Lesson 1.1

Light and Shadow

Overview

During this lesson, students will gain understanding of how light and shadows affect our everyday life. They will experiment with light brightness to understand how shadows are formed. Students will consider how the human eye perceives color, measuring the shadows created by different colored lights and presenting their results.

Key Information

Level 1: (Ages 7-9) US Grades 2 or 3 Time: 45/90 minutes

Lesson consists of...		Learning Objectives
Warm-Up	5 mins	**As a result of this lesson, students will be able to**
Mini-lesson	10 mins	➜ Recognize the time of day and night in different cities of the world
Worked Example	7 mins	➜ Explain how the eye uses light to see and how perception is affected.
Challenge 1	7 mins	➜ Experiment with how shadows are created depending on light source.
Challenge 1 - Debug	5 mins	➜ Create a SAM system to generate a shadow on an object experimenting with brightness, color and position.
Challenge 2	7 mins	
Tidy Up / Exit Ticket	4 mins	

Lesson Topics

Physical Science
- ➜ Light reflecting from objects enters the eye to allow objects to be seen
- ➜ Shadows are formed when light from a source is blocked by an object

Computing
- ➜ Inputs, outputs, abstraction, debugging.

Scientific Thinking
- ➜ Generating relevant questions and using scientific inquiry to explore answers.

Design and Technology
- ➜ Generate, develop, model and communicate ideas through talking, drawing and mock-ups

Art and Design
- ➜ Explore and use mechanisms, devices and materials for imaginative activity that leads to original and creative outcomes.

English Language Arts
- ➜ Use information gained from illustrations and the words in a text to demonstrate understanding of the text.
- ➜ Determine the meaning domain-specific words and phrases in a text relevant to a grade 2-3 topic or subject area

Materials required

➜ SAM Labs Kit ➜ Student Workbook ➜ Large flashlight ➜ Pencils

Light and Shadow

- ➔ Ping pong balls or equivalent
- Spherical globe (which can be rotated)
- ➔ Time zone chart
- ➔ Plain white paper

Warm Up – 'Scientific Investigation' — 5 minutes

What is the time of day in different cities of the world?

Objective: Recognize how light and shadow relate to the time of day or night in different cities of the world

Procedures: *"Today, we are going to learn about light and shadow and the role they play in our everyday life. Did you know that light and shadow help us to know what time of day it is?"*

- Adjust the light in the classroom such that subtleties between light and shadow are apparent to students.
- Using a spherical globe and a strong flashlight. Point the flashlight directly on a city/country.
- Students identify the time of day or night in different cities of the world by the amount of light or darkness they perceive in those places.
    - Probe students as to why shadows appear in some areas and not others.
- Teacher leads students through one example in student workbook 'Observation - Prediction - Result' chart.
- Options to select one or two additional cities for students to investigate and record their results.

Link forward: The color and brightness of the light affects how we perceive the shadows generated.

Mini-lesson — 10 minutes

How does the human eye use light to see?

Objective: Explain how the human eye uses light to see and how perception is affected

Procedures: "*We know light and shadow helps us to know what time of day it is. But how do we see? Does anyone know? Do we all see the same thing? We're going to investigate how the human eye perceives light and color."*

- T uses the circle in the mini-lesson portion of the Student Workbook to draw the iris, lens and retina. Students follow along.
    - The 'iris', situated at the front of the eye and it lets the light in.
    - Light travels through the 'iris' to the 'lens'.
    - The 'lens' focuses an amount of light onto the 'retina' at the back of the eye.
    - The 'retina' detects the light and special cells (rods and cones) that react to red, green and blue. This sends signals to the brain allowing us to see.
    - To increase the amount of light our pupils gets bigger. To decrease it, our pupils gets smaller.
        - Option to illustrate this by turning the classroom light off then on and using a mirror to notice the size of the pupil decrease.
    - Color plays a part in the amount of light that is filtered to the retina; yellow is perceived as brighter than red, blue and green.
    - When a yellow (or white) light is used we 'detect' the shadow easier than when cast from a red light.
    - The retina can be faulty and not detect red, green and blue accurately. This results in color blindness.
- Option to show a portion of this video (https://www.youtube.com/watch?v=HkcxRYdhQ5s) discussing how the eye works. (8 minutes)

At the end of the mini-lesson, students can match or define keywords in their workbooks. (2 minutes)

Light and Shadow

Keywords

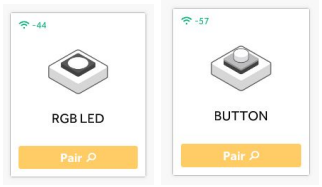
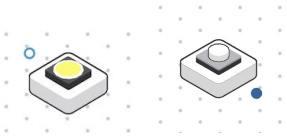
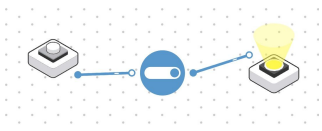
- Lens
- Retina
- Iris
- Color blindness

Let's Discuss: *How do shadows appear? Using the diagram in your workbook, describe one way light and shadows help us in our everyday life.*

Link forward: Student design and conduct an experiment to test how brightness and color can affect our perception of the shadow generated.

Worked Example — 7 minutes

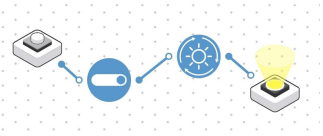
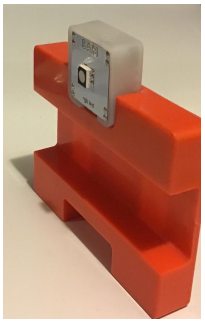
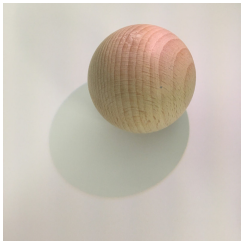
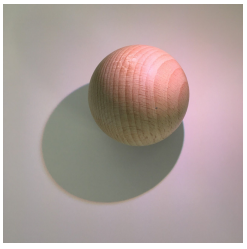
Create a system that forms shadows.

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 1 RGB LED • 1 Button/Virtual Button		*Remind students they need to hold the on/off button down for a few seconds for it to turn on. A red light will appear once it is on.*
Step 2. Drag the RGB LED and Button onto the workspace.		*The RGB LED block will enable us to create shadows from the light source.*
Step 3. Add a Toggle block to the workspace.		*What is the difference in how our system operates if we add or remove the Toggle block? (Hint: The Toggle Block is an input/output which allows you to keep the light on or off without having to hold down the Button).*
Step 4. Connect the Button and RGB LED. Add the Toggle between them. Test your system.		

Challenge 1 — 7 minutes

Create a system to test how the brightness affects the shadow created

Light and Shadow

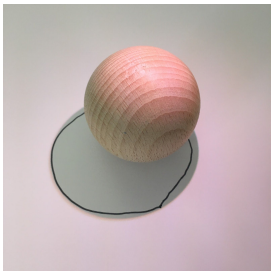
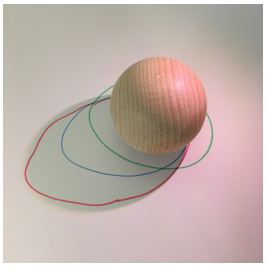
Instructions	Workspace	Notes for Teachers
Step 1. Add a Cycle Brightness block to the workspace.		*Test how the brightness of a light can affect the shadow created by adding the Cycle Brightness block to the system, between the Toggle and RGB LED.*
Step 2. Connect the Cycle Brightness block between the Toggle and the RGB LED.		*Explore the Cycle Brightness block by pressing the Button. The the level of brightness will change from 100%, 60% and 30%. How does the brightness of the light have an effect on the shadow cast?*
Step 4. Place a ping-pong ball in the middle of the table. Place the RGB LED block in the red accessory and position it 3 inches from the ping-pong ball.		*Turn on the system, place the light 3 inches from your ping pong ball and notice the shadow created by the light at its current setting.* *In testing, an experiment should be fair. The position of the light should be consistent for a fair test. You may want to hand out rulers to ensure accuracy - a nice mathematics extension.*
Step 5. Press the Button. The brightness of the RGB LED will change intensity with each press.	 	*Shadows change shape and size depending on the brightness of the light.*

Checks for understanding: *What happens to the shadow when the light source is dimmed? What happens to a shadow if the light source is moved closer or farther away from the object?*

Challenge 1 - Debug it — 5 minutes

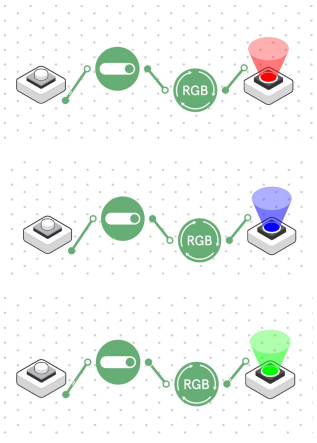
How much does the shadows move?

