



# Kodu Curriculum: Math Module

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# Kodu Curriculum: Math Module

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## Note to Teachers

The goal of this curriculum is to reinforce math concepts and introduce programming concepts through the use of an interactive game development environment. While this curriculum is intended for students who have had a previous exposure to the topics listed above, it can also be adapted to provide a first experience with those concepts.

These lessons are ideally paced and not all the material in a lesson may be covered in the allotted time. This curriculum acknowledges that teachers are professionals and will use these lessons as a guide, adapting and prioritizing the pace and content when needed.

There are extension opportunities throughout the curriculum which serve as additional experiences to explore math or Kodu programming concepts.

Please use the video tutorials to review the Kodu programming experience for yourself and feel free to make them available to your students as a resource.

## Kodu Curriculum: Math Module Framework

Audience: 4th and 5th graders

Duration: 10 lessons

Standards Reference: NCTM - National Council of Teachers of Mathematics (NCTM)



### Overview

In this module students will examine how to use the Kodu programming environment to create simulations and games to explore mathematical problems and examine relationships among data. The Kodu environment provides an accessible and age-appropriate user interface to allow students to create and interact with objects within a three-dimensional world to study algebraic and geometric concepts. In addition, students will learn some of the core concepts in programming and game design, such as conditional execution of statements and object-oriented programming. The objectives in this curriculum module are geared towards 4th and 5th grade math courses and are correlated to the National Council of Teachers of Mathematics (NCTM) Principles and Standards for School Mathematics

### Enduring Understandings

- Computer simulations provide an interactive method for examining functional relationships within a problem.
- Algebraic equations can be used to describe functional relationships among different variables
- Two-dimensional and three-dimensional shapes have geometric properties (such as length, width, area, and perimeter) that are related to one another and are measured using different units.
- Coordinates are used as a system to describe the location, direction, and distance between points or objects.
- Data is collected and analyzed using calculations (such as mean, median) and tables in order to derive conclusions about the data.
- Collaboration within a team and communication to the intended audience is a vital aspect of the mathematical process.

### Essential Question(s)

- How are problem situations modeled, represented, and analyzed to draw conclusions?
- What are the different ways to compare and measure the properties of objects and their relationships?
- How is data collected, organized, and communicated?
- What are effective techniques for teamwork?

Results	Standards	Assessment
<p><b>Lesson 1</b></p> <ul style="list-style-type: none"> <li>• When given incremental changes in the area of a square, students will describe and analyze the pattern using math sentences and relationships.</li> <li>• When given a condition and consequence, students will represent it as a When...Do... statement in Kodu.</li> <li>• When given a control scheme, students will program their Kodu character to respond according to the specifications.</li> </ul>	<ul style="list-style-type: none"> <li>• Describe, extend, and make generalizations about geometric and numeric patterns. <i>(NCTM - Algebra, Gr. 3-5)</i></li> <li>• Represent and analyze patterns and functions, using words, tables, and graphs. <i>(NCTM - Algebra, Gr. 3-5)</i></li> <li>• Model problem situations with objects and use representations such as graphs, tables, and equations to draw conclusions. <i>(NCTM - Algebra, Gr. 3-5)</i></li> <li>• Represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules. <i>(NCTM - Algebra, Gr. 6-8)</i></li> </ul>	
<p><b>Lesson 2</b></p> <ul style="list-style-type: none"> <li>• When given the length, width, and height measurements for quadrilaterals, students will create a three-dimensional object from two-dimensional representations.</li> <li>• When given a three-dimensional quadrilateral, students will measure its length, width, and height using unit blocks.</li> <li>• When given a multiplication problem, students will describe the effect of multiplying whole numbers and define multiplication in their</li> </ul>	<ul style="list-style-type: none"> <li>• Identify such properties as commutativity, associativity, and distributivity and use them to compute with whole numbers. <i>(NCTM - Algebra, Gr. 3-5)</i></li> <li>• Identify, compare, and analyze attributes of two- and three-dimensional shapes and develop vocabulary to describe the attributes. <i>(NCTM - Geometry, Gr. 3-5)</i></li> <li>• Build and draw geometric objects. <i>(NCTM - Geometry, Gr. 3-5)</i></li> <li>• Develop, understand, and use formulas to find the area of rectangles and related triangles and parallelograms. <i>(NCTM - Measurement, Gr. 3-5)</i></li> </ul>	Perimeter

<p><b>Lesson 3</b></p> <ul style="list-style-type: none"> <li>• When given a measure of length, width, height, surface area, perimeter, and volume, students will describe the property with the appropriate standard units.</li> <li>• When calculating the volume of a three-dimensional quadrilateral, students will demonstrate computational fluency, by using the associative property of multiplication.</li> <li>• When given an irregular shape, students will determine the shape's area and volume</li> </ul>	<ul style="list-style-type: none"> <li>• Identify such properties as commutativity, associativity, and distributivity and use them to compute with whole numbers. <i>(NCTM - Algebra, Gr. 3-5)</i></li> <li>• Build and draw geometric objects. <i>(NCTM - Geometry, Gr. 3-5)</i></li> <li>• Explore what happens to measurements of a two-dimensional shape such as its perimeter and area when the shape is changed in some way. <i>(NCTM - Measurement, Gr. 3-5)</i></li> <li>• Develop strategies for estimating the perimeters, areas, and volumes of irregular shapes. <i>(NCTM - Measurement, Gr. 3-5)</i></li> <li>• Develop, understand, and use formulas to find the area of rectangles and related triangles and parallelograms. <i>(NCTM - Measurement, Gr. 3-5)</i></li> <li>• Understand such attributes as length, area, weight, volume, and size of angle and select the appropriate type of unit for measuring each attribute. <i>(NCTM – Measurement, Gr. 3-5)</i></li> <li>• Understand the need for measuring with standard units and become familiar with standard units in the customary and metric systems. <i>(NCTM – Measurement, Gr. 3-5)</i></li> </ul>	<p>Area and Perimeter</p>
<p><b>Lesson 4</b></p> <ul style="list-style-type: none"> <li>• When given a change to a shape, students will describe the change as a fraction of the original shape.</li> <li>• When given a three-dimensional quadrilateral, students will measure its length, width, and height using a coordinate plane.</li> <li>• When calculating the surface area of a three-dimensional quadrilateral, students will generalize and extend the pattern by using mental math</li> </ul>	<ul style="list-style-type: none"> <li>• Develop understanding of fractions as parts of unit wholes, as parts of a collection, as locations on number lines, and as divisions of whole numbers. <i>(NCTM – Numbers and Operations, Gr. 3-5)</i></li> <li>• Use models, benchmarks, and equivalent forms to judge the size of fractions. <i>(NCTM – Numbers and Operations,</i></li> </ul>	<p>Creating Shapes According to Specifications</p>

<p>techniques involving multiples of ten.</p> <ul style="list-style-type: none"> <li>• When given changes to the length and width of a quadrilateral, students will describe and calculate the effect the changes have on surface area, perimeter, and volume.</li> </ul>	<p><i>Gr. 3-5)</i></p> <ul style="list-style-type: none"> <li>• Recognize and generate equivalent forms of commonly used fractions, decimals, and percents. <i>(NCTM – Numbers and Operations, Gr. 3-5)</i></li> <li>• Develop fluency with basic number combinations for multiplication and division and use these combinations to mentally compute related problems, such as <math>30 \times 50</math>. <i>(NCTM – Numbers and Operations, Gr. 3-5)</i></li> <li>• Describe, extend, and make generalizations about geometric and numeric patterns. <i>(NCTM – Algebra, Gr. 3-5)</i></li> <li>• Identify, compare, and analyze attributes of two- and three-dimensional shapes and develop vocabulary to describe the attributes. <i>(NCTM – Geometry, Gr. 3-5)</i></li> <li>• Identify and build a three-dimensional object from two-dimensional representations of that object. <i>(NCTM – Geometry, Gr. 3-5)</i></li> <li>• Develop strategies to determine the surface areas and volumes of rectangular solids. <i>(NCTM – Measurement, Gr. 3-5)</i></li> </ul>	
<p><b>Lesson 5</b></p> <ul style="list-style-type: none"> <li>• When given a scenario, students will design a computer simulation to represent the situation, analyze the resulting data, and display the data in a table or graph.</li> <li>• When given an object’s properties such as length, width, height, surface area, volume, and location, students will represent that object as a three-dimensional shape in a coordinate plane.</li> </ul>	<ul style="list-style-type: none"> <li>• Identify, compare, and analyze attributes of two- and three-dimensional shapes and develop vocabulary to describe the attributes. <i>(NCTM – Geometry, Gr. 3-5)</i></li> <li>• Identify and build a three-dimensional object from two-dimensional representations of that object. <i>(NCTM – Geometry, Gr. 3-5)</i></li> <li>• Develop strategies to determine the surface areas and volumes of rectangular solids. <i>(NCTM – Measurement, Gr. 3-5)</i></li> <li>• Understand such attributes as length, area, weight, volume, and</li> </ul>	<p>Obstacle Course Construction</p>

	<p>size of angle and select the appropriate type of unit for measuring each attribute. <i>(NCTM – Measurement, Gr. 3-5)</i></p> <ul style="list-style-type: none"> <li>Describe location and movement using common language and geometric vocabulary. <i>(NCTM – Geometry, Gr. 3-5)</i></li> <li>Make and use coordinate systems to specify locations and to describe paths. <i>(NCTM – Geometry, Gr. 3-5)</i></li> </ul>	
<p><b>Lesson 6</b></p> <ul style="list-style-type: none"> <li>When given an object’s properties such as length, width, height, surface area, volume, and location, students will represent that object as a three-dimensional shape in a coordinate plane.</li> <li>When given an object, students will place that object at pre-designated and student-determined locations in a coordinate plane.</li> <li>When given a condition and consequence, students will represent it as a When...Do... statement in Kodu.</li> </ul>	<ul style="list-style-type: none"> <li>Identify, compare, and analyze attributes of two- and three-dimensional shapes and develop vocabulary to describe the attributes. <i>(NCTM – Geometry, Gr. 3-5)</i></li> <li>Identify and build a three-dimensional object from two-dimensional representations of that object. <i>(NCTM – Geometry, Gr. 3-5)</i></li> <li>Develop strategies to determine the surface areas and volumes of rectangular solids. <i>(NCTM – Measurement, Gr. 3-5)</i></li> <li>Understand such attributes as length, area, weight, volume, and size of angle and select the appropriate type of unit for measuring each attribute. <i>(NCTM – Measurement, Gr. 3-5)</i></li> <li>Describe location and movement using common language and geometric vocabulary. <i>(NCTM – Geometry, Gr. 3-5)</i></li> <li>Make and use coordinate systems to specify locations and to describe paths. <i>(NCTM – Geometry, Gr. 3-5)</i></li> </ul>	<p>Placing Items</p>

