratch cats! for 2 seconds
  
```

Callout boxes provide instructions:

- Top callout:** "If you connect this purple block to your code the cat will describe an exponent where the first number is the base whereas the second number is the exponent" (points to the first 'say' block).
- Middle callout:** "If you want the cat to tell you the correct answer after repeated multiplication, drag these blocks up and connect them to the rest of the code under the repeat block" (points to the 'say' blocks within the first 'repeat' loop).
- Bottom callout:** "If you connect this purple block to your code the cat will describe multiplication on the two numbers" (points to the second 'say' block).
- Bottom callout:** "If you want the cat to tell you the correct answer after the repeated additions, drag these blocks up and connect them to the rest of the code under the repeat block" (points to the 'say' blocks within the second 'repeat' loop).

What will the output of the code be? (Answer: The cats will first grow in numbers by exponentially and then by multiplication).

Let's run this program.

Click the green flag to run this set of code.

Now have the students try it.

Have the students go to the Scratch program: <https://scratch.mit.edu/projects/565358174/>

Push it out via GoGuardian if needed.

Say: Click on the blue "see inside" button to see the code. Click on the = in the code area to center the code so you can see it properly.



After students open the code, they will see disconnected Scratch blocks with instructions written in the code.

Main block

when clicked
set First_number to 3
set Second_number to 4

Code for multiplication

repeat Second_number
set addition answer to addition answer + First_number
Coding magic +

Code for exponent

repeat Second_number
set multiplication answer to multiplication answer * First_number
Coding magic x

say join That's join First_number join x Second_number for 2 seconds

say join The answer is addition answer for 2 seconds

say join That's join addition answer Scratch cats! for 2 seconds

say join That's join First_number join to the Second_number th power for 2 seconds

say join The answer is multiplication answer for 2 seconds

say join That's join multiplication answer Scratch cats! for 2 seconds

If you connect this purple block to your code the cat will describe multiplication on the two numbers

If you connect this purple block to your code the cat will describe an exponent where the first number is the base whereas the second number is the exponent

Here you have two repeat blocks. The repeat block on the left hand side repeatedly "adds" a number to the answer in every repetition. Repeated addition is basically multiplication. e.g. $2 \times 3 = 2+2+2 = 6$. The repeat block on the right hand side repeatedly "multiplies" a number to the answer in every repetition. Repeated multiplication is basically exponentiation. e.g. $2^3 = 2 \times 2 \times 2 = 8$.

If you want the cat to tell you the correct answer after the repeated additions, drag these blocks up and connect them to the rest of the code under the repeat block

If you want the cat to tell you the correct answer after repeated multiplication, drag these blocks up and connect them to the rest of the code under the repeat block

Say: As you look at the code remember these things:

- **treat the first three lines of the code at the top middle as the main block.**
- **connect the code blocks on the left hand side of the window together in the order that they appear and connect them all to the main block and click the green flag.**
- **disconnect the code for multiplication from the main block (the first three lines).**
- **connect the code blocks on the right hand side of the window together in the order that they appear and connect them all to the main block and click the green flag.**
- **connect the blocks on the left side of the window below the exponent blocks to make one full set of code.**

Allow the students to change the numbers and see what happens. Suggest that they use small ones, but we know they won't. :)