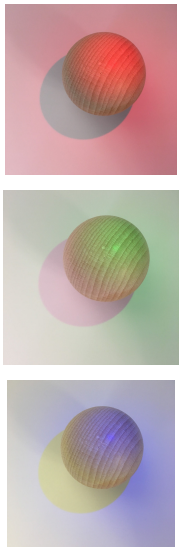
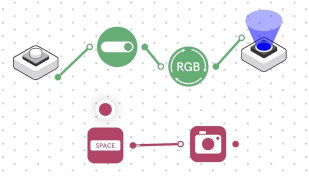
Instructions	Workspace	Notes for Teachers

Step 1. Place the ping pong ball on a white piece of paper and trace the shadow.		*You may want to dim, switch off the lights or draw blinds. Remind students that the proximity and position of the RGB LED will also affect the visibility of the shadow.*
Step 2. Change the distance of the light to the ping-pong - 1 inch, 3 inches and 6 inches from the ball. Trace the shadow each time.		*Each time you change the light's distance from the object, draw around the shadow and discuss how the shadows shape and size changes.* *What happens to the visibility of the shadow as the distance from the light is increased?*

Challenge 2 — 7 minutes

Create a system to test how the color of the light affects the shadow

Instructions	Workspace	Notes for Teachers
Step 1. Remove the Cycle Brightness block from the system and replace with the RGB Cycle Colors block		*We are now looking at the effect color has on shadows. The Cycle Colors block allows the color to change from Red, Green and Blue. Remind students that the brightness of the light will persist so it's important to check the brightness is set to 100%.*
Step 2. Place the RGB Cycle Colors block between the Toggle and the RGB LED blocks.		*The Toggle block acts as the switch and each time the switch is on the color will change.*
Step 3. Press the Button to see the light change between the 3 colors red, green and blue.		*Ask students to consider how color has an effect on how we feel, like traffic lights and temperature. In the case of temperature, red = hot, blue = cold.* *Ensure the system is working effectively before moving to the experiment.*

Step 4. What is the difference between the shadows? Which is easiest/hardest to see?		*Remember to keep the light position the same in all tests to allow it to be a fair test.*
Step 5. Present your results. To photograph your experiment, add a Key Press and a Camera block to the workspace and connect them. Press the Key Press each time you want to take a photo.		*Using the Camera block, students can photograph each light change and effect. (Photos are saved to the 'Photos/Pictures' folder/desktop of your device). Notice that the shadow stays the same but the strength of a shadow's visibility is different depending on the color of the light . "Based on these results, why do you think yellow is the common color for lights?"*

Extension Ideas:

- **Science**:
  - Does light appear differently on materials (e.g. concrete versus aluminum foil)? What about the shadow cast?
  - How does pollution affect the intensity of the sun?
  - How have other animals evolved to "see" light and color?
  - Does the color of the Sun affect the shadow created? Does the moon cast shadows?
- **Engineering**:
  - Can you create a machine to investigate the best colors for color blind individuals?
  - Can you design a traffic light system that would alert color blind or hearing impaired individuals that the light has changed color?
- **Geography**:
  - How else does the position of the sun in the world affect the shadows created? Zero shadow day on the equator. Lahaina noon in Hawaii
- **English**:
  - Describe other effects the color could have on an object. For example, what does the color red make you think of (hot)?

Checks for understanding: *Which block caused the shadow move and change shape? Why do you think yellow is the most common color of lights?*

Tidy Up / Exit Ticket — 4 minutes

Reinforcing the learning objectives of the lesson, students can reflect on key takeaways by completing and submitting an exit ticket.

Compose a Song

Overview

During this lesson, students will gain an understanding of music therapy and that music is composed of notes. Students will integrate and exhibit learning by performing a song which uses the Do-Re-Mi scale.

Key Information

Level 1: (Ages 7-9) US Grades 2 or 3 Time: 45/90 minutes

Lesson consists of...		Learning Objectives
Warm-Up	5 mins	**As a result of this lesson, students will be able to**
Mini-lesson	10 mins	➜ Recall a memory that corresponds with the chosen music
Worked Example	7 mins	➜ Explain how notes are combined to create music
Challenge 1	7 mins	➜ Create a SAM keyboard using Sol-fa notation
Challenge 1 - Play it!	5 mins	➜ Develop the system to play the song automatically
Challenge 2	7 mins	
Tidy Up / Exit Ticket	4 mins	

Lesson Topics

Music
Create rhythmic and melodic patterns for a specific purpose, including:
- ➜ Playing a song
- ➜ Playing a musical instrument
- ➜ Musical notation (sol - fa)

Computing
- ➜ Inputs, outputs, composition, decomposition, debugging

Scientific Thinking
- ➜ Asking relevant questions and using different types of scientific enquiries to answer them

English Language Arts
- ➜ Use information gained from illustrations and the words in a text to demonstrate understanding of the text
- ➜ Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area

Materials required

- ➜ SAM Labs Kit
- ➜ Sheet music for Twinkle, Twinkle Little Star (optional)
- ➜ Student Workbook

Warm Up – 'Do you remember this song?' 5 minutes

What memories do you associate with music?

Objective: Recall a memory that corresponds with the chosen music

Procedures: *"Today we are going to learn how music is made by a combinations of notes"*
- Listen to a few popular songs and discuss/write/share 'what memory they associate with the song'.
- Look at the songs chosen and discuss why they are memorable
- What makes a good song?

Sample song ideas:
- Happy Birthday
- Twinkle, Twinkle Little Star
- "Where You Are" - Moana soundtrack

Link forward: Link to what notes are and the sequences that they can be put in to make music

Mini-lesson 10 minutes

How is music created and how can it help people?

Objective: Explain how notes are combined to create music

Procedures:
- Music is now being used as a form of therapy to help dementia patients remember things and this clip (https://www.youtube.com/watch?v=fyZQf0p73QM&feature=youtu.be) will show a patient benefitting from music therapy.
- Music is composed of notes, and these notes can evoke emotions that we can associate with good/bad memories.
- Music is made up of individual sounds called 'notes', a group of sounds called 'chords' and a combination of pitches and rhythms called a 'melody'.
- One of the most popular scales in music is the solfège major scale of 'C' and there are 8 notes which comprise the scale (Do, Re, Mi, Fa, Sol, La, Ti, Do.). (8 minutes)

At the end of the mini-lesson, students match or define keywords in their workbooks (2 minutes).

Keywords
- Notes
- Chord
- Music therapy
- Melody
- Solfège Scale

Let's Discuss: *How can music therapy help people? In your workbook or with a partner, record, discuss, or share your favorite song and what memory you associate with it.*

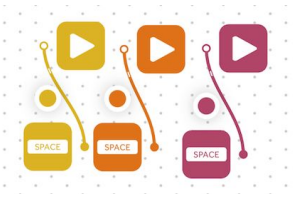
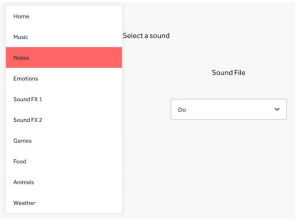
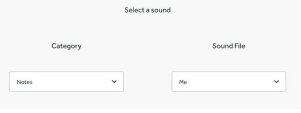
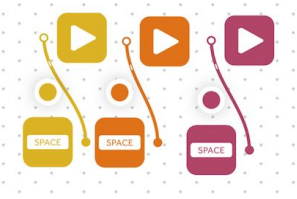
Link forward: Teacher links to the practical portion of the lesson whereby students compose a song (Twinkle, Twinkle, Little Star) that can be used in a (mock) musical therapy session.

Compose a Song

Worked Example

7 minutes

Make a system that plays three notes

Instructions	Workspace	Notes for Teachers
Step 1. Drag 3 Key Press blocks onto the Workspace.		*The Key Press blocks will act as keys of a 'piano' in our system.* *Alternatively, you can use Button or Virtual Button blocks.*
Step 2. Drag 3 Sound Player blocks onto the Workspace.		*Each Sound Player block will be programmed to play a different note.*
Step 3. Connect each Sound block to a Key Press block.		*(If using a computer) assign 'Q', 'W' and 'E' to each Key Press block in the settings as this will mimic the piano keys in a line to play.*
Step 4. The Key Press block will act as our input and help us to play the notes. Test it out.		*On a tablet, the Key Press block has a dot above it. Use these to generate an input.* *On a computer (Windows/Chromebook) utilise 'Q', 'W' and 'E' to mimic a keyboard - notes in a line are easier for students to play*
Step 5. Open the Settings icon of the first (leftmost) Sound Player block. Select 'Notes' and 'Do'.		*We are using 'absolute' sol - fa here where 'Do' = C. This is less confusing for students than 'moveable sol-fa' where 'Do' is always the tonic or base note of the scale, irrespective of the key.*
Step 6. Repeat step 5 with the remaining 2 Sound Player blocks, selecting 'Re' and 'Mi'.		*We are adding D and C, giving students the first three notes of the Major scale.*
Step 7. Test your system.		*Play the notes for a short time. Do they notice that they can play chords? (two notes simultaneously)*

Compose a Song

Challenge 1 — 7 minutes

Make a keyboard instrument

Instructions	Workspace	Notes for Teachers
Step 1. Drag 5 additional Sound Player and Key Press blocks onto the workspace.		*We recommend arranging the blocks horizontally like a keyboard and the correct order for the Notes is: do, re, mi, fa, sol, la ,ti, do +1*
Step 2. Program each note in the appropriate order of the Do-Re-Mi scale. Ensure the final Player is set to 'Do + 1'.		*The note Do +1 is the higher of the notes and needs to be at the end of the scale*
Step 3. Test your system.		*As the Key Press blocks are in a line on the screen it will make the final instrument easier to play. (If using a computer) use the keys across the top line Q, W, E, R, T, Y … etc so they are inline too.*
Step 4. Let's play some songs. Here is one...	do, do, sol, sol, la, la, so_, fa, fa, mi, mi, re, re, do_	*Do you recognize the song? (Twinkle, Twinkle, Little Star.)*
Step 5. Play the whole song.	do, do, sol, sol, la, la, sol_ fa, fa, mi, mi, re, re, do_ sol, sol, fa, fa, mi, mi, re_ sol, sol, fa, fa, mi, mi, re_ do, do, sol, sol, la, la, sol_ fa, fa, mi, mi, re, re, do_	*If using a keyboard the sequence is :* Q, Q, T, T, Y, Y, T_, R, R, E, E, W, W, Q T, T, R, R, E, E, W_ T, T, R, R, E, E, W_ Q, Q, T, T, Y, Y, T_, R, R, E, E, W, W, Q

Checks for understanding: *What's the difference between a note and a chord? What is a melody?*

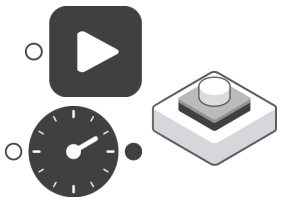
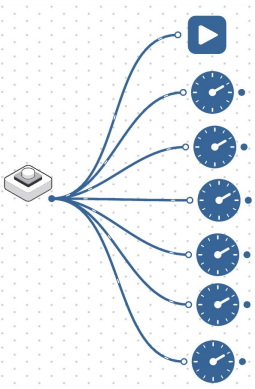
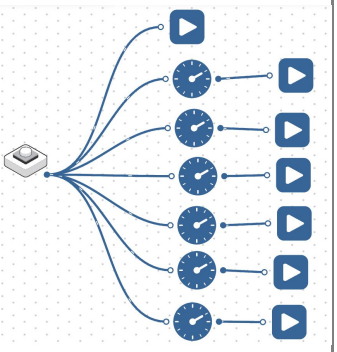
Challenge 1 - Debug it — 5 minutes

Something doesn't sound right in our music, what is missing?