<p><b>Lesson 7</b></p> <ul style="list-style-type: none"> <li>• When given multiple target locations and obstacles, students will plot and model the shortest paths between the locations using a computer simulation.</li> <li>• When given a set of locations, students will determine different routes to visit all of the locations and determine the efficiency of each route by measuring the duration of travel.</li> <li>• When given a game goal, students will time how long it takes to achieve the goal and display the time as a countdown.</li> </ul>	<ul style="list-style-type: none"> <li>• Describe location and movement using common language and geometric vocabulary. <i>(NCTM – Geometry, Gr. 3-5)</i></li> <li>• Make and use coordinate systems to specify locations and to describe paths. <i>(NCTM – Geometry, Gr. 3-5)</i></li> <li>• Create and describe mental images of objects, patterns, and paths. <i>(NCTM – Geometry, Gr. 3-5)</i></li> </ul>	
<p><b>Lesson 8</b></p> <ul style="list-style-type: none"> <li>• When given an increase in target items, students will design an investigation to determine the effect on the time it takes to complete the retrieval of the items.</li> <li>• When given code templates, students will code their own specific actions by using the template as an example.</li> </ul>	<ul style="list-style-type: none"> <li>• Describe location and movement using common language and geometric vocabulary. <i>(NCTM – Geometry, Gr. 3-5)</i></li> <li>• Make and use coordinate systems to specify locations and to describe paths. <i>(NCTM – Geometry, Gr. 3-5)</i></li> <li>• Create and describe mental images of objects, patterns, and paths. <i>(NCTM – Geometry, Gr. 3-5)</i></li> <li>• Design investigations to address a question and consider how data-collection methods affect the nature of the data set. <i>(NCTM – Data Analysis and Probability, Gr. 3-5)</i></li> <li>• Collect data using observations, surveys, and experiments. <i>(NCTM – Data Analysis and Probability, Gr. 3-5)</i></li> </ul>	<p>Student Activity - Double the Items</p>

<p><b>Lesson 9</b></p> <ul style="list-style-type: none"> <li>• When given a task, students will sample a population to collect performance data on the task.</li> <li>• When given a set of data, students will use measures of center such as the mean and median, to describe the data set.</li> </ul>	<ul style="list-style-type: none"> <li>• Design investigations to address a question and consider how data-collection methods affect the nature of the data set. <i>(NCTM – Data Analysis and Probability, Gr. 3-5)</i></li> <li>• Collect data using observations, surveys, and experiments. <i>(NCTM – Data Analysis and Probability, Gr. 3-5)</i></li> <li>• Represent data using tables and graphs such as line plots, bar graphs, and line graphs. <i>(NCTM – Data Analysis and Probability, Gr. 3-5)</i></li> <li>• Use measures of center, focusing on the median, and understand what each does and does not indicate about the data set. <i>(NCTM – Data Analysis and Probability, Gr. 3-5)</i></li> <li>• Propose and justify conclusions and predictions that are based on data and design studies to further investigate the conclusions or predictions. <i>(NCTM – Data Analysis and Probability, Gr. 3-5)</i></li> </ul>	<p>Data Analysis</p>
<p><b>Lesson 10</b></p> <ul style="list-style-type: none"> <li>• When given a complete product, students will showcase their work and reflect on their learning.</li> </ul>	<ul style="list-style-type: none"> <li>• Organize and consolidate their mathematical thinking through communication. <i>(NCTM – Communication, Gr. 3-5)</i></li> <li>• Communicate their mathematical thinking coherently and clearly to peers, teachers, and others. <i>(NCTM – Communication, Gr. 3-5)</i></li> <li>• Recognize and apply mathematics in contexts outside of mathematics. <i>(NCTM – Connections, Gr. 3-5)</i></li> </ul>	

# Lesson 1: Growing Squares

## Standards

- Describe, extend, and make generalizations about geometric and numeric patterns.  
*(NCTM - Algebra, Gr. 3-5)*
- Represent and analyze patterns and functions, using words, tables, and graphs.  
*(NCTM - Algebra, Gr. 3-5)*
- Model problem situations with objects and use representations such as graphs, tables, and equations to draw conclusions.  
*(NCTM - Algebra, Gr. 3-5)*
- Represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules.  
*(NCTM - Algebra, Gr. 6-8)*

## Mastery Objectives/Results

- When given incremental changes in the area of a square, students will describe and analyze the pattern using math sentences and relationships.
- When given a condition and consequence, students will represent it as a When...Do... statement in Kodu.
- When given a control scheme, students will program their Kodu character to respond according to the specifications.

## Student Resources

- Clock Buddies (pdf)

## Teacher Resources

- Camera View Tutorial (video)  
*\* This foundational tutorial demonstrates how to change the camera perspective.*

## Vocabulary

- area
- pattern

## Lesson Sequence

### Activator (10 minutes)

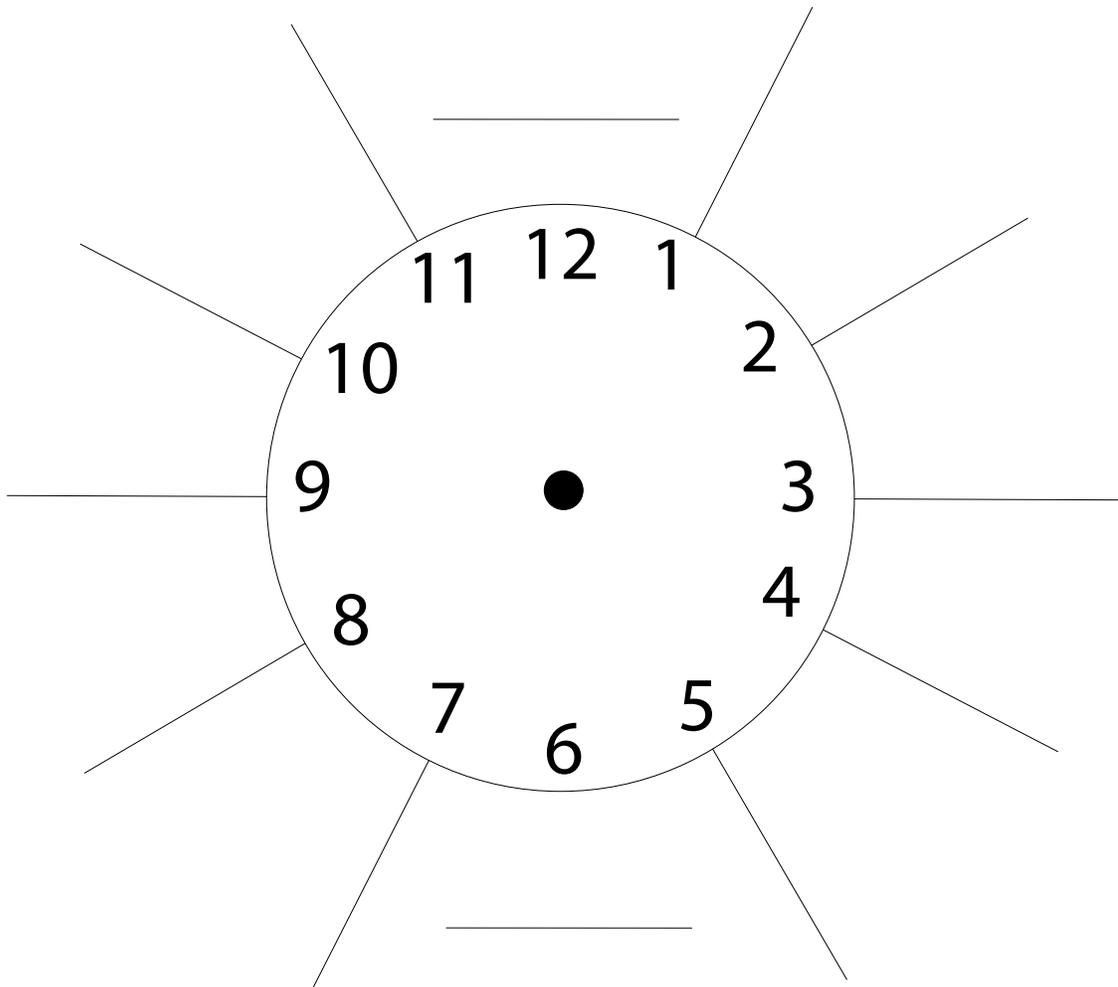
1. Tell students to fill out their clock buddies sheets in order to have a ready set of partners to work with. In clock buddies, students set up partnerships with a number of students.

Student A will go to student B and ask them if they have a 12 o'clock spot open. If student B does, then they will exchange names on their sheets.

The teacher will call out what clock buddy to work with when assigning a task involving pairs.



# CLOCK BUDDIES



## Navigating the Main Page and Selecting an Empty World (5 minutes)

2. Show students the Main Page of Kodu, how to navigate the menu, and what each option represents:

**Resume:** opens the game that was edited last by the user. If the user opens this window, the last game that was programmed or opened will appear. To back out of this window, click the House icon and then select Exit to Main Menu.

**Load World:** opens a series of games from which the user can select. The games can be perused by using either the arrow keys or clicking the on screen arrows with the mouse. To go back to the Main Menu, users press Escape.

**Options:** provides the user with the ability to change some broad level features of the game. To navigate this list, users either press the arrow keys or hover the mouse cursor over the green arrows on the screen. Escape will bring the user back to the Main Menu.

**Help:** offers a quick explanation of Kodu. Users press Escape to exit this menu.

**Quit Kodu:** allows users to leave the program.

3. Lead students through the opening of a new world

- Select “**Load World**” and click on Empty World.
- Click on “**Play**”. You will now have an empty world to work with.
- Press ESC to begin editing the world.

### Pair Programming

This curriculum utilizes a collaborative work method called pair programming.

Pair programming is an industry-based technique in which two people work at one computer together.

Each person has a different role. One person (called the driver), types in code, while the other person (the observer), reviews the code as it is entered.

In the case of Kodu, one student will be using the controller or keyboard to create/edit land and program objects, while the other student reviews the work and makes comments.

The roles switch after a teacher-designated time.

Pair programming has been shown to increase student enjoyment, engagement, and quality of work.

## Adding Land and Growing Squares (10 minutes)

4. Demonstrate how to add land in Kodu and give the students time to practice.
  - a. Choose the paintbrush in the toolbar.
  - b. Select the appropriate landscape material by clicking on the materials icon to the upper left of the paint brush and use the arrows to make a selection.

We will start out by using material 29, which provides a grid and dots within the squares to make them easy to count.

### Landscape

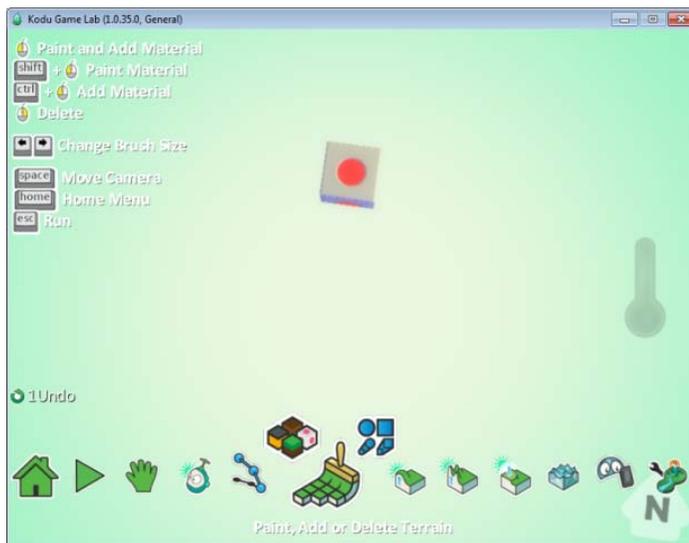
Creating and changing the Kodu landscape is one of the most interesting initial activities for early users of Kodu.