Instructions	Workspace	Notes for Teachers
Step 1. Hold down the Key Press for notes with '__' after them.	do, do, sol, sol, la, la, sol_, fa, fa, mi, mi, re, re, do_	*After two notes is an underscore - what does this mean? The '_' means the note should be played for a bit longer."*
Step 2. Replay your song..	do, do, sol, sol, la, la, sol._, fa, fa, mi, mi, re, re, do_	*Test the song now by holding the key press block a little longer on the notes with '_' after it.*

Challenge 2 — 7 minutes

Automate your song!

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 1 Button/Virtual Button block Drag onto the workspace: • 6 Delay blocks • 7 Sound Player blocks		*We are going to set the first line of the song play automatically when you press the Button block*
Step 2. Connect the Button block to the Sound Player block and each of the Delay blocks.		*The Button block will be our input to trigger the system and start the music playing.*
Step 3. Connect the each Delay blocks to a Sound Player block.		*The delay blocks will be used to stop the notes all playing at once and play one after another*
Step 4. Set the time delay.		*A nice mathematics challenge here!* *Access the settings of the Delay blocks. 1 second = 1000 milliseconds. Set the 1st delay at 500 milliseconds, 2nd at 1 second, 3rd at 1 second 500 milliseconds and keep increasing each one by 500 milliseconds.*
Step 5. Program each note, following the order of notes for the song you want to play. *The first Sound Player will start with the first note of the song.*		*Set the Sound Player blocks in order to = do, do, sol, sol, la, la, sol*

Extension Ideas:
• **Computing**:
  ○ Can you complete the program to play a full song?
• **Music**:
  ○ Can you compose another song and perform it to the class?		

- Can you guess the song from the tune played?
- Try composing 'We wish you a Merry Christmas'.

- **History**:
  - How has music changed over the years?
  - Who are the famous composers of history?
- **Geography**:
  - How is music different in cultures around the world?
- **Science**:
  - How does sound affect our surroundings?
  - How do we hear - use of technology to enhance hearing in the deaf?

Checks for understanding: *What is the complete scale? Which is the input and output in your system (song)?*

Tidy Up / Exit Ticket — 4 minutes

Reinforcing the learning objectives of the lesson, students can reflect on key takeaways by completing and submitting an exit ticket.

Design a Habitat

Overview

During this lesson, students will gain understanding of how living things require certain elements in order to thrive in an interdependent ecosystem. Students will integrate and exhibit learning by designing a sea turtle habitat which requires sunshine and seawater in order to function.

Key Information

Level 1: (Ages 7-9) US Grades 2 or 3 Time: 45/90 minutes

Lesson consists of...		Learning Objectives
Warm-Up	5 mins	**As a result of this lesson, students will be able to**
Mini-lesson	10 mins	➜ Identify similarities and differences in the elements which enable animals to thrive
Worked Example	7 mins	➜ Explain why sea turtles need water and sunshine to thrive
Challenge 1	7 mins	➜ Create a SAM Habitat for sea turtles that includes a requirement to survive
Challenge 1 - Debug	5 mins	➜ Design a SAM Habitat for sea turtles that systematically enables periodic sunshine and ocean current
Challenge 2	7 mins	
Tidy Up / Exit Ticket	4 mins	

Lesson Topics

Life Science
- ➜ The requirements of plants for life and growth (light and water)

Scientific Thinking
- ➜ Asking relevant questions and using different types of scientific enquiries to answer them

Design and Technology
- ➜ Generate, develop, model and communicate ideas through talking, drawing and mock-ups

Computing
- ➜ Inputs, outputs, abstraction, debugging

Art and Design
- ➜ Explore and use mechanisms, devices and materials for imaginative activity that leads to original and creative outcomes

English Language Arts
- ➜ Use information gained from illustrations and text to demonstrate understanding
- ➜ Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 2 or 3 topic or subject area
- ➜ Participate in collaborative conversations

Materials required

- ➜ SAM Labs Kit
- ➜ SAM Labs Student Workbook
- ➜ SAM Labs Kit
- ➜ Gluesticks
- ➜ Flip chart paper
- ➜ Colored construction paper
- ➜ Shoebox for a diorama
- ➜ Markers

Warm Up – 'Odd One Out' — 5 minutes

What do living things need in order to thrive in their habitat?

Objective: Identify similarities and differences in the elements which enable animals to thrive

Procedures: *"Today we are going to learn how living things require certain elements to thrive"*

- Play 'Odd One Out' discussing the similarities and difference between living things e.g. frog, sea turtle and lion
- What do these living things need in order to thrive in their habitat?
    - Students could search the internet or use texts to help facilitate this activity.
- Added Challenge = Record and share their findings via the chart in their workbooks.

Link forward: Link to identifying sun and water as essential aspects for all living things to survive and to focus on the sea turtle.

Mini-lesson — 10 minutes

What do sea turtles need to survive in their habitat and why?

Objective: Explain why sea turtles need water and sunshine to thrive

Procedures:

- Focusing now on sea turtles, the teacher reiterates two requirements for their survival, sunshine and seawater.
- Sea turtles need water and sunshine to thrive in their habitat (oceans, beaches and sand dunes).
- The teacher gives concrete examples of how sea turtles access and utilise sunshine and seawater in their habitat throughout their lifecycle.
- The teacher may decide to show a short clip from *Finding Nemo* (https://drive.google.com/drive/folders/1NGNUJk_y_HgsKyAJOilZvl6LMxBeGZKS) to support explanation and discussion (8 minutes).

At the end of the mini-lesson, students can match or define keywords in their workbooks. (2 minutes)

Keywords

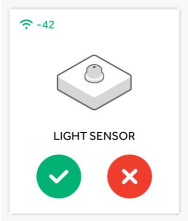
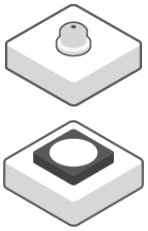
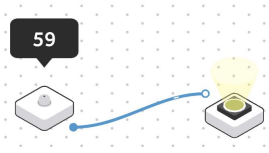
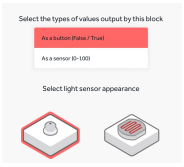
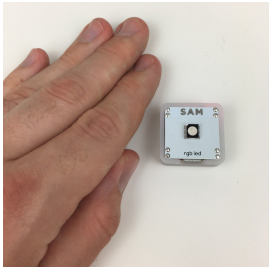
- Class or classification (as in animals)
- Reptile
- Thrive
- Elements
- Need
- Lifecycle
- Habitat
- Survival
- Migration

Let's Discuss: *Why do sea turtles need saltwater and sunshine? In your workbook or with a partner, record, discuss, or share an example of how sea turtles access and use these elements during their lifecycle.*

Link forward: Link to designing a habitat for sea turtles using SAM blocks which replicate the sunshine and ocean water.

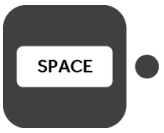
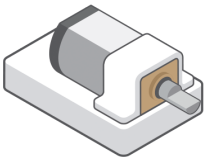
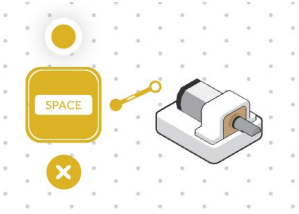
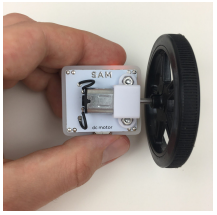
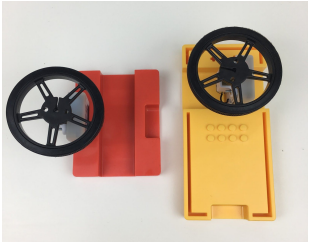
Worked Example — 7 minutes

Design a SAM Habitat for sea turtles that includes one requirement for them to thrive, periodic sunshine.

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 1 Light Sensor block • 1 RGB LED block		*The RGB LED is going to act as our sunshine in our habitat. The Light Sensor will allow us to turn the sunshine on or off. If you don't have a Light Sensor, you can use a Button or Virtual Button as the input.*
Step 2. Drag the Light Sensor block and RGB LED onto the workspace.		*The number above the Light Sensor is the value of the light in the room. The Light Sensor spans 1-100 and the small filled in circle to the bottom right of the Light Sensor means it's an input.* *The open circle to the top left of the RGB LED block means it's an output.*
Step 3. Connect the Light Sensor and RGB LED.		*The Light Sensor is an input and the RGB LED is an output. When these blocks are connected (blue line) in a system, the Light Sensor collects information that the RGB LED conveys*
Step 4. Open the Settings icon of the Light Sensor and select the button option.		*Test the Light Sensor as now it is a button means it will register one of two values: true or false*
Step 5. Test your system. Put your entire palm over the Light Sensor.		*When the light sensor is covered by your hand the input is TRUE so will turn the light on as if it's dark outside. Remove your hand and the input will be FALSE and will turn the light off as if it's light outside*

Challenge 1 — 7 minutes

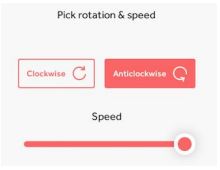
Design a SAM Habitat for sea turtles that includes another requirement of their habitat, ocean water.

Instructions	Workspace	Notes for Teachers
Step 1. Drag a Key Press block onto the workspace.		*The Key Press block is an input function. Can you find any others that can act as an input to 'start' the system?*
Step 2. Turn on and pair: • 2 DC Motors		*DC motors are outputs. Our motors are going to act as the backdrop of our habitat and replicate the ocean current*
Step 3. Drag the DC Motors onto the workspace.		*Is there a clue on the workspace which tells us why DC Motors are outputs? (Hint: the open circles indicate the block is an output). Can outputs connect to one another? Why or why not?*
Step 4. Connect the Key Press to the DC Motors.		*When you connect the Key Press to the DC Motors, they are now a system and we can tell as the colors synchronize*
Step 5. Test your system. Press the Key Press. *This should turn the motors on.*		*Press the button to turn the system on*
Step 6. Put wheels on the motors. *Be sure to match the flat part of the wheel with the flat part of the axel.*		*The wheels will create a current for our habitat's ocean water. Sea turtles need the ocean's current to move from place to place and migrate and they also need salt water to drink.*
Step 7. Put the 1st motor in the chassis. Put the 2nd motor in the control block. *This may require some pressure*		*The chassis and control box act as a base to hold our motors in place and secure them in a vertical position within the waves created.*
Step 8. Cut out a strip of paper and draw blue waves on it. Place it around the two wheels. *This will be the backdrop to your habitat.*		

Checks for understanding: *What is one reason sea turtles require sunlight? What is one reason sea turtles require sea water?*

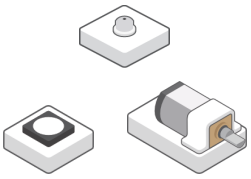
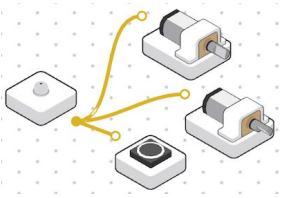
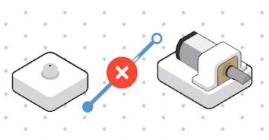
Challenge 1 - Debug it — 5 minutes

Why is the current not working properly and too fast with the motors?

Instructions	Workspace	Notes for Teachers
Step 1. Open the Settings icon of both DC Motors and lower the speed.		*We need to replicate the ocean current near a shoreline by lowering the speed of the motor. Link the ocean current to sea turtle migration*
Step 2. Open the Settings icon of one of the DC Motors. Change the direction to anticlockwise.		*To ensure our ocean current is moving in one direction. You need to change the direction of one of the motors to anti-clockwise.*

Challenge 2 — 7 minutes

Design a SAM habitat for your sea turtle that works in a system to fulfil two requirements of their ecosystem, periodic sunshine and ocean water.

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 1 Light Sensor block • 1 RGB LED block • 2 DC Motors		*Did you know we can identify our blocks by proximity? What symbol or value indicates proximity on this screen?*
Step 2. Drag the Light Sensor block, RGB LED block and (2) DC Motors onto the workspace.		*If you zoom out of the workspace quickly the workspace goes striped? This allows you to view all the blocks but it doesn't allow you to edit them*
Step 3. Connect the Light sensor block to the DC Motors and the RGB LED block. *This will turn the system on.*		*The system is on but we want the habitat to mimic the sea turtle's real ecosystem. How can we ensure the water has a current when the turtle decides to swim? How can we make a smart light that turns on when it's dark to regulate the amount of sunshine available?*
Step 4. Select each connection and click "X" to disconnect the system.		*To make a smart habitat, we need a way to turn the system on and off as right now, the system is always on. We also need a way to have just the right amount of light or darkness to turn the system on as the system is not sensitive to the environment.*

Step 5. Drag an Inverse block to the workspace		*Add the Inverse function to our system and this allows the opposite to happen. At present any value the Light Sensor displays turns the system on. The Inverse block will do the opposite, any value the Light Sensor displays will turn the system off. Now, how can we regulate the system turning it off and on?*
Step 6. Drag a Threshold block to the workspace. Select the settings and edit the threshold value to 51	 	*Threshold means we can set a range of values that will turn the light on or off. Set the Threshold value to 51. This means that any value the Light Sensor detects under 51 will turn the system on. Any value over will keep it off*

Extension Ideas:

- **Computing**:
  - Can you find another way to regulate the system so that just the right amount of light or darkness turns the system on?
  - Set a Time Trigger or an Alarm function to prompt the turtle to wake up and take a swim
  - Mimic the sunrise with your RGB LED block, enabling it to increase brightness over time
  - Use the Proximity Sensor to turn on the water current when the turtle gets near to it
- **Geography/Science**:
  - What species are there and does this differ with location in the wild
- **Science**:
  - What are currents and tides?
  - What animals can be kept as pets?

Checks for understanding: *Which output/s replicate the sunshine in our habitat? Which inputs help replicate the seawater in our habitat?*

Tidy Up / Exit Ticket — 4 minutes

Reinforcing the learning objectives of the lesson, students can reflect on key takeaways by completing and submitting an exit ticket.

Lesson 1.4

Smart Lighting Systems

Overview

During this lesson, students will gain an understanding of what smart technology is and how to identify technology that is 'smart'. Students will integrate and exhibit learning by designing components of a smart lighting system.

Key Information

Level 1: (Ages 7-9) US Grades 2 or 3 Time: 45/90 minutes

Lesson consists of...		Learning Objectives
Warm-Up	5 mins	**As a result of this lesson, students will be able to** ➜ Identify and label devices as 'smart' ➜ Describe the similarities and differences between smart lighting and regular lighting ➜ Design a smart lighting system that responds to the amount of light in the environment ➜ Develop a SAM system utilising sensors to ensure our device is 'Smart'
Mini-lesson	10 mins	
Worked Example	7 mins	
Challenge 1	7 mins	
Challenge 1 - Debug	5 mins	
Challenge 2	7 mins	
Tidy Up / Exit Ticket	4 mins	

Lesson Topics

Physical Science

➜ Investigate the effect of using different materials for the purpose of a smart lighting system

Design and Technology

➜ Analysing problems, designing solutions, multiple solutions to a problem, sketching and design

➜ Design purposeful, functional, appealing products for themselves and other users based on design criteria

Computing

➜ Inputs, outputs, abstraction, debugging

➜ Boolean states (true/false)

Materials required

➜ SAM Labs Kit

➜ Student Workbook

Warm Up – 'Scientific Investigation' 5 minutes

What is a smart grid?

Objective: Identify key differences in devices that are 'smart'.

Procedures: *"Today we are going to learn what smart lighting is and how we can recreate it"*

- Look at images of different objects and identify what is a 'smart' device and what is not
- Discuss what is meant by the word 'smart' in relation to the functionality or interactivity of a device
- The first 1.18 minutes of this clip (https://www.youtube.com/watch?v=hIElGDsbKqY) offers an interesting talking point for using 'smart' technology

Sample photo ideas: Apple watch, Alexa, wrist watch, wireless speaker

Link forward: Link to defining key components of smart lighting systems

Mini-lesson 10 minutes

What is smart lighting? What makes it 'smart'?

Objective: Describe the similarities and differences between smart lighting and regular lighting

Procedures:

- Establish the importance of electricity to our lives and compare a smart lighting system with a typical lighting system (used in some classrooms, homes and cities).
- The main difference in smart technology is that it is capable of adapting automatically, collecting and using information from the environment.
- There are three important facts about smart lighting:
    - 1) smart lighting is smart because it is designed to be energy efficient;
    - 2) the use of automatic light dimming and;
    - 3) daylight and occupancy sensors reduce energy consumption. (8 minutes)

At the end of the mini-lesson, students match or define keywords in their workbooks. (2 minutes)

Sample photo ideas: Light sensor, occupancy sensor, solar-powered light.

Keywords

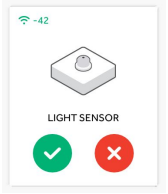
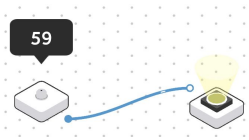
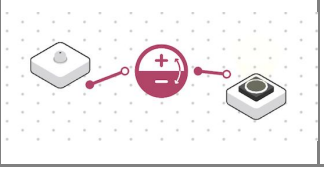
- Smart technology
- Electricity
- Dim
- Sensor
- Consumption

Let's Discuss: *What is the definition of smart technology? In your workbook or with a partner, record, discuss, or share one example of 'Smart technology' and what makes it 'smart'.*

Link forward: Link to creating a system that changes/reacts to the environment around it.

Worked Example — 7 minutes

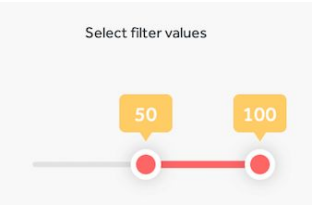
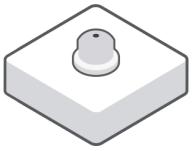
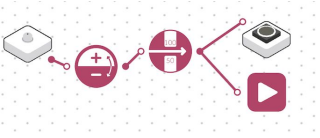
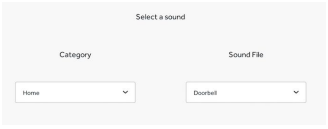
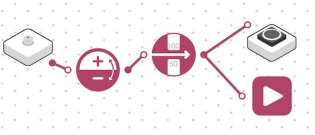
Design a smart light system that responds to the amount of light in the environment

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 1 Light Sensor block • 1 RGB LED block		*Smart lights often have sensors which respond to the amount of light in the environment, our light sensor block will work the same*
Step 2. Drag the Light Sensor and RGB LED blocks onto the workspace.		*Notice the number (48) above the Light Sensor. This is the value of the light in the room. The Light Sensor spans 1-100; 1 is very dim and 100 is very bright*
Step 3. Connect the Light Sensor and RGB LED blocks.		
Step 4. Put one or two fingers over the Light Sensor. This should dim the RGB LED slightly.		*When the light value changes, the RGB LED responds by dimming. We want the light to increase/decrease as the light value increases/decreases as it responds to the light in the environment*
Step 5. Put your entire palm over the Light Sensor and cover it completely. This should turn the RGB LED off.		*Cover the light sensor completely and see the light turn off, we need the sensor to turn the light on when it is dark so need the opposite to happen*
Step 6. Drag the Inverse block onto the workspace. Connect it between the Light Sensor and RGB LED.		*Inverse means opposite in position, direction, order, or effect, when we add this to the system the output will be the opposite to what happened before*

Challenge 1

7 minutes

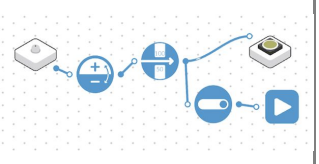
Design a smart lighting system that has a sensor and an alert

Instructions	Workspace	Notes for Teachers
Step 1. Add the Filter block between the Inverse and RGB LED blocks.		*Adding the Filter block means the light will turn on and off based on a certain range of values.*
Step 2. Open the Settings icon on the Filter block. Set the filter range to '50-100'.		*Set the range to 50-100. This means if the light value is within this range, the light will be off. If the light value is lower than 50, it will turn off and act as a sensor for movement in the light.*
Step 3. Move your hand slowly to and from the Light Sensor.		*To test our sensor we need to get closer to the light and it will turn on and when we move away it turns off.*
Step 4. Drag a Sound Player block onto the workspace.		*To add an alert to our system add the Sound Player block to the output of the Filter block.*
Step 5. Open the Settings icon on the Sound Player block and select a sound.		*Select a suitable sound from the settings of the Sound Player block.*
Step 6. Test your system.		*Test this system and find that the alert is not playing at this time and links to the debug.*

Checks for understanding: *In what way does our system use a sensor? How is this system 'smart'?*

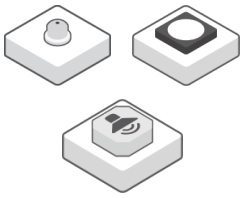
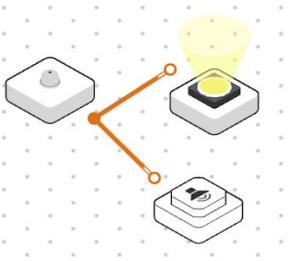
Challenge 1 - Debug it — 5 minutes

Why isn't the Sound Player working?