Their tendency is to spend hours changing and designing intricate landscapes in which their games and animations operate. The landscapes in this Kodu math module are primarily used to explore geometric concepts and patterns, rather than affect the mood or tone of a game's setting.

The intentions of the activities are for the kids to begin building worlds from the ground up (literally) and thinking about how to assemble the blocks to represent a particular geometric object. *There will be set opportunities for creative expression through landscape design.*



- c. Use the right and left arrow keys to change the brush size. Select a one square unit brush size.
- d. Zoom in for a good look at the square you will create by using the mouse's scroll wheel.
- e. Click the left mouse button once to add one square piece of land
- f. Orbit the camera to an overhead view by holding the space bar and holding the right mouse button to maneuver the camera perspective. To move the camera, hold the



space bar and hold the left mouse button to drag the camera.

(See the camera tutorial for help)

- g. To “paint” larger areas of land, press and hold the left mouse button while moving the mouse
- h. If students ever make a mistake, tell them to press and hold the right mouse button while moving the mouse to “erase” land.

### Choosing a Brush Shape

Choose the green paintbrush in the toolbar and the appropriate paintbrush by clicking on the geometric shapes icon to the upper right of the icon. Arrow through the choices and display the different brush shapes.

The square brush is the default brush shape and will give users a flat edge. *This module will use the square brush throughout the lessons.*

The circle brush gives a more rounded edge.

The extended square and circle icons allow users to draw stretches of land with a clearer edge.

The magic wand icon supplies an easy way to change the color and texture of a landscape en masse with ease.

## Growing Squares and Adding Objects (25 minutes)

- 5. Ask “How much space does one square take up?”
  - a. Allow for various responses.
  - b. Tell students that the area is one, because there is only one square.
- 6. Add a Kodu to the world. Say: “The Kodu barely fits onto one square.”
- 7. Tell students that you will now create a square that has two blocks on each side. Demonstrate the creation of a 2 x 2 square by changing the brush size.
- 8. Ask: “Does the Kodu have enough space now?”
- 9. Explain to students that the space available for placing objects is called area.
- 10. Ask students to calculate the area of the 2 x 2 square. Have them record the area in a table like the one below:

Side length	Area of Land
1	1
2	4
3	...
...	...

Show the students how to add different objects to the area. Give them some time to experiment with adding different objects.

- a. One way to add an object is to click on the Kodu tool and then click on the location where you want to add an object.
- b. To delete an object, you can click on the Kodu tool and right-click on the object you want to delete, then select Cut. You also select the Delete Objects tool and click on area where you want to delete objects, which is useful for deleting more than one object at a time.



11. Tell the students that you want to add more Kodu characters and objects, therefore you will need to add more area to the world.
12. Change the brush size to 3 x 3. Before creating this next square, pause and allow the brush to overlap the previous square for a while. Ask students to use this display to predict what the size of the next square will be. Some students may notice that the area increases by the next odd number with each new square. Allow students to come up with various ways to predict the new area without judgment.
13. Make an area that is 3 x 3 and ask students to record the new area (9).
14. Create a growing squares pattern up to 10 x 10 by continuing to create larger and larger squares and have students record the area of each square by counting the blocks that make up the square. They should end up with a table like this:

Side length	Area of Land
1	1
2	4
3	9
4	16
5	25
6	36
7	49
8	64
9	81
10	100

15. Once the 10 x 10 square is made, give the students time to add different objects to Kodu. Suggest adding clouds, trees, and rocks as landscape items.

16. Tell students to analyze the data in the table and describe the pattern they saw in the growing squares display. Encourage the students to explain the pattern verbally and to predict what will happen if the sequence is continued.

17. The growing squares pattern allows students to articulate a generalization such as "How does this pattern work for squares of other sizes?" Students in grade 3 or 4 should be able to predict the next element in a sequence by looking at a specific set of examples. By grade 5 or 6, students should be able to generalize by reasoning about the structure of a pattern, such as "the area of a square with side N is  $N \times N$ ".

### Control a Kodu with Arrow Keys

1. Right-click on the Kodu, select program
2. Click the When section and click keyboard. Note to the students that a Kodu can also be programmed to move using the Xbox 360 controller.
3. Click the Do area and click move.
4. Now exit the current view and go back to the world by pressing Esc.

### 18. Reflection

a. Ask students to describe the patterns below and determine the next number in the sequence:

- 1 3 5 7 \_\_\_\_
- 0 20 40 60 \_\_\_\_
- 1 1 2 3 5 8 \_\_\_\_\_

## Lesson 2: Length, Width, Area, and Perimeter

### Standards

- Identify such properties as commutativity, associativity, and distributivity and use them to compute with whole numbers.  
(NCTM - Algebra, Gr. 3-5)
- Identify, compare, and analyze attributes of two- and three-dimensional shapes and develop vocabulary to describe the attributes. (NCTM - Geometry, Gr. 3-5)
- Build and draw geometric objects.  
(NCTM - Geometry, Gr. 3-5)
- Develop, understand, and use formulas to find the area of rectangles and related triangles and parallelograms.  
(NCTM - Measurement, Gr. 3-5)

### Mastery Objectives/Results

- When given the length, width, and height measurements for quadrilaterals, students will create a three-dimensional object from two-dimensional representations.
- When given a three-dimensional quadrilateral, students will measure its length, width, and height using unit blocks.
- When given a multiplication problem, students will describe the effect of multiplying whole numbers and define multiplication in their own words.

### Student Resources

- Lesson 2 - Student Activity - Perimeter (doc)

### Teacher Resources

- Lesson 2 - Student Activity Key - Perimeter (doc)

### Vocabulary

- commutative
- length
- perimeter
- quadrilateral
- width

## Lesson Sequence

### Activator (5 minutes)

1. Display a square and a rectangle (not necessarily in Kodu).
2. Tell students to create a table listing the similarities and differences between the two shapes.
3. Describe what a quadrilateral is and how squares and rectangles are examples.

### Length, Width, and the Commutative Property of Multiplication (15 minutes)

4. Open up a new world.
5. Using material 29, add a 3 x 2 area of land by showing students how to add land and then trim it by deleting parts.
6. Ask students how this shape is different from a square. Explain the relationship that a square is a rectangle, but a rectangle is not necessarily a square. A square is a special type of rectangle.
7. Ask students to describe the length and width of the land. Students might differ over which side is the length and which side is the width. Explain that the side going North and South is the length, and the side going East and West is the width.
8. As a connection to the last lesson, ask students to calculate the rectangle's area by multiplying the length and width and note that it is the same method for calculating the area of a square.
9. Explain the commutative property of multiplication. In this example, whether you multiply 3 x 2 or 2 x 3, they produce the same result.

#### Add and Delete Land

1. Set the brush size to 3 x
2. Place the land.
3. Overlap only the blocks that you want to delete.
4. Click the right mouse button to delete them.

### Perimeter (20 minutes)

10. Create a 10 x 10 area of land
11. Add an apple or a coin to the middle of the land.
12. Add a Kodu at one of the corners.

13. Tell students, "A Kodu needs to guard this land and will patrol the edge."
14. Ask students, "If each side of a block were measured out to be one foot, how much would the Kodu move for one complete patrol of the land?"
15. Describe the notion of perimeter and have students calculate the perimeter of the rectangle.
16. Show students how to create a path and program a Kodu to follow a path to patrol the perimeter of the land.
17. Allow students time to practice this skill and experiment creating different paths. A wall can be built using the path tool and a character can be placed on top of the wall to patrol the wall. The students might choose to create paths in their end-of-module project.

### Create a Path

1. Click on the path tool and right-click on a location in the world. Select which type of path you want.
2. In this case, select Plain Path and click on the four corners of the land successively, making sure to end the path at the point of origin.
3. Click Esc to exit the path tool.
4. Click on the Kodu tool
5. Highlight the Kodu and click Program.
6. Click the Do area and click Move.
7. Click the plus sign after the Move tile and click On Path.
8. Click Esc twice to see the world play.

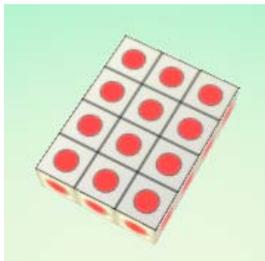
### Assessment (10 minutes)

18. Have students complete the Perimeter student activity.  
They will determine the length and width of different objects to calculate perimeter.

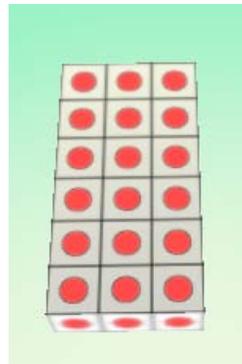
## Lesson 2 Student Activity – Area and Perimeter (KEY)

### Directions

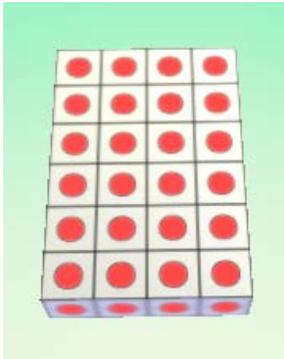
1. Determine the length and width of each shape.
2. Use the length and width to calculate the perimeter of each shape.
3. Include appropriate units. In this activity, 1 square is 1 meter (m).



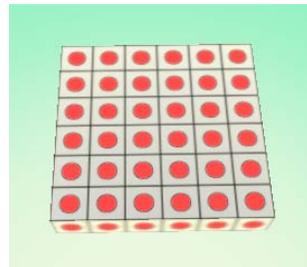
Length	4 m
Width	3 m
Perimeter	14 m



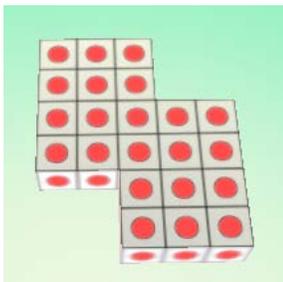
Length	6 m
Width	3 m
Perimeter	18 m



Length	6 m
Width	4 m
Perimeter	20 m



Length	6 m
Width	6 m
Perimeter	24 m



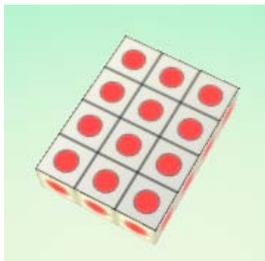
Bonus: Try this shape.	
Length	N/A
Width	N/A
Perimeter	22 m



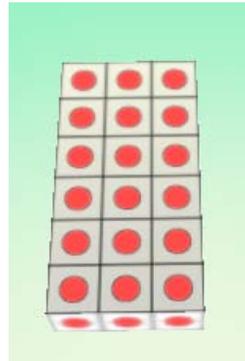
## Lesson 2 Student Activity: Area and Perimeter

### Directions

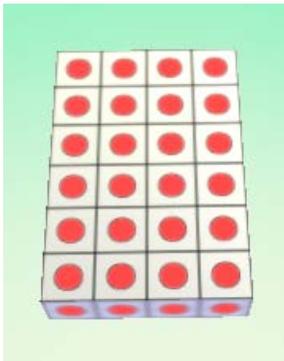
1. Determine the length and width of each shape.
2. Use the length and width to calculate the perimeter of each shape.
3. Include appropriate units. In this activity, 1 square is 1 meter (m).