Instructions	Workspace	Notes for Teachers
Step 1. Drag a Toggle block onto the workspace. Connect it between the Filter and Sound Player blocks		*The Sound Player block is not working as it needs a seperate part to the system to turn it on, the Toggle block will be our switch.*
Step 2. Test it your system.		*When the value of the Light Sensor is '0' it will turn on the RGB LED and sound the alert.*

Challenge 2 — 7 minutes

Design a smart lighting system that responds to the amount of light in the environment, has a sensor and an alert

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • Buzzer/Virtual Buzzer Keep the Light Sensor and RGB LED on the workspace but delete everything else.		*The light sensor is the input and the buzzer and RGB LED are the outputs, show how this is seen on the workspace by the connections only able to come out of the inputs and into the outputs.*
Step 2. Connect the RGB LED and the Buzzer blocks to the Light Sensor block.		*The RGB LED will activate as it responds to any value from the light sensor input but the Buzzer will not as this responds to Boolean true / false not the 0-100 values of a Light Sensor.*
Step 3. Drag the Filter block onto the workspace and add it between the Light Sensor, RGB LED and Buzzer blocks. Set the Filter range to '0-30'.		*The filter range may need to be adjusted depending on the amount of light in the classroom.*
Step 4. Drag the On/Off block to the workspace and add it between the Filter and Buzzer blocks.		*Adding the On/Off block turns the sensors into buttons.*

Step 5. Test it and try replacing the Buzzer with Sound Player blocks to see if they work interchangeably.		*Try the system and by changing the Buzzer block to the Sound Player block the students will see that the outputs can be changed and a system can have more than one solution.*

Extension Ideas:

- **Computing**:
  - Can you find another way to sound an alarm?
  - Can you add 2 DC motors to the system, as if to power a machine (like an air conditioner or heater) when the system turns on?
  - Can you build a lighting system that is solar-powered?
- **Science/Geography**:
  - How does Smart technology differ around the world
- **History**:
  - Who invented the lightbulb?
  - How did smart technology start? What difference does it make?

Checks for understanding: *What does the On/Off block do? What is the purpose of the Filter block?*

Tidy Up / Exit Ticket — 4 minutes

Reinforcing the learning objectives of the lesson, students can reflect on key takeaways by completing and submitting an exit ticket.

Overview

During this lesson, students will solve word problems involving addition and subtraction of time intervals in minutes. Students will integrate and exhibit learning by creating an addition/subtraction game that enables them to practice.

Key Information

Level 1: (Ages 7-9) US Grades 2 or 3 Time: 45/90 minutes

Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➜ Demonstrate how to add time to the nearest minute to solve real world problems
- ➜ Identify a set of activities that can be done in an hour with minimal left over time
- ➜ Design a SAM system to create an addition/subtraction game
- ➜ Extend the SAM system to add a counter and sound to the game

Lesson Topics

Math
- ➜ Solve word problems involving addition and subtraction of time intervals in minutes

Art and Design
- ➜ Explore and use mechanisms, devices and materials for imaginative activity that leads to original and creative outcomes

Design and Technology
- ➜ Generate, develop, model and communicate ideas through talking, drawing and mock-ups

Computing
- ➜ Inputs, outputs, abstraction, debugging

English Language Arts
- ➜ Use information gained from illustrations and text to demonstrate understanding
- ➜ Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 2-3 topic or subject area

Materials required

- ➜ SAM Labs Kit
- ➜ Blank sheets of paper for writing math problems
- ➜ Student Workbook
- ➜ Popsicle sticks with activities and timings recorded on them

Warm Up – 'Estimation' — 5 minutes

What can the teacher do before school?

Objective: Demonstrate how to add time to the nearest minute to solve real world problems

Procedures: *"Today we are going to learn about time and how to solve problems by adding or subtracting time intervals."*

- Scenario; Teacher has 1 hour to get to school, she wanted to stop to get paint and markers for the class.
- It takes her 20 minutes to drive to school without stopping. She estimates it would add 15 minutes to her trip if she stopped at the paint store and another 16 mins if she stopped for markers.
- Students have 2 minutes to solve/discuss/share if this is possible can how they solved this problem

Link forward: Link to using addition and subtraction to consider how to best utilise an hour of time

Mini-lesson — 10 minutes

How many activities can you accomplish in an hour?

Objective: Identify a set of activities that can be done in an hour with minimal left over time

Procedures: Students are asked to imagine that it is 4:00 pm and they need to be home at 5:00 pm. Groups of students are then given a canister of popsicle sticks with an activity and time length for the activity. In groups of 3, students decide how many activities they can combine within the hour of time they have with to time to arrive back home.

Activity ideas:

- Play soccer with friends (24 min)
- Play a game of go-fish (15 min)
- Ride a bicycle to the park (17 min)
- Walk home (10 minutes)
- Watch a video on the internet (12 min)
- Visit a friend or family (35 min)
- Jump rope with a friend (17 min)
- Listen to a song (5 min)
- Read a book (12 min)

At the end of the mini-lesson, students match or define keywords in their workbooks. (2 minutes)

Keywords

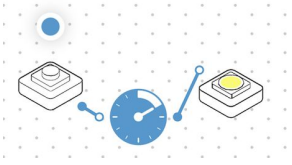
- Time
- Calculate
- Hour
- Minute
- Second
- Millisecond

Let's Discuss: *How many minutes and seconds make up an hour? In your workbook or with a partner, record, discuss, or share one of the strategies you used to solve the problem*

Link forward: Link to designing an addition/subtraction game to practice and verify their solutions. (The timer students design is intended to motivate them to practice their addition and subtraction.)

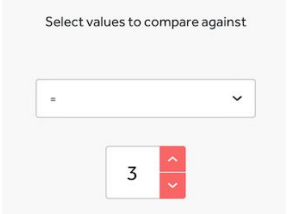
Worked Example — 7 minutes

Create a simple timer

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • Button/Virtual Button • RGB LED block Drag these blocks onto the Workspace and connect them.		*We are going to build a timer which we'll be using in a game to test our addition and subtraction skills. In your small groups work together to create a counter with an alert.* *The input in this system is our Button. The output in our system is the RGB LED.*
Step 2. Add the Interval block between them		*This is the first time students will be getting to know the Interval block so spend time relating it to what they're doing in math. Interval is a lot like what we learnt in the warm-up and mini-lesson--it allows things to occur at set times.*

Challenge 1 — 7 minutes

Create a timer with an alert for an addition/subtraction game

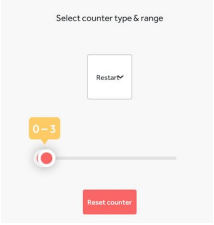
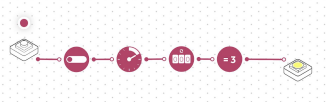
Instructions	Workspace	Notes for Teachers
Step 1. Set the Interval block to '1 second'		*You can set Interval to occur by hours, minutes, seconds and or milliseconds. Reinforce concepts of time when explaining the differences in increments.*
Step 3. Drag the Counter, Compare and Toggle blocks onto the workspace		*The Counter and Compare blocks both need to be set to specified values for the system to work properly. Allow students to experiment, then ask them if they have any clues as to how to "debug" the system.*
Step 4. Connect the blocks in this order after the Button block; Toggle block, Counter block, Compare block.		*If you do not have the Button block you can use a Light Sensor block set as a button or a Key Press block. The Toggle block acts as the switch to start the timer when the button is pressed.*
Step 5. Open the Settings of the Compare block and set to '= 3'.		*The Compare block sends a true value when a specific number is reached. In this system, when the button is pressed 3 times the light will turn on. Then, the system will reset.*

Step 6. Test your system.		*Test the system to see if it turns on the light when the Counter block = 3*

Checks for understanding: *What does the Compare block do in the system? What is the input for the system?*

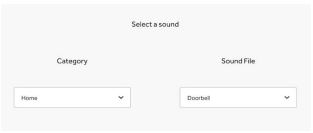
Challenge 1 - Debug it — 5 minutes

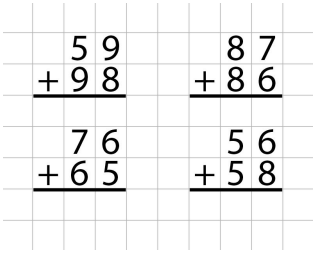
How can we automate the Counter?