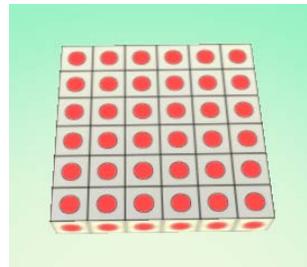
Length	
Width	
Perimeter	



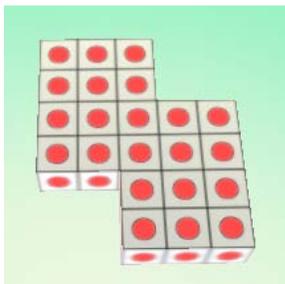
Length	
Width	
Perimeter	



Length	
Width	
Perimeter	



Length	
Width	
Perimeter	



Bonus: Try this shape.	
Length	
Width	
Perimeter	

## Lesson 3: Area, Perimeter, and Volume

### Standards

- Identify such properties as commutativity, associativity, and distributivity and use them to compute with whole numbers.  
(NCTM - Algebra, Gr. 3-5)
- Build and draw geometric objects.  
(NCTM - Geometry, Gr. 3-5)
- Explore what happens to measurements of a two-dimensional shape such as its perimeter and area when the shape is changed in some way.  
(NCTM - Measurement, Gr. 3-5)
- Develop strategies for estimating the perimeters, areas, and volumes of irregular shapes.  
(NCTM - Measurement, Gr. 3-5)
- Develop, understand, and use formulas to find the area of rectangles and related triangles and parallelograms.  
(NCTM - Measurement, Gr. 3-5)
- Understand such attributes as length, area, weight, volume, and size of angle and select the appropriate type of unit for measuring each attribute.  
(NCTM – Measurement, Gr. 3-5)
- Understand the need for measuring with standard units and become familiar with standard units in the customary and metric systems.  
(NCTM – Measurement, Gr. 3-5)

### Mastery Objectives/Results

- When given a measure of length, width, height, surface area, perimeter, and volume, students will describe the property with the appropriate standard units.
- When calculating the volume of a three-dimensional quadrilateral, students will demonstrate computational fluency, by using the associative property of multiplication.
- When given an irregular shape, students will determine the shape's area and volume.

### Student Resources

- Lesson 3 - Student Activity - Area and Perimeter (doc)

### Teacher Resources

- Lesson 3 - Student Activity Key - Area and Perimeter (doc)

### Vocabulary

- cube
- volume

## Lesson Sequence

### Activator (5 minutes)

1. Display the following shape properties and have students write the unit used to measure each property. They will choose from m, m<sup>2</sup>, and m<sup>3</sup>.
  - area
  - length
  - volume
  - width
  - height
  - perimeter

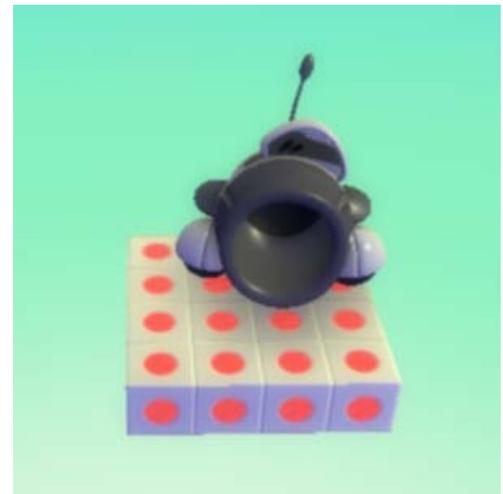
### Units (15 minutes)

2. Display a 3D quadrilateral in Kodu. The term for a 3D square is cube, while the proper term for a 3D rectangle is rectangular cuboid. Students should not need to know the latter term.
3. Explain that length, width, height, and perimeter can be measured in meters, where one unit is one meter (m). Feet can be a substitute for meters if it is the unit of measure the class is studying.
4. Explain that area is measured in m<sup>2</sup> because there are two numbers used to calculate it (length and width).
5. Explain that volume is measured in m<sup>3</sup> because there are three numbers used to calculate it (length, width, and height).
6. Create and display a shape such as a 4 x 6 x 2 island in Kodu. Point to different parts of the shape and ask students to calculate the length, width, height, area, surface area, perimeter, and volume of the object.
7. When students calculate the volume, ask them if  $(4 \times 6) \times 2$  is the same as  $4 \times (6 \times 2)$ , where the last operation is done first.
8. Describe this phenomena as the associative property of multiplication.

### Area and Perimeter (25 minutes)

9. Create a 2 x 2 square in Kodu. Ask students for the area and the perimeter.
10. Have students complete the Area and Perimeter student activity.

- a. Students will create shapes in Kodu and calculate the area of the top surface and the perimeter of each shape.
  - b. They should discover that while area of the shapes stays the same, the perimeter changes.
11. As an added exercise, have students explore the different objects in Kodu by placing them in the areas created.



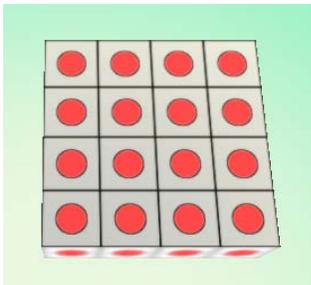
**Conclusion (5 minutes)**

12. Discuss how measurements are affected when one attribute to be measured is held constant and another is changed.
- a. Ask students, "What was the area for each shape?"
  - b. Ask students, "What was the perimeter for each shape?"
  - c. Ask students, "Why did the area stay the same but not the perimeter?"

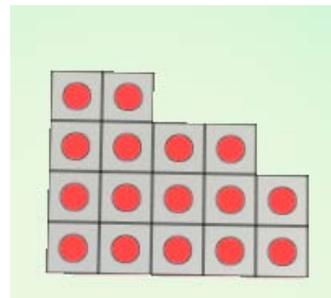
## Lesson 3 Student Activity – Area and Perimeter (KEY)

### Directions

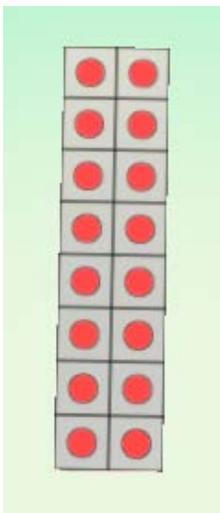
1. You will work with a teacher-designated clock buddy for this assignment and use pair programming rules to cooperate with one another. Your teacher will tell you when it is time to switch roles.
2. Create the shapes according to the pictures below.
3. You may only use materials 29, 30, or 31.
4. After creating a shape, calculate its area and perimeter. Record these next to each shape using the proper units.
5. When you are done with the shapes, answer the brief constructed response.



Area	16 m
Perimeter	16 m

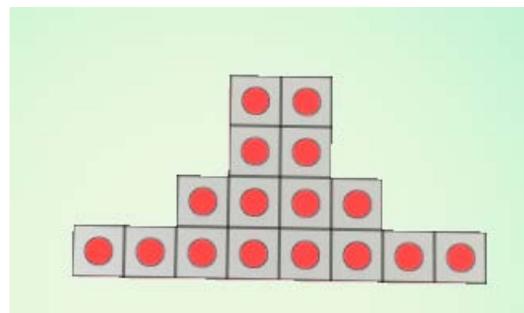


Area	16 m
Perimeter	18 m



Area	16 m
Perimeter	20 m

Area	16 m
Perimeter	24 m

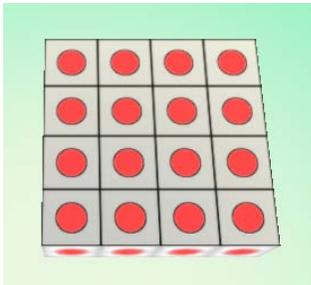




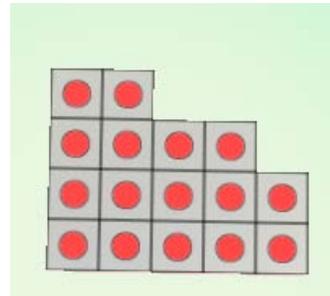
## Lesson 3 Student Activity: Area and Perimeter

### Directions

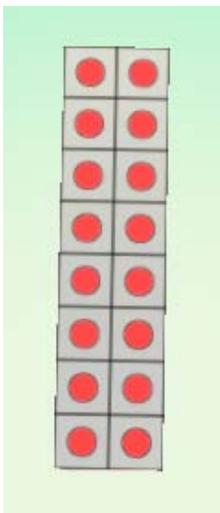
1. You will work with a teacher-designated clock buddy for this assignment and use pair programming rules to cooperate with one another. Your teacher will tell you when it is time to switch roles.
2. Create the shapes according to the pictures below.
3. You may only use materials 29, 30, or 31.
4. After creating a shape, calculate its area and perimeter. Record these next to each shape using the proper units.
5. When you are done with the shapes, answer the brief constructed response.



Area	
Perimeter	

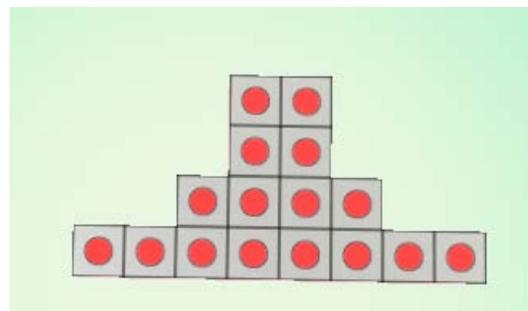


Area	
Perimeter	



Area	
Perimeter	

Area	
Perimeter	





### Brief Constructed Response

Can shapes with the same area have different perimeters? Support your answer with data from the table. Use the back of the sheet if you need more space.

## Lesson 4 - Surface Area and Volume

### Standards

- Develop understanding of fractions as parts of unit wholes, as parts of a collection, as locations on number lines, and as divisions of whole numbers. (NCTM – Numbers and Operations, Gr. 3-5)
- Use models, benchmarks, and equivalent forms to judge the size of fractions. (NCTM – Numbers and Operations, Gr. 3-5)
- Recognize and generate equivalent forms of commonly used fractions, decimals, and percents. (NCTM – Numbers and Operations, Gr. 3-5)
- Develop fluency with basic number combinations for multiplication and division and use these combinations to mentally compute related problems, such as  $30 \times 50$ . (NCTM – Numbers and Operations, Gr. 3-5)
- Describe, extend, and make generalizations about geometric and numeric patterns. (NCTM – Algebra, Gr. 3-5)
- Identify, compare, and analyze attributes of two- and three-dimensional shapes and develop vocabulary to describe the attributes. (NCTM – Geometry, Gr. 3-5)
- Identify and build a three-dimensional object from two-dimensional representations of that object. (NCTM – Geometry, Gr. 3-5)
- Develop strategies to determine the surface areas and volumes of rectangular solids. (NCTM – Measurement, Gr. 3-5)

### Mastery Objectives/Results

- When given a change to a shape, students will describe the change as a fraction of the original shape.
- When given a three-dimensional quadrilateral, students will measure its length, width, and height using a coordinate plane.
- When calculating the surface area of a three-dimensional quadrilateral, students will generalize and extend the pattern by using mental math techniques involving multiples of ten.
- When given changes to the length and width of a quadrilateral, students will describe and calculate the effect the changes have on surface area, perimeter, and volume.

### Student Resources

- Lesson 4 - Student Activity - Creating Shapes According to Specifications (doc)

### Teacher Resources

- Lesson 4 - Flying Blimp (Kodu file)

\* This world contains the first three shapes specified in the student activity as well as a flying blimp that creates apples when the space button is pressed.