Instructions	Workspace	Notes for Teachers
Step 1. Open the Settings of the Counter block and set it to 'Restart' and '0-3'		*The Counter block allows students to identify a number to count up to (0-100)*
Step 2. Test it.		*Start the system and make sure that the Counter block resets when it has reached 3 and that the light also resets.*

Challenge 2 — 7 minutes

Add a Sound Player to your timer

Instructions	Workspace	Notes for Teachers
Step 1. Drag the Sound Player block to the Workspace		*The Sound Player block will help students keep track of how many questions they got correct. There are a plethora of sounds to select so you may want to choose the sound all students utilise to keep the pace of the lesson.*
Step 2. Open the Settings icon and set the sound.		
Step 3. Connect the Sound Player block to the Number block and test it!		*Encourage students to try their system a few times*

Step 4. Write single and double-digit addition and subtraction questions and put them in the canister. Each student chooses a question and for every question your classmate gets correct, press the button. Once you get 3 correct, the timer will sound! Keep track of how many your team gets correct!		*There should be a sufficient number of simple and difficult questions and could be pre-written as well. The group with the highest count wins!*

Extension Ideas:

- **Computing**:
  - Include a timer in your system so there's a time limit to students' responses
  - Can you increase the number needed to get right before the timer sounds?
- **Math/Geography:**
  - How does time differ as you travel?
- **Science/Math/ICT:**
  - How does a clock work and what is the difference between analogue and digital?

Checks for understanding: *What are the main inputs and outputs of our system? What does the Counter do in our system?*

Tidy Up / Exit Ticket — 4 minutes

Reinforcing the learning objectives of the lesson, students can reflect on key takeaways by completing and submitting an exit ticket.

Build It Up, Break It Down

Overview

During this lesson, students will investigate how a house can be built, disassembled and rebuilt using a small set of pieces and a variety of materials. They will create a SAM Earthquake Simulator to test the effectiveness of their structure.

Key Information

Level 1: (Ages 7-9) US Grades 2 or 3 Time: 45/90 minutes

Lesson consists of...		Learning Objectives
Warm-Up	5 mins	**As a result of this lesson, students will be able to**
Mini-lesson	10 mins	➜ Recognize that an object can be made up of a smaller subset of parts and pieces.
Worked Example	7 mins	➜ Investigate how objects can be broken into smaller pieces and made into a new object.
Challenge 1	7 mins	➜ Design and build a house using a variety of materials.
Challenge 1 - Debug	5 mins	➜ Build a SAM Earthquake Simulator to test the effectiveness of a structure.
Challenge 2	7 mins	
Tidy Up / Exit Ticket	4 mins	

Lesson Topics

Physical Science
- ➜ Investigate how an object made up of small pieces can be disassembled and rebuilt into a new structure
- ➜ Effectiveness and suitability of a variety of different materials

Engineering
- ➜ Earthquake-proof designs

Design and Technology
- ➜ Generate, develop, model and communicate ideas through talking

Computing
- ➜ Inputs, outputs, abstraction, debugging

Scientific Thinking
- ➜ Asking relevant questions and using different types of scientific enquiries to answer them

Maths
- ➜ Units of time
- ➜ Properties of 3D shapes

English Language Arts
- ➜ Participate in collaborative conversations.
- ➜ Use information gained from illustrations and text to demonstrate understanding
- ➜ Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 2-3 topic or subject area

Materials required

- ➜ SAM Labs Kit
- ➜ Paper plate
- ➜ Gummy candy
- ➜ Blu Tack
- ➜ Lego Bricks
- ➜ Cocktail Sticks
- ➜ Student Workbook

Build It Up, Break It Down

Warm Up – 'Build it up' 5 minutes

How many different objects can students make with the same set of Lego bricks?

Objective: Students observe that objects made up of a smaller set of pieces can be disassembled and made into a new object.

Procedures: *"Today we are going to learn that some objects are made up of a smaller set of pieces. Some objects can be broken down and built back up into new things. We are going to use the Lego bricks to try it out."*

- Students have one minute to build a structure or object using Lego bricks. All students are given the same amount of bricks. Repeat twice.
- Discuss the different structures students were able to create within the time limit.
- Students are supported to dismantle and create a different structure or object using the same set of bricks with each try.
- Encourage students to compare and contrast their constructions.

Student Workbook: How many different patterns can you create in 2 minutes using the same set of coloured Lego bricks?

Link forward: Objects made from a small set of pieces can be disassembled and made into a new object.

Mini-lesson - Earthquake-proof structures 10 minutes

How are structures built to withstand an earthquake?

Objective: Students design a structure to withstand an earthquake using a small set of pieces.

Procedures: "*Scientists and engineers are constantly creating and updating designs to make earthquake-proof structures".*

- Students prepare to design and build an earthquake proof house.
- Why do you think it is important that your design is not too rigid?
- Discuss materials which would be effective and materials which would not.
- Look at images of structures which are already built to withstand an earthquake. What do students notice about the design and build of those houses? What shapes have been used to form the structure of the house?
- Students will be using gummy candy and cocktail sticks to build their house. We will use these materials to avoid too rigid a structure. Students discuss ideas for their design with a partner.
- Students sketch their design. Encourage them to think about features they could include to strengthen their building. E.g. forming a base from triangles. (8 minutes)

At the end of the mini-lesson, students can match or define keywords in their workbooks.
(2 minutes)

Keywords

- Earthquake-proof
- Rigid
- Structure

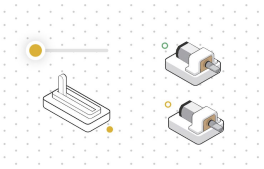
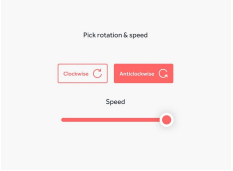
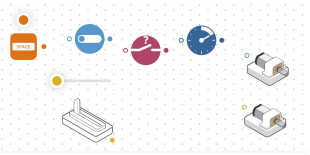
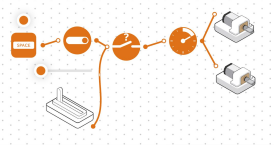
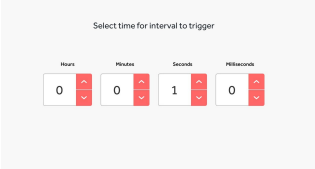
Build It Up, Break It Down

Let's Discuss: *What is an earthquake? In your workbook or with a partner, record or discuss the best materials for building an earthquake-proof house.*

Link forward: We are going to build a SAM Earthquake Simulator and use it to test our designs.

Worked Example — 7 minutes

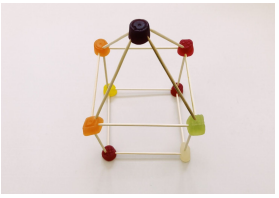
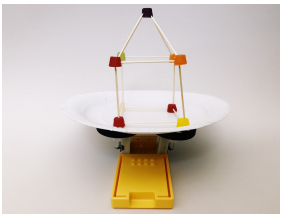
Build a system which will act as our SAM Earthquake Simulator

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 2 DC Motor Blocks • Slider/Virtual Slider Block Drag them onto the workspace.		*Use a Virtual Slider if you do not have the Slider Block.*
Step 2. Attach the wheels to the motors. Then, fit the motors into the yellow Car Chassis.		*You may need to use blu tack to attach the Car Chassis panel to the table as the motion of the wheels can cause it to move.*
Step 3. Select the settings icon of one of the motors. Change the direction to 'anticlockwise'.		*This will mimic the movement of two tectonic plates.*
Step 4. Drag the following blocks onto the workspace: • Key Press block • Toggle block • Switch block • Interval block		*Encourage students to notice that the colours are different because we have not yet connected the blocks in a system yet.* *As the other input, a Button/Virtual Button can be used in lieu of a Key Press.*
Step 5. Connect the Key Press to the Toggle, the Toggle to the Slider and Switch. Connect the Switch to the Interval and the Interval to both Motors.		*The Switch block will have a question mark on it because we have not yet determined its input.*
Step 6. Click on the settings icon of the Switch block and select 'slider'.		*The icon on the Switch block will now have changed from a question mark to a finger.*
Step 7. Click on the settings icon of the Interval block and ensure it is set to '1' second.		*The Interval should already be set to '1' second, but encourage students to check before proceeding.*

Step 8. Place a small dot of blu tack in the center of each wheel.		*This will ensure the paper plate does not immediately fly off as soon as the motor starts. You may find that after about 30 seconds the paper plate becomes more unstable.*
Step 9. Place a paper plate over the top of both wheels. This will represent the Earth's crust in the investigation. Test your system.		*You may need to spend a couple of minutes adjusting the blu tack. You want the plate to be firmly secured, but not so much that it prevents the movement of the motors.*

Challenge 1 — 7 minutes

Test the effectiveness of your earthquake-proof house using the SAM Earthquake Simulator

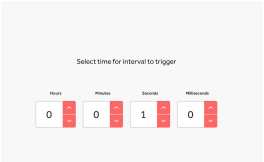
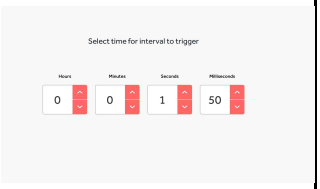
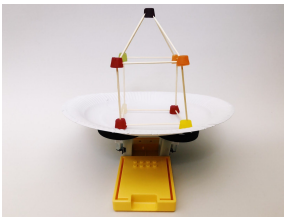
Instructions	Workspace	Notes for Teachers
Step 1. Construct an earthquake-proof house using gummy candy and cocktail sticks.		*Provide a time limit in which students must construct their house. A variety of sweets can be used to connect the cocktail sticks. Gummy candies work well because they still allow for some movement in the structure.*
Step 2. Place the structure onto the paper plate.		*Predict the effectiveness of their structure before testing it with with simulator. Why do they think some structures will be stronger than others?*
Step 3. Slowly move the slider to start the SAM Earthquake Simulator.		*How long do the structures last before collapsing? Students can time each others designs using a stopwatch. Which structure lasted the longest? Why do they think this is?*

Checks for understanding: *It is important our structure is not rigid because… Why do we need to include an Interval block in the system?*

Build It Up, Break It Down

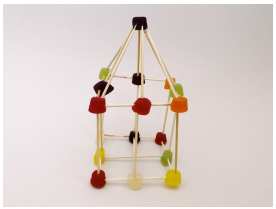
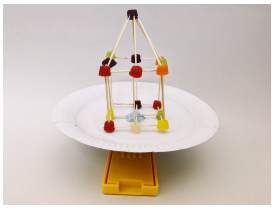
Challenge 1 - Debug it — 5 minutes

Alter the speed interval to vary the pulse of the earthquake.