## Vocabulary

- face
- surface area
- volume

## Lesson Sequence

### Activator (5 minutes)

1. Display a single square block in Kodu.
  - a. Ask students: “What is the area of one side of this cube?”
  - b. Ask students: “How many sides (surfaces) does it have?”
  - c. Ask students: “What is the total area of all of the surfaces?”
2. Explain that the area of all of the surfaces combined is called **surface area**.
3. Explain that today’s goal is to examine surface area and how it is affected when a shape is divided.

### Surface Area (15 minutes)

4. Tell students to create a 1 x 1 x 8 (L x W x H) tower in a new world. Write the answer (8) on a board.



5. Tell students to calculate the surface area of this tower (34). Remind them to not forget the bottom surface. An easy way to count surface area is to count the number of blocks that make up all of the faces of the object. Write the answer (34) on a board.
6. Create an irregular shape and ask them to calculate the surface area again. Have them give definitions for surface area in their own words.

### Extension: Exploring Fractions

Tell students to lower the tower to  $1 \times 1 \times 7$ . Ask students, "How high is the tower now?" (7 blocks). Write the answer (7) on a board. Ask students, "By what fraction of the original tower was the tower decreased ( $\frac{1}{8}$ )?" Now have them compute the surface area again (30).

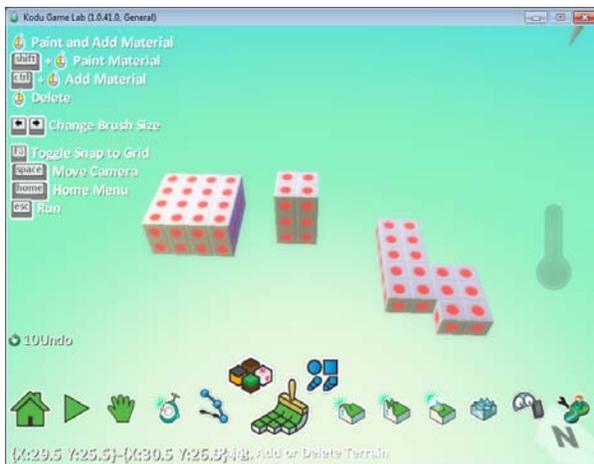
Tell students to lower the tower to  $1 \times 1 \times 6$ . Ask students, "How high is the tower now?" (6 blocks). Write the answer (6) on a board. Ask students, "By what fraction of the original tower has the tower been decreased now ( $\frac{2}{8}$  or  $\frac{1}{4}$ )?" Now have them compute the surface area again (26).

Repeat this process of lowering the tower by one block in height until students see the relationship between the height of the tower and the surface area. A student may remark that, "The surface area is always four times the number of cubes plus two more for the top and bottom surfaces." Another student may remark that whenever one block is removed, the surface area decreases by 4.

Ask students, "What would be the surface area of a tower with fifty cubes? (202)"

## Student Activity: Creating Shapes According to Specifications (30 minutes)

- Students will create shapes with certain lengths, widths, and heights.
- Students will also create shapes with specified surface areas and volumes, but they will get to decide the length, width, and heights themselves, so the resulting shapes will vary.
- Do the first question together and show students how to program a flying character to move and drop objects.
- This task will serve as a pre-requisite for creating the layout of the final project: a game in which a Kodu must navigate through an obstacle course of various shapes in order to find items in a certain amount of time.



### Extension:

#### Flying and Dropping Apples

Select the Kodu tool and click on the world.

Select the blimp.

Right-click on the blimp and select Program.

#### Statement 1:

Click the When section and click keyboard.

Click the Do area and click move.

#### Statement 2:

Click the When section and click keyboard.

Click the plus sign after the "keyboard" tile and select "misc", and then select "Space".

Click the Do area and click actions, and then create.

Click the plus sign after the "create" tile and select "apple".

## Lesson 4 Student Activity: Creating Shapes According to Specifications



### Directions

1. You will work with a teacher-designated clock buddy for this assignment and use pair programming rules to cooperate with one another. Your teacher will tell you when it is time to switch roles.
2. Create a shape according to the specifications in the questions below.
3. You may only use materials 29, 30, or 31.
4. You might also be asked to calculate some of the shape's properties. Remember to use proper units.
5. Print out pictures of your shapes when you are done.
6. If you are done early, experiment with your world by adding trees, clouds, and other objects or programming the object to perform actions.



**Extension:** Create a flying character that will visit the different areas you created and drop an object such as an apple or coin when the space button is pressed. Use the following code:



## Questions

1. Create a shape with a length of 4, a width of 4, and a height of 2.
  - a. What is the perimeter of this shape?
  
  
  
  
  
  
  
  
  
  
  - b. What is the surface area of this shape?
  
  
  
  
  
  
  
  
  
  
  - c. What is the volume of this shape?
  
2. Create a shape with a length of 2, a width of 2, and a height of 3.
  - a. What is the perimeter of this shape?
  
  
  
  
  
  
  
  
  
  
  - b. What is the surface area of this shape?
  
  
  
  
  
  
  
  
  
  
  - c. What is the volume of this shape?
  
3. Create a shape with a perimeter of 20.
  - a. What is the length of this shape?
  
  
  
  
  
  
  
  
  
  
  - b. What is the width of this shape?
  
  
  
  
  
  
  
  
  
  
  - c. If it is an irregular shape, draw a sketch and label the dimensions.

4. Create a shape with a surface area of 32.
  - a. What is the length of this shape?
  
  
  
  
  
  
  
  
  
  
  - b. What is the width of this shape?
  
  
  
  
  
  
  
  
  
  
  - c. What is the height of this shape?
  
  
  
  
  
  
  
  
  
  
  - d. If it is an irregular shape, draw a sketch and label the dimensions.
  
  
  
  
  
  
  
  
  
  
  - e. What is the volume of this shape?
  
  
  
  
  
  
  
  
  
  
5. Create a shape with a volume of 40.
  - a. What is the length of this shape?
  
  
  
  
  
  
  
  
  
  
  - b. What is the width of this shape?
  
  
  
  
  
  
  
  
  
  
  - c. What is the height of this shape?
  
  
  
  
  
  
  
  
  
  
  - d. What is the surface area of this shape?

## Lesson 5: Obstacle Course

### Prerequisite skills

- Locate points on an x,y coordinate plane

### Standards

- Identify, compare, and analyze attributes of two- and three-dimensional shapes and develop vocabulary to describe the attributes.  
(NCTM – Geometry, Gr. 3-5)
- Identify and build a three-dimensional object from two-dimensional representations of that object.  
(NCTM – Geometry, Gr. 3-5)
- Develop strategies to determine the surface areas and volumes of rectangular solids.  
(NCTM – Measurement, Gr. 3-5)
- Understand such attributes as length, area, weight, volume, and size of angle and select the appropriate type of unit for measuring each attribute. (NCTM – Measurement, Gr. 3-5)
- Describe location and movement using common language and geometric vocabulary.  
(NCTM – Geometry, Gr. 3-5)
- Make and use coordinate systems to specify locations and to describe paths.  
(NCTM – Geometry, Gr. 3-5)

### Mastery Objectives/Results

- When given a scenario, students will design a computer simulation to represent the situation, analyze the resulting data, and display the data in a table or graph.
- When given an object's properties such as length, width, height, surface area, volume, and location, students will represent that object as a three-dimensional shape in a coordinate plane.

### Student Resources

- Obstacle Course Mini-Game (doc)
- Lesson 5 - Student Activity - Obstacle Course Construction (doc)

### Teacher Resources

- Obstacle Course – Complete (Kodu file)
- Video Tutorial – Placing and Sizing an Obstacle

### Vocabulary

- coordinate
- simulation

## Lesson Sequence

### Activator (5 minutes)

1. Have students complete the Obstacle Course Mini-Game
  - a. Students will use their pencil to draw paths to navigate an obstacle course.
  - b. They are to draw lines from the starting point to each target and then come back to the starting point.
2. Explain to students that the game they just played represents a common problem people have in deciding which paths are the most efficient between different locations. This might be similar to the way students travel the hallways to and from classes or how someone decides the order of errands to perform. Explain that they will be simulating this situation as a video game in Kodu.
3. Explain that today's goal is to create an obstacle course composed of the 3D quadrilaterals that they have been studying recently. The shapes will be designed according to detailed specifications.

### Obstacle Course Game Demonstration (10 minutes)

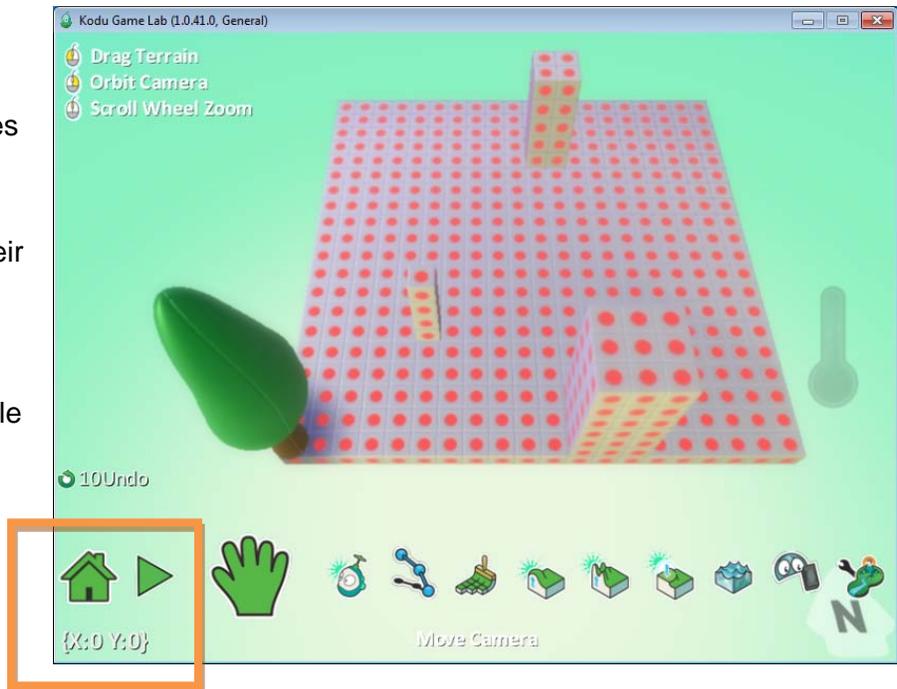
4. Show students the game demo and focus on the following aspects:
  - a. the grid that the world exists on
  - b. the raised shapes of different sizes at different locations on the grid that compose the landscape of the game
    - Zoom in on a few of the shapes and ask students to measure attributes such as length, width, and height. You may also want to have students calculate perimeter, volume, and area.
    - Describe how the location of the obstacles and targets are determined in terms of x and y coordinates.
  - c. how to play the game
  - d. WHEN-DO code for the
    - Kodu
    - tree
    - apples
    - timer
  - e. the extra decorations and objects that compose the world





## Student Activity: Obstacle Course Construction (25 minutes)

10. The rest of the class should be spent creating the required obstacles as detailed in the specification sheet.
11. Do the first obstacle with the students. Review how to:
  - a. maneuver the camera to change perspective
  - b. change the brush size to the desired length and width.
  - c. use the x,y coordinates to locate the spot for an obstacle.
  - d. place the obstacle by its bottom left corner.
  - e. raise the ground to the desired height.
  - f. calculate the perimeter, surface area, and volume of the resulting shape. In this case, the bottom does not count in the total surface area because it is not exposed.
12. Remind pairs to switch roles after a designated time.
13. Monitor the students' progress as they create their obstacle courses.
14. Make sure they complete they completely record the dimensions of each obstacle on their activity sheets in preparation for their homework.