Instructions	Workspace	Notes for Teachers
Step 1. Click the settings icon on the Interval block.		*The default setting is 1 second. You can alter hours, minutes, seconds and milliseconds.* *You could discuss how many milliseconds are in 1 second.*
Step 2. Set the Interval icon to '1' second and '50' milliseconds.		*This will alter the pulses of the motor and change the movement of the paper plate.*
Step 3. Test your system.		*If 50 milliseconds does not work well, alter the settings of the interval to make it faster or slower. Encourage students to experiment with their own time settings.*

Challenge 2 — 7 minutes

How can you improve your structure?

Instructions	Workspace	Notes for Teachers
Step 1. Students disassemble their structure and evaluate its effectiveness.		*Reinforce the objective that all objects are made from a smaller set of pieces, and that these objects can be disassembled and rebuilt into a new object or structure.*
Step 2. Use a combination of new and existing materials to build a new, improved structure.		*Provide students with a selection of new materials for them to choose from. E.g. blu tack, card, pipe cleaners. How have you improved your design? Encourage students to predict how long the structure will remain on the paper plate.*
Step 3. Test the effectiveness of the new structure using the SAM Earthquake Simulator.		*Students can use timers to measure the effectiveness of their design. How long does the structure last before collapsing?* *In this example, I increased the number of gummies and cocktail sticks to strengthen the building. It was not stable enough in my first build. I also added some blu tack to act as my (very rudimentary!) base isolator.*

Extension Ideas:

- **Computing:**
  - How does altering the pulse of the SAM Earthquake Simulator affect the durability of the structure?
  - Is a faster or slower pulse more devastating on the building design?
- **Math:**
  - Which 3D shapes create the strongest structure and why?
  - Build and test a variety of 3D shapes using bricks or small weights. Which structure can hold the most weight?
- **Geography/Science**:
  - Investigate creating taller structures. How does a country with skyscrapers (E.g. New York, Tokyo) design buildings to earthquake proof them. Use cocktail sticks or pipe cleaners to build taller structures.

Checks for understanding: *How did you improve your structure to make it more effective? How did altering the pulse of the SAM Earthquake Simulator affect your structure?*

Tidy Up / Exit Ticket — 4 minutes

Reinforcing the learning objectives of the lesson, students can reflect on key takeaways by completing and submitting an exit ticket.

Seed Dispersal

Overview

During this lesson, students will gain understanding of seed dispersal as the movement or transport of seeds away from the parent plant. Students will integrate and exhibit learning by designing a SAM Robo Squirrel that mimics seed dispersion.

Key Information

Level 1: (Ages 7-9) US Grades 2 or 3 Time: 45/90 minutes

Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➜ Identify how different animals disperse seeds
- ➜ Summarize the sequence of events in seed dispersal by the Eurasian Red Squirrel.
- ➜ Create a SAM system that will allow the Eurasian Red Squirrel to see in the dark.
- ➜ Design a SAM Robo Squirrel that will disperse seeds.

Lesson Topics

Life Science
- ➜ The role of seed dispersal in the growth of new plants

Art and Design
- ➜ Explore and use mechanisms, devices and materials for imaginative activity that leads to original and creative outcomes

Computing
- ➜ Inputs, outputs, abstraction, debugging, decomposition, tinkering

Scientific Thinking
- ➜ Asking relevant questions and using different types of scientific enquiries to answer them

Design and Technology
- ➜ Generate, develop, model and communicate ideas through talking, drawing and mock-ups

English Language Arts
- ➜ Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area

Materials required

- ➜ SAM Labs Kit
- ➜ Student Workbook
- ➜ Scissors / Glue
- ➜ Printable Squirrel Mask
- ➜ Yogurt pot
- ➜ Blu Tack
- ➜ Cardboard
- ➜ Coffee Beans (as seeds)

Warm Up – 'Match Up' — 5 minutes

How do different animals disperse seeds?

Objective: Identify how different animals disperse seeds.

Procedures: *"Today we are going to learn about how animals disperse seeds. Seed dispersal is the way that seeds are spread over a wide area."*

- Explain that when animals disperse seeds, new plants grow.
- In their workbook, students match each pictured animal with its correct description of how it disperses seeds.
- What are the similarities and differences between each of the different ways?

Link forward: Identify the sequence of events related to how a squirrel disperses seeds.

Mini-lesson - Decomposition — 10 minutes

Can you break down the process of seed dispersal into a sequence of events?

Objective: Summarize the sequence of events in seed dispersal by the Eurasian Red Squirrel.

Procedures:

- Focusing now on the Eurasian Red Squirrel, explain the specific process of seed dispersal which results in the growth of new acorn trees.
- Accompanying clip showing from 5:28 to 7:00 minutes - clip (https://www.youtube.com/watch?v=wx88A0cqGLs&t=328s)
- Explain how the Eurasian Red Squirrel unwittingly disperses seeds via acorns.
- This eventually results in new oak trees growing.
- Ask students to consider why this is important or significant to the ecosystem. (8 minutes)

At the end of the mini-lesson, students can match or define keywords in their workbooks. (2 minutes)

Keywords

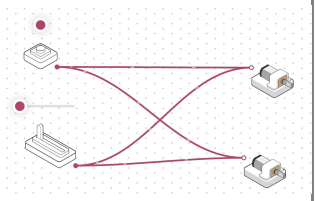
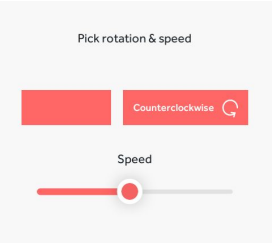
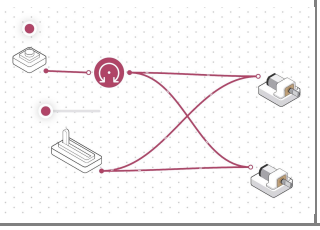
- Dispersal
- Acorns
- Oak Tree
- Unwittingly
- Seeds

Let's Discuss: *What word is used to describe spreading seeds over a wide area? In your workbook or with a partner, record, discuss, or share the process by which a Eurasian Red Squirrel disperses seeds using keywords.*

Link forward: Link to designing a system using SAM blocks which will replicate seed dispersal by a squirrel.

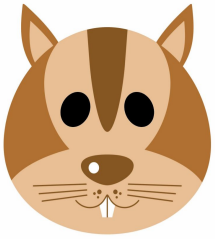
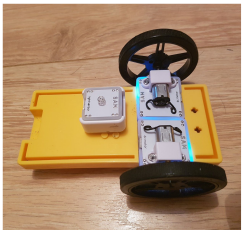
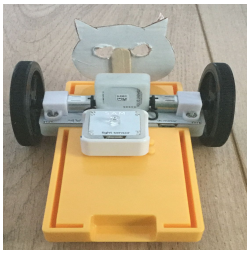
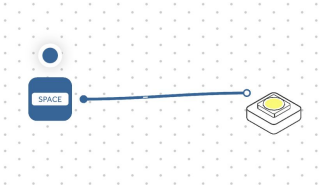
Worked Example — 7 minutes

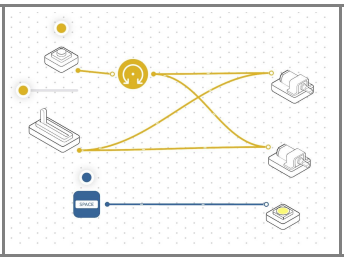
Build a system that moves SAM Robo Squirrel in two directions

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 1 Slider/Virtual Slider block • 1 Button/Virtual Button block • 2 DC Motors Connect the Slider and Button to both motors.		*The Slider and Button will act as our **inputs**. If you don't have access to Slider/Button you can use the virtual blocks from the toolbox. The DC Motors will act as our **outputs** and this will power the car to move.*
Step 2. Connect the 2 wheels to the DC Motors and fit them into the yellow Car Chassis. Insert the roller underneath the car. Test your system.		*Students may notice the car is going in a circle. Encourage them to consider what they could change to get the car to go in a straight line.*
Step 3. Click the settings icon of one of the DC Motors. Set it to Counterclockwise.		*It is important to change the rotation of one of the motors to Counterclockwise to get the car to go in a straight line.*
Step 4. Add a Switch Direction block to the workspace. Place it between the Button and the 2 DC Motors. Now, test your system again.		*Note that you may need to prompt students to delete the current connection between the Button and motors to do so.* *Students may also wish to fit the Button and Slider into the red Car Controller block for ease.*

Challenge 1 — 7 minutes

Create a SAM system that will allow the Eurasian Red Squirrel to see in the dark

Instructions	Workspace	Notes for Teachers
Step 1. Print and cut out the squirrel head.		*Create a squirrel head from, for example, a print out mounted on cardboard and secure in the front of the Car Chassis .*
Step 2. Cut out the eyes.		*Cutting out the eyes will allow the light to shine through when activated.*
Step 3. Secure the Light Sensor block to the lego grid on top of the Car Chassis.		*The Light Sensor block needs to be mounted in the lego connection holder, secure to the top of the Car Chassis.*
Step 4. Secure the RGB LED behind the eyes of the squirrel.		*Using, for example, the RGB LED behind the head of the squirrel. If you move both motors slightly to the side, this will fit in between both motors, which will hold it in place.*
Step 5. Turn on and pair: • RGB LED block Add the RGB LED and Key Press to the workspace.		*Remind students they need to hold the on/off button down for a few seconds for it to turn on. A red light will appear once it is on.*
Step 6. Connect the Key Press to the RGB LED.		*This will need to be a separate system working alongside the SAM Robo Squirrel.*

Step 7. Test your system.		*Test the system to see if the light output is correctly activated by the Key Press. It turns on but does it stay on?*

Checks for understanding: *Which block is now acting as our new input? Which block is now acting as our new output?*

Challenge 1 - Debug it — 5 minutes

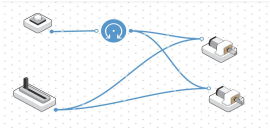
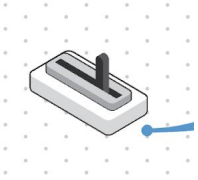
How can we keep the RGB LED on?