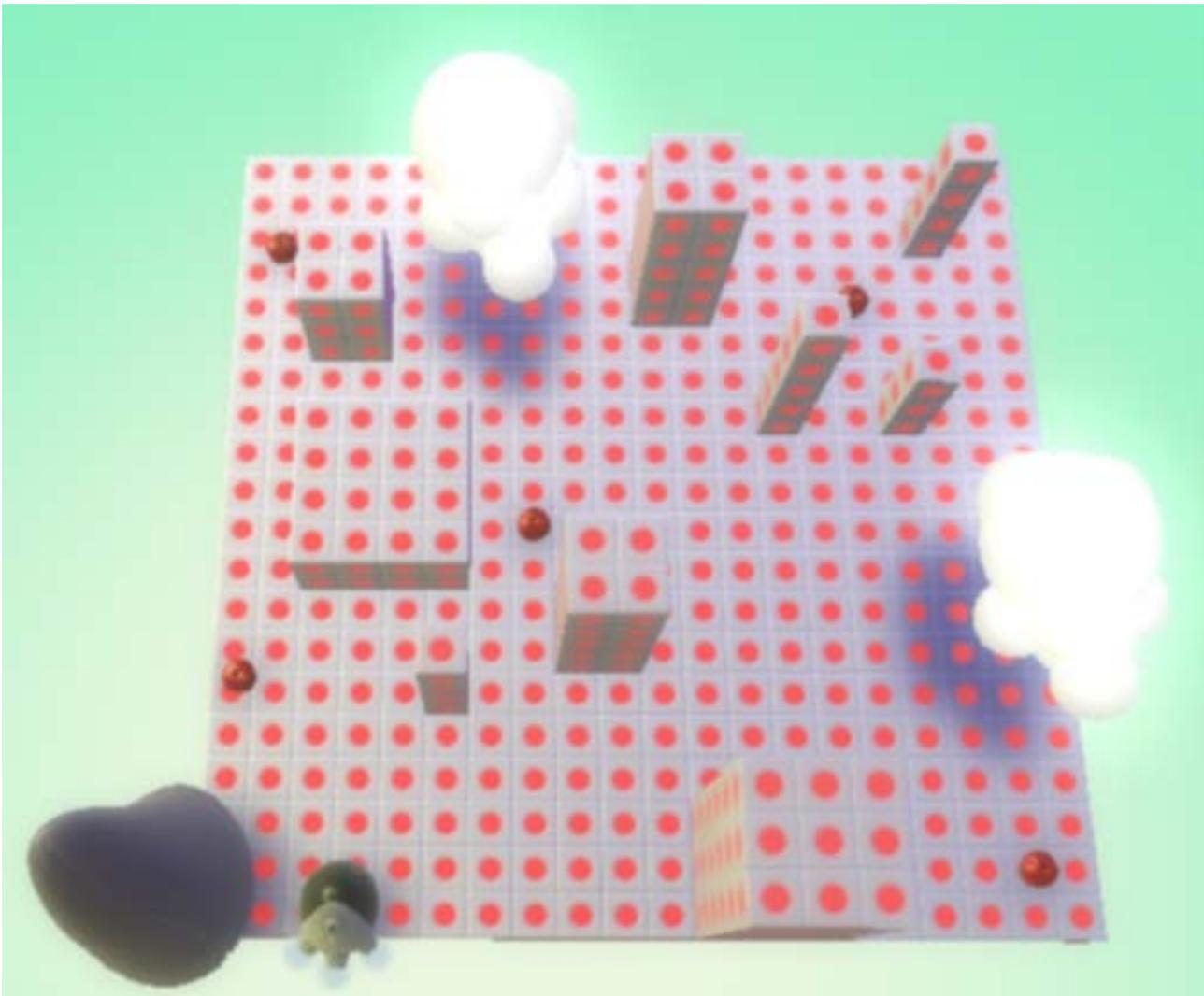


## Homework: Finish Calculations

The students should finish calculating the perimeter, surface area, and volume of their obstacles if they did not finish in class.

## Lesson 5: Activator - Obstacle Course Mini-Game

**Directions:** Use a pencil to draw paths to navigate the obstacle course. You are to draw lines from the starting point through each target and then come back to the starting point.





## Lesson 5 Student Activity: Obstacle Course Construction

### Directions

1. You will work with a teacher-designated clock buddy for this assignment and use pair programming rules to cooperate with one another. Your teacher will tell you when it is time to switch roles.
2. Start a new world and create a grid that is at least 20 x 20 and is placed so that the bottom left corner is at (0,0).
3. You may only use materials 29, 30, or 31.



4. Place a small tree in the bottom right corner of the grid. This will mark the origin (0,0).
5. Create an obstacle course according to the specifications in the table below.
6. You will be asked to calculate some of the shape's properties. Remember to use proper units.
7. You will have the option of choosing the location and dimensions of some of your obstacles.
8. If you are done early, decorate your game by adding trees, clouds, other objects, and additional obstacles. If you do choose to add more obstacles, you must record their data in the table below by adding more rows.

### Specifications

Obstacle	Location	Length	Width	Height	Perimeter	Surface Area	Volume
A	(5,5)	1	1	4			
B	(10,15)	2	2	5			
C	(11,0)	3	3	6			
D	( , )						
E	( , )						
F	( , )						
Additional							
Additional							

## Lesson 6: Placing and Programming Items

### Standards

- Identify, compare, and analyze attributes of two- and three-dimensional shapes and develop vocabulary to describe the attributes.  
(NCTM – Geometry, Gr. 3-5)
- Identify and build a three-dimensional object from two-dimensional representations of that object.  
(NCTM – Geometry, Gr. 3-5)
- Develop strategies to determine the surface areas and volumes of rectangular solids.  
(NCTM – Measurement, Gr. 3-5)
- Understand such attributes as length, area, weight, volume, and size of angle and select the appropriate type of unit for measuring each attribute. (NCTM – Measurement, Gr. 3-5)
- Describe location and movement using common language and geometric vocabulary.  
(NCTM – Geometry, Gr. 3-5)
- Make and use coordinate systems to specify locations and to describe paths.  
(NCTM – Geometry, Gr. 3-5)

### Mastery Objectives/Results

- When given an object's properties such as length, width, height, surface area, volume, and location, students will represent that object as a three-dimensional shape in a coordinate plane.
- When given an object, students will place that object at pre-designated and student-determined locations in a coordinate plane.
- When given a condition and consequence, students will represent it as a When...Do... statement in Kodu.

### Student Resources

- Lesson 6 - Student Activity - Placing Items (doc)

### Teacher Resources

- Obstacle Course - Stage 1 (Kodu file)

*\*This world contains a Kodu, obstacles, and a tree.*

### Vocabulary

- conditional

## Lesson Sequence

### Activator (5 minutes)

1. Tell students to write 2-3 pieces of advice they would give to other students who are creating the Kodu obstacle course made of shapes.
2. Ask students to share their answers with the class.
3. Tell students that they have finished creating their obstacles and will now place their apples, and then program the apples to score a point and disappear when touched.

### Placing and Programming an Apple to Score and Disappear (15 minutes)

4. Placing an apple
  - a. Open up Obstacle Course - Stage 1. This world contains the obstacles, but not the apples.
  - b. Show students how to select an apple and place it at an example location (3,3).
    - Select the Kodu tool.
    - Move the mouse to (3,3).
    - Click and select apple.
5. Programming an apple
  - a. Tell students to right-click on the apple and select Program.
  - b. Tell students that since they want the apple to do two different actions when it is touched by a Kodu, they will need two WHEN-DO statements.
  - c. Ask students to describe the WHEN-DO statements required to tell the apple to score a point and disappear when touched by the Kodu.
    - Ex: "WHEN the apple is touched, DO score a point"
    - Ex: "WHEN the apple is touched, DO disappear"



- d. Explain to students that a WHEN-DO statement is a **conditional** statement. An action is based on a condition being met. Only when the apple is touched will it score a point and disappear. Then WHEN part of the statement is the condition.
  - e. Demonstrate how to create the following WHEN-DO statements:
6. Now exit the current view and go back to the world by pressing Esc.
  7. Click the play button to play the world. You can alternatively press Esc again.
  8. Tell the students to add a Kodu to the game and program it to move like they have done previously.
  9. Have the Kodu touch the apple. The apple should disappear and a point should be scored!

### Programming an Apple

Add a tile to the WHEN section by clicking on the plus sign. Select the “bump” tile.

Click on the plus sign again. Select the “kodu” tile.

Add a tile to the DO section by clicking on the adjacent plus sign. Select the “game” tile, then the “score” tile.

Click on the plus sign again. Select the “1 point” tile.

Another WHEN-DO statement is required to make the apple disappear.

In a second WHEN-DO statement, add a tile to the WHEN section by clicking on the plus sign. Select the “bump” tile.

Click on the plus sign again. Select the “kodu” tile.

Add a tile to the DO section by clicking on the plus sign. Select the “combat” tile and then the “vanish” tile.

Click on the plus sign again. Select the “me” tile.

### Programming a Kodu to Move

Right-click on the Kodu, select Program

Add a tile to the WHEN section by clicking on the plus sign. Select the “keyboard” tile.

Add a tile to the DO section by clicking on the plus sign. Select the “move” tile.

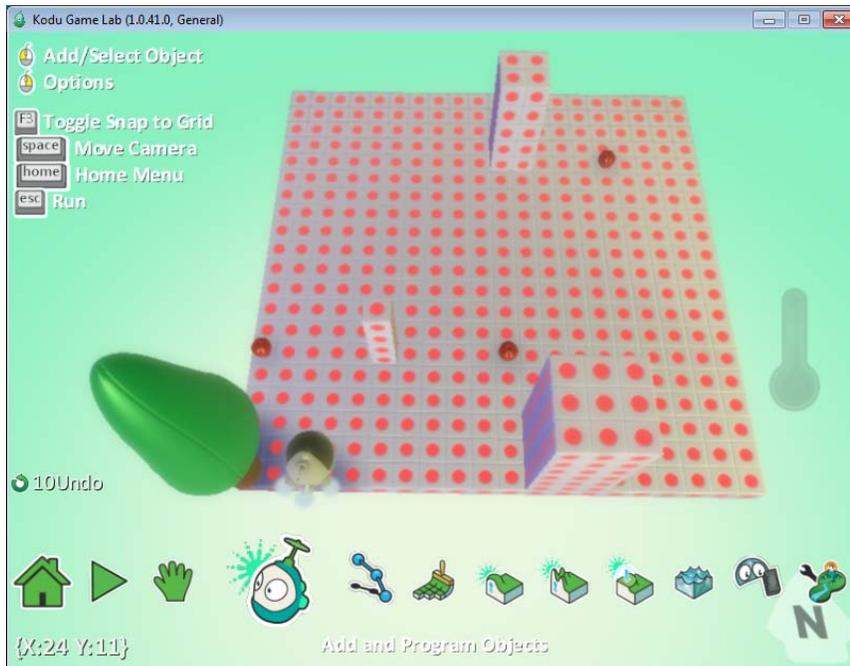
The Kodu will move according to the keyboard's arrow keys.

### Copying an Object (5 minutes)

10. Tell students that they will have to repeat the same procedure above for at least 5 apples total. (Wait for groans)
11. Now tell students that there is a way to copy the object along with its code.
12. Right-click on the apple. Select copy.

13. Right-click on a location. Select paste.

14. The apple will appear and contain the same code as the initial apple.



### Student Activity: Placing Items (25 minutes)

15. Give out the worksheet titled, “Student Activity – Placing Items”.
16. Tell students that they will now place the items that the Kodu will find. Some of the items have specific locations (coordinates), and some locations are left up to the students to determine.
17. Monitor the students' progress as they place items in their worlds.
18. Student who finish early can decorate their worlds or try the following extra programming task: When the Kodu bumps into an apple, it says, “Yippee!” Students may want to use the code as a template for other actions as well.

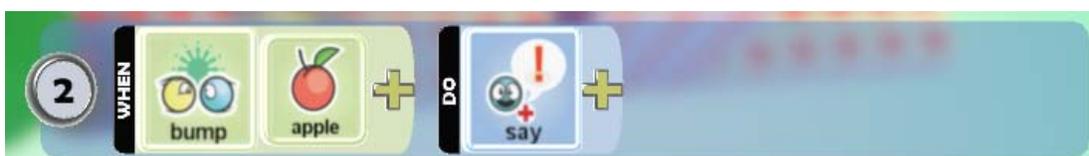
#### Extension: Say

Add a tile to the WHEN section by clicking on the plus sign. Select the “bump” tile.

Click on the plus sign again. Select the “objects” tile and then the “apple” tile.

Add a tile to the DO section by clicking on the adjacent plus sign. Select the “actions” tile, then the “say” tile.

Type the message that you want the Kodu to say.



## Lesson 6 Student Activity: Placing Items

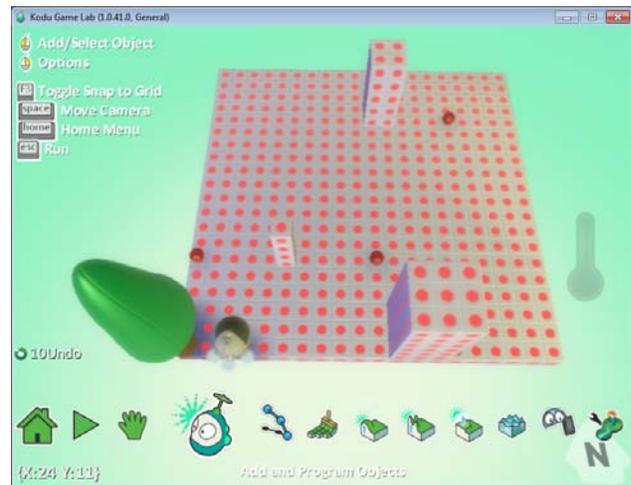
### Directions

1. You will work with a teacher-designated clock buddy for this assignment and use pair programming rules to cooperate with one another. Your teacher will tell you when it is time to switch roles.
2. In your game, your character will navigate through the obstacle course and find items. You may choose what type of item (apple, coin, etc.) that your character will pick up.
3. Place the items at the locations in the table below.
4. You may choose the location of some of the items yourself, but you must record the location in the table below.
5. If you are done early, decorate your game by adding trees, clouds, and other objects.



### Specifications

Item	Location
A	(0,5)
B	(10,5)
C	(15,15)
D	( , )
E	( , )
F	( , )
Additional	
Additional	



## Lesson 7: Timing and Winning

### Standards

- Describe location and movement using common language and geometric vocabulary. (NCTM – Geometry, Gr. 3-5)
- Make and use coordinate systems to specify locations and to describe paths. (NCTM – Geometry, Gr. 3-5)
- Create and describe mental images of objects, patterns, and paths. (NCTM – Geometry, Gr. 3-5)

### Mastery Objectives/Results

- When given multiple target locations and obstacles, students will plot and model the shortest paths between the locations using a computer simulation.
- When given a set of locations, students will determine different routes to visit all of the locations and determine the efficiency of each route by measuring the duration of travel.
- When given a game goal, students will time how long it takes to achieve the goal and display the time as a countdown.

### Teacher Resources

- Obstacle Course - Stage 2 (Kodu file)  
*\*This world contains a Kodu, obstacles, a tree, and items.*

### Vocabulary

- path

### Lesson Sequence

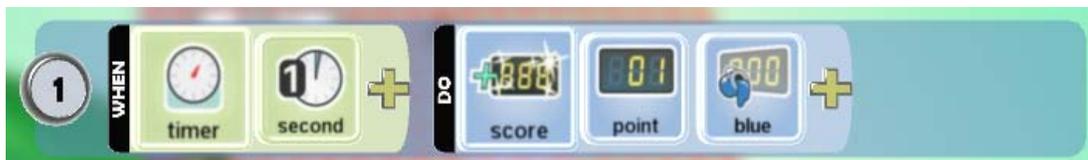
#### Activator (5 minutes)

1. Create an obstacle course in your room consisting of desks, chairs, tables, or just tape.
2. Place an item in the obstacle course and mark out a starting point.
3. Ask students, “Are there multiple paths to get to the item?”
4. Ask students, “How do you know which path is faster?”
  - a. Students may answer that the path with the shortest distance is best. Ask them how they would measure the shortest distance.

- b. Some may say that you'd have to have people take different paths and time how long they take to see which path is shortest.
5. Tell students that the goal of today's lesson is to model this scenario using our Kodu worlds. They will create a timer to record how long it takes people to travel to the target items.

### Programming a timer (15 minutes)

6. Select the Kodu tool and right-click on the tree. Select **"Program"**.
7. Program the tree to act as a timer. *(Note: The tree doesn't have to contain the code for the timer, any object in the world can)*
  - a. Add a tile to the WHEN section by clicking on the plus sign. Select the "timer" tile.
  - b. Add a tile after the "timer" tile by clicking on the plus sign. Select the "1 second" tile.
  - c. Add a tile to the accompanying DO section by clicking on the plus sign. Select the "score" tile.
  - d. Add a tile after the "score" tile by clicking on the plus sign. Select the "1 point" tile. (Here the score represents seconds that have passed since the start of the game)
  - e. Multiple scores can be shown at one time. Currently, the apples increase the score when they are touched and are displayed as a red score by default. The tree code should display the timer in a different color.
  - f. Add a tile after the "1 point" tile by clicking on the plus sign. Select the "scores" tile and then the "blue" tile.



### Winning the game (15 minutes)

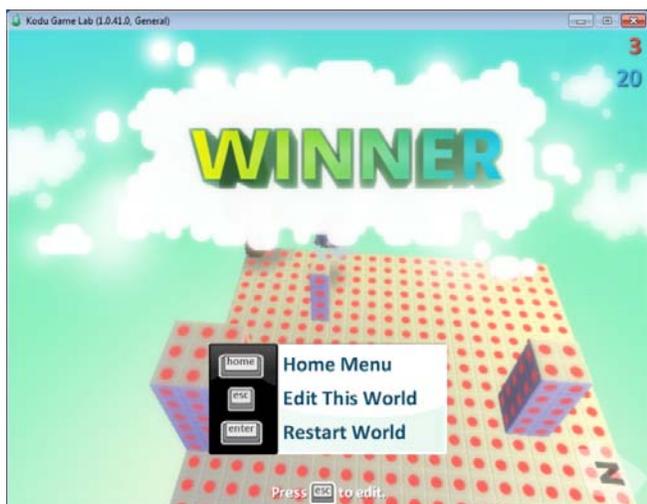
8. Program the game to stop the timer (and the game) when the Kodu has reached all of the items.
  - a. Select the Kodu tool, right-click on the tree, and select Program.
  - b. Add a tile to the WHEN section by clicking on the plus sign. Select the "scored" tile.
  - c. Add a tile after the "scored" tile by clicking on the plus sign. Select the "points" tile and then the number of points corresponding to the number of items in your world.

- d. Add a tile to the accompanying DO section by clicking on the plus sign. Select the “game” tile and then the “win” tile.



- e. When the Kodu scores the required number of points, the timer will stop, and “Winner” will be displayed. At this point the time can be recorded.

9. Allow students time to work on this task.



### Programming Actions (15 minutes)

10. Students may want their Kodu to perform actions in response to the keyboard. The following example code shows how to program the space key to make the Kodu jump. It can be used as a template to program other actions as well.

#### Keyboard-Controlled Actions

Add a tile to the WHEN section by clicking on the plus sign. Select the “keyboard” tile.

Click on the plus sign again. Select the “misc” tile, and then the “Space” tile.

Add a tile to the DO section by clicking on the adjacent plus sign. Select the “actions” tile, then the “jump” tile.



## Lesson 8: Double the Items, Double the Time?

### Standards

- Describe location and movement using common language and geometric vocabulary. (NCTM – Geometry, Gr. 3-5)
- Make and use coordinate systems to specify locations and to describe paths. (NCTM – Geometry, Gr. 3-5)
- Create and describe mental images of objects, patterns, and paths. (NCTM – Geometry, Gr. 3-5)
- Design investigations to address a question and consider how data-collection methods affect the nature of the data set. (NCTM – Data Analysis and Probability, Gr. 3-5)
- Collect data using observations, surveys, and experiments. (NCTM – Data Analysis and Probability, Gr. 3-5)

### Mastery Objectives/Results

- When given an increase in target items, students will design an investigation to determine the effect on the time it takes to complete the retrieval of the items.
- When given code templates, students will code their own specific actions by using the template as an example.

### Student Resources

- Lesson 8 – Student Activity – Double the Items (doc)
- Obstacle Course – Cannon and Rock (Kodu file)

*\*This world contains a Kodu, obstacles, a tree, items, a timer, a cannon, and a rock.*

### Teacher Resources

- Obstacle Course - Stage 3 (Kodu file)

*\*This world contains a Kodu, obstacles, a tree, items, and a timer.*

### Lesson Sequence

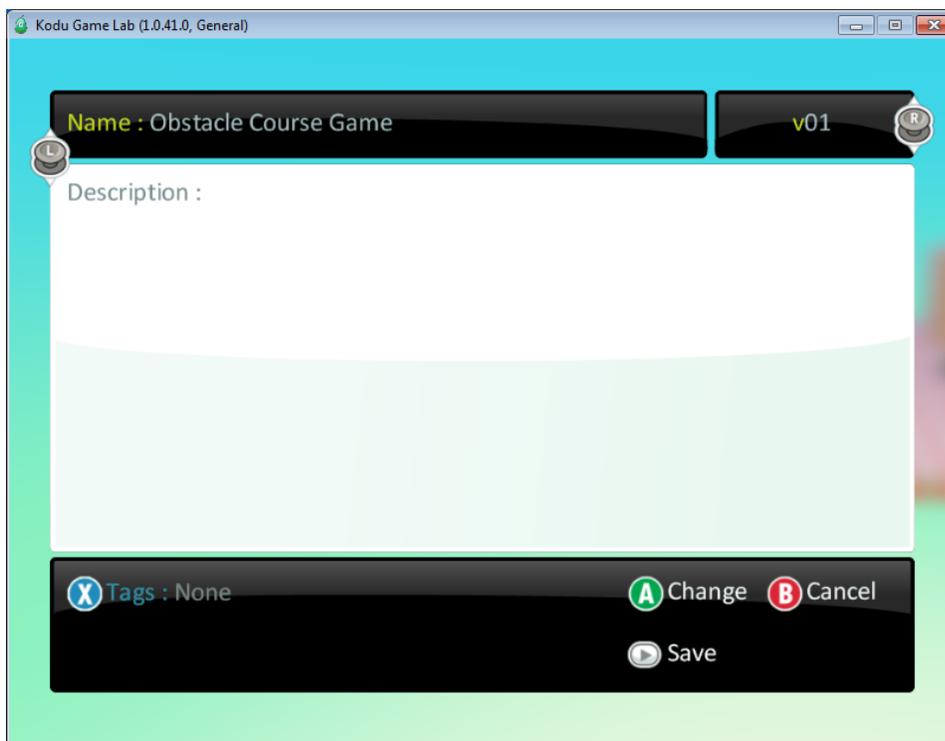
#### Activator (5 minutes)

1. Show students the current state of the Kodu world.
2. Ask: “How does the game change if there are even more items to pick up?”
3. We want to investigate a new scenario in which there are more errands to run represented by more apples placed in more locations.

4. Tell students that the goal of today's lesson is to investigate how doubling the number of items to find and pick up affects the time it takes to complete the game. Will it increase the time? By how much? Will it double the time?
5. Students will also get some free time to express themselves creatively in their worlds before showing their games to their friends.

### Student Activity: Creating Obstacle Course Version 2 (15 minutes)

6. Have students open up their current game.
7. Tell them to save their world, but give it a different name signifying the different version. There is also a version chooser in the top right corner of the Save menu.



8. Select the Kodu tool and right-click on one of the apples. Select Copy.
9. Right-click on a location and select Paste.
10. Repeat this until the number of items has doubled.
11. Students should record the new items in their student activity sheet.

### Creative Programming using a Template (30 minutes)

12. Demonstrate how to code the following actions:
  - a. When the Kodu bumps into a rock, the Kodu gets stunned

- Add a rock to the world.
- Right-click on the rock and select Program.
- Add a tile to the WHEN section by clicking on the plus sign. Select the “bump” tile.
- Add a tile after the “bump” tile by clicking on the plus sign. Select the “Kodu” tile.
- Add a tile to the accompanying DO section by clicking on the plus sign. Select the “combat” tile, and then the “stun” tile.
- Add a tile after the “stun” tile by clicking on the plus sign. Select the “once” tile. This will ensure that the Kodu is not permanently stunned.



b. A cannon wanders around the world. When the Kodu bumps into the cannon, the Kodu will explode and the game will end.

- Add a cannon to the world.
- Right-click on the rock and select Program.
- 1<sup>st</sup> statement
- Add a tile to the accompanying DO section by clicking on the plus sign. Select the “move” tile.
- Add a tile after the “move” tile by clicking on the plus sign. Select the “wander” tile.
- 2<sup>nd</sup> statement
- Add a tile to the WHEN section by clicking on the plus sign. Select the “bump” tile.
- Add a tile after the “bump” tile by clicking on the plus sign. Select the “Kodu” tile.
- Add a tile to the accompanying DO section by clicking on the plus sign. Select the “combat” tile, and then the “boom” tile.
- 3<sup>rd</sup> statement
- Add a tile to the WHEN section by clicking on the plus sign. Select the “bump” tile.
- Add a tile after the “bump” tile by clicking on the plus sign. Select the “Kodu” tile.
- Add a tile to the accompanying DO section by clicking on the plus sign. Select the “game” tile, and then the “end” tile.

**13.** Ask: “What are some other actions/events that you would like to create in your worlds?” Give students hints as to how to achieve their proposed actions.

**14.** Give students time to edit their worlds by using the examples learned in the demonstration. The demonstration code is contained in an example Kodu world named “Obstacle Course – Cannon and Rock”.



Name \_\_\_\_\_ Per \_\_\_\_\_ Date \_\_\_\_\_

## Lesson 8 Student Activity: Double the Items

### Directions

1. You will create a second version of your obstacle course game that contains double the number of items.
2. Place more items and record the locations in the table below.
3. Remember that you can just copy and paste the existing items.
4. If you are done early, decorate your game by adding trees, clouds, and other objects.



### Specifications

Item	Location
G	( , )
H	( , )
I	( , )
J	( , )
K	( , )
L	( , )
Additional	( , )
Additional	( , )



## Lesson 9: Data

### Standards

- Design investigations to address a question and consider how data-collection methods affect the nature of the data set.  
(NCTM – Data Analysis and Probability, Gr. 3-5)
- Collect data using observations, surveys, and experiments.  
(NCTM – Data Analysis and Probability, Gr. 3-5)
- Represent data using tables and graphs such as line plots, bar graphs, and line graphs.  
(NCTM – Data Analysis and Probability, Gr. 3-5)
- Use measures of center, focusing on the median, and understand what each does and does not indicate about the data set.  
(NCTM – Data Analysis and Probability, Gr. 3-5)
- Propose and justify conclusions and predictions that are based on data and design studies to further investigate the conclusions or predictions.  
(NCTM – Data Analysis and Probability, Gr. 3-5)

### Mastery Objectives/Results

- When given a task, students will sample a population to collect performance data on the task.
- When given a set of data, students will use measures of center such as the mean and median, to describe the data set.

### Student Resources

- Kodu Obstacle Course Demo World (Kodu File)

### Lesson Sequence

#### Activator (5 minutes)

1. Have students review how to calculate the average of the following number sets:
  - a. 5, 7, 2, 3, 3 (average = 4)
  - b. 6, 4 (average = 5)
  - c. 12, 13, 10, 13 (average = 12)
2. Tell students that they will be collecting data on how quickly people complete their obstacle courses when the number of apples to pick up increases.

### Data Collection and Calculation (30 minutes)

- Students will recruit at least 4 students from outside their group to play their game. The students will play two versions of the game. One version will have  $x$  items to pick up, while the other version will have  $2x$  items. In this lesson we will use 5 and 10 items.
- Tell the students to hypothesize how long it will take students to collect 5 items and then 10 items. Have them calculate the difference between the two hypothesized times.
- Ask: "Do you think it will take it will take double the time to collect double the items? Why or why not? ". They will later include their hypotheses and answers in an analysis of the project.
- They will collect the completion times for each version of the game in a table similar to the one below:

Name	Time to collect 5 items	Time to collect 10 items	Difference in times
Student A	34 seconds	45 seconds	+11 seconds
Student B	38 seconds	44 seconds	+6 seconds
Student C	39 seconds	52 seconds	+13 seconds
Student D	24 seconds	34 seconds	+10 seconds

- They will then perform calculations on the data and create a table like the one below:

Average time to collect 5 items	33.75 seconds
Average time to collect 10 items	43.75 seconds
Average difference in times	10 seconds

### Data Analysis (15 minutes)

8. The students will answer the following questions in their student activity sheet to report the results of their data collection. It is up to the teacher's discretion whether to assign the data analysis as group or individual work. They may have to finish this for homework.
- What was your hypothesis for how long it would take to collect 5 and 10 items?
  - What were the actual average results?
  - Did you think it would take double the time to collect double the items? Why or why not?
  - What was the actual average difference in times between picking up 5 or 10 items? Was this what you expected? Why or why not?
  - Explain why you think the difference in times was what it was.
  - What other experiment(s) would you perform to further investigate your conclusions?

## Lesson 9: Student Activity

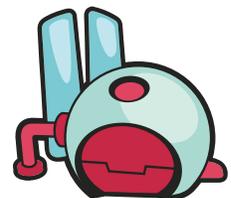
**Objectives:** Collect data, analyze it, and report your findings.

**Directions:** Pick four students to play two different versions of your game. In one version there will be  $x$  items to pick up, and the other version will have  $2x$  items. Complete the headings in the tables below by filling in the number of items you have in each version. Hypothesize the average time it will take your peers to complete each version of your game. Collect the data and calculate the averages. Analyze the data to see if it turned out the way you expected it.

Complete the tables and questions below.

Name	Time to collect ___ items (s)	Time to collect ___ items (s)	Difference in times (s)

Average time to collect ___ items	
Average time to collect ___ items	
Average difference in times	



## Questions

1. What was your hypothesis for how long it would take to collect 5 and 10 items?
2. What were the actual average results?
3. Did you think it would take double the time to collect double the items? Why or why not?
4. What was the actual average difference in times between picking up 5 or 10 items? Was this what you expected? Why or why not?
5. Explain why you think the difference in times was what it was.

## Lesson 10: Showcasing Creativity

### Standards

- Organize and consolidate their mathematical thinking through communication.  
(NCTM – Communication, Gr. 3-5)
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.  
(NCTM – Communication, Gr. 3-5)
- Recognize and apply mathematics in contexts outside of mathematics.  
(NCTM – Connections, Gr. 3-5)

### Mastery Objectives/Results

- When given a complete product, students will showcase their work and reflect on their learning

### Extension: 2 Player Game

#### Extension: 2-Player Game

Add another object, such as a cycle.

Program the cycle to move according to another set of keyboard keys. You will have to specify the keys and the corresponding directions.

Add code to the items so if a cycle bumps into them, they perform the same actions as if a Kodu hit them, but the score should be changed from the default red score to another color.

Edit the timer and win code similarly.

Now you can race to see who gets the most apples!

### Lesson Sequence

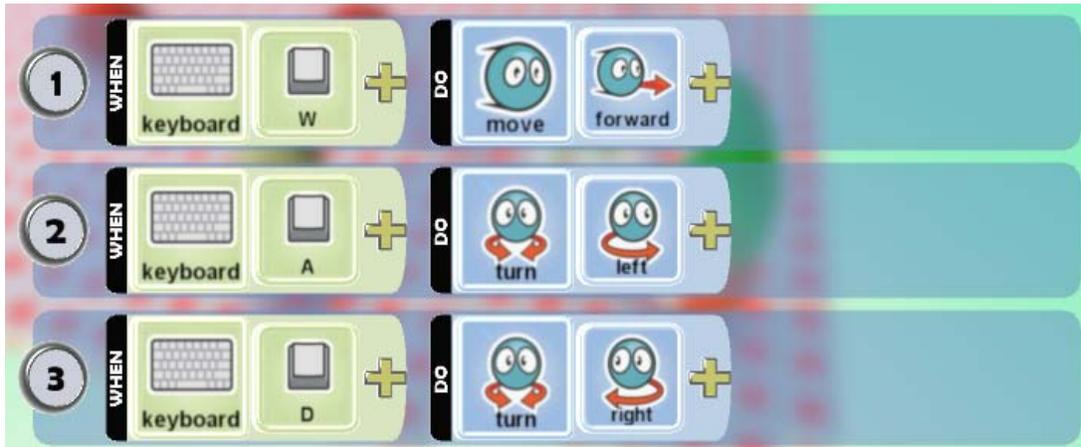
#### Activator (5 minutes)

1. List 5 things you have learned from the Kodu Math Module
2. Have students share what they learned.

#### Reporting the Results (20 minutes)

3. Have each student group read their data analysis to the class.
4. Also have each group describe any unique aspects of their game.

## Other keys for movement



### Gallery Walk (25 minutes)

5. Congratulate the students for their work and creativity.
6. Students should display their work at their computers and place a piece of paper next to their computer to allow for comments.
7. Students will walk around trying out each other's games and make positive comments on the comment sheets.