Instructions	Workspace	Notes for Teachers
Step 1. Add an Toggle block to the workspace.		*The Toggle block sends an on off signal between an input and output*
Step 2. Place the Toggle block between the Key Press and the RGB LED.		*Placing a Toggle block between the Key Press and RGB LED will keep the light on or off.*
Step 3. Test your system.		

Challenge 2 — 7 minutes

Design a SAM Robo Squirrel that will disperse seeds

Instructions	Workspace	Notes for Teachers
Step 1. Collect a yogurt pot and cut a hole in the lower side.		*The position of the hole needs to be considered so the seeds do not fall out straight away. Place the hole just off the bottom to allow storing of the seeds to take place until movement disperses them.*

Step 2. Use blue tack to secure to the Car Chassis.		*Here we have used blue tack to secure the yogurt pot to the Car Chassis so that it does not move. The position at the back of the Car Chassis is important so the seeds are dispersed on the ground.*
Step 3. Add coffee beans (seeds) to the yogurt pot.		*Here we have used coffee so you can see it clearly, but any seeds can be placed in the yoghurt pot and dispersed.*
Step 4. Direct the SAM Robo Squirrel.		*Using the system built in the worked example, maneuver the car backwards and forwards and see the seed dispersal.* *You may wish to map out an area of the classroom so that students have a particular path to follow. Might be to and from an oak tree or wooded area.*
Step 5. Measure dispersal area.		*Look at the seed dispersal and measure the distance between seeds, radius from starting point or furthest away from the endpoint. Using a ruler, calculate the difference in distance using halves and fourths of an inch.*
Step 6. Change the speed.		*Experiment with speed and the amount of seeds dispersed.*

Extension Ideas:

- **Computing/Maths**:
  - Timing and measuring of the seed dispersal
- **Science**:
  - Research how other animals and or machines disperse seeds. Why is most effective and why?
- **Geography/Science**
  - Do different animals in different countries have similarities/differences in seed dispersal?
- **ELA**
  - When animals become endangered, their ecosystem is affected. One example is the honeybee. Based on seed dispersal (or 'pollination'), write an persuasive argument for bee conservation.

Checks for understanding: *What is the function of the Slider block? Which block enables you to change direction?*

Tidy Up / Exit Ticket — 4 minutes

Reinforcing the learning objectives of the lesson, students can reflect on key takeaways by completing and submitting an exit ticket.

Earthquake Alert

Overview

During this lesson, students will gain understanding of how technology can be used to reduce the impact of a weather-related hazard. Students will integrate and exhibit learning by designing a SAM Earthquake Alert that will warn people when an earthquake is starting.

Key Information

Level 1: (Ages 7-9) US Grades 2 or 3 Time: 45/90 minutes

Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➜ Identify the need for alert systems in weather-related hazards.
- ➜ Describe the causes of earthquakes and it spreads from an epicenter.
- ➜ Design a SAM Earthquake Alert using sound and light.
- ➜ Create a system to simulate an earthquake and test the alert system.

Lesson Topics

Earth Science
- ➜ How and why earthquakes occur

Design and Technology
- ➜ Explore design solutions that reduces the impact of a weather-related hazard
- ➜ Generate, develop and communicate ideas through talking, drawing and mock-ups

Computing
- ➜ Inputs, outputs, abstraction, debugging

Scientific Thinking
- ➜ Asking relevant questions and using different types of scientific inquiries to answer them

Art and Design
- ➜ Explore and use mechanisms, devices and materials for imaginative activity that leads to original and creative outcomes

English Language Arts
- ➜ Use information gained from illustrations and text to demonstrate understanding.
- ➜ Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area

Materials required

➜ SAM Labs Kit ➜ Student Workbook ➜ Elastic bands ➜ Blue Tack

➜ Lego

Earthquake Alert

Warm Up — 5 minutes

How do we stay safe when an earthquake occurs?

Objective: Recognize the need for alert systems in weather-related hazards.

Procedures: *"Today we are going to learn how earthquakes occur and create a system that can effectively warn people."*

- Look at the three images and decide which image is labelled; Drop, Cover and Hold
- Discuss why this method is intended to help people stay safe
- Discuss if these steps are enough to help keep people safe when an earthquake occurs
- Option to discuss a brief history of Drop, Cover and Hold

Sample photo ideas: set of 3 images of Drop, Cover and Hold

Link forward: Link to describing how an earthquake spreads from an epicenter

Mini-lesson — 10 minutes

What causes an earthquake?

Objective: Describe what causes an earthquake and how it spreads from an epicenter.

Procedures:

- The earth has a layer called the 'crust' and the crust is split into many pieces called 'Tectonic Plates'
- When these pieces collide against each other an earthquake can occur
- The place where the tectonic plates collide is called the epicenter
- Depending on how strong the earthquake is, the epicenter is where the most damage can occur
- Some earthquakes can be felt hundreds of miles away
- Option to watch short clip (https://video.nationalgeographic.com/video/earthquake-montage) which shows the devastation of earthquakes
- Discuss how can we issue an effective warning that an earthquake is going to happen when they happen so fast?

At the end of the mini-lesson, students can match or define keywords in their workbooks. (2 minutes)

Keywords

- Earthquake
- Tectonic Plates
- Crust
- Warning
- Epicenter

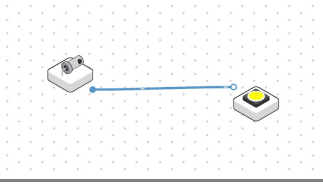
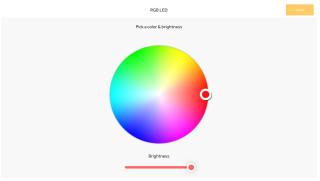
Let's Discuss: *What is the center of an earthquake called? In your workbook or with a partner, record, discuss, or share one idea of how we can warn others when an earthquake starts.*

Link forward: Link to creating our own SAM Earthquake Alert that reacts to movement, starting when an earthquake begins.

Earthquake Alert

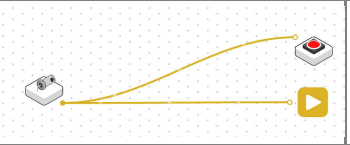
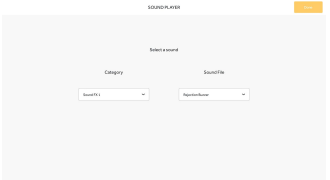
Worked Example — 7 minutes

Create a system that is motion-activated

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 1 Tilt Sensor block • 1 RGB LED block Drag them onto the workspace.		*The Tilt Sensor will be the input for the system and the RGB LED the output.* *If you do not have a Tilt Sensor you could use the Light Sensor block and use the change in light as the input as light changes as movement starts.*
Step 2. Connect the Tilt Sensor to the RGB LED.		*Notice the color change of the blocks on the workspace when paired - they have a shaded 3d color to them so you know they are paired with the system.*
Step 3. Click on the settings icon of the RGB LED. Select a color for an alert.		*Access the settings of the RGB LED and select a red light as this is the expected color for an alert.*
Step 4. Test system by shaking the Tilt Sensor.		*Shake your Tilt Sensor and see the RGB LED light up.*

Challenge 1 — 7 minutes

Create a SAM Earthquake Alert using sound and light

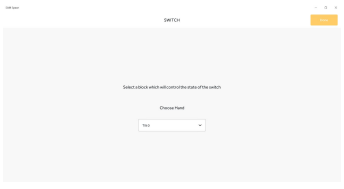
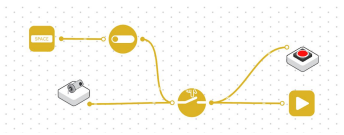
Instructions	Workspace	Notes for Teachers
Step 1. Drag a Sound Player block.		*We are going to create a system that detects earthquake tremors and sounds an alert and light.*
Step 2. Connect the Sound Player block to the Tilt Sensor.		*To maximise the alert system we need to have light and sound to ensure the person is aware of the earthquake.*
Step 3. Click on the settings icon of the Sound Player block. Set the sound.		*Access the settings of the Sound Player block and select the category '**Sound FX 1**' and the sound file '**Rejection Buzzer**'.*

Step 4. Test your system.		*Shake the Tilt Sensor and test the RGB LED lights up and the sound alert plays*

Checks for understanding: *What are the outputs of the system? What causes an earthquake?*

Challenge 1 - Debug it — 5 minutes

Can we automate the system to turn on or off when we are in the house?

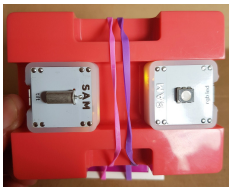
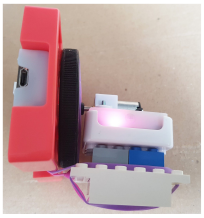
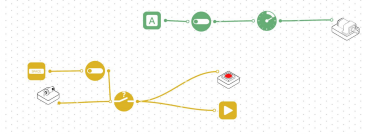
Instructions	Workspace	Notes for Teachers
Step 1. Drag a Key Press block, Switch block and a Toggle block onto the workspace.		*The Key Press block will be another input to our system alongside the Tilt Sensor. If you have a Button block, this can also be used in place of a Key Press.* *If you have a Button/Virtual Button, this can be used in place of the Key Press.*
Step 2. Connect the Switch in between the Tilt Sensor, the RGB LED and Sound Player block.		*The switch is going to allow the input to travel through to the output.*
Step 3. Set the input of the Switch to be the Toggle.		*Access the settings of the Switch block and select the Tilt Sensor from the drop down list.*
Step 4. Connect the Key Press block to the Toggle block and the Toggle to the Switch block.		*The Key Press block and the Toggle block will act as our on/off button for the alert system.*
Step 5. Test your system.		*Press the Key Press block and shake the Tilt Sensor to see it work, press the Key Press block and shake the Tilt Sensor to test it is off.*

Earthquake Alert

Challenge 2

7 minutes

Create a system to simulate an earthquake to test your SAM Earthquake Alert

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 1 DC Motor		*Connect the wheel to the DC Motor.*
Step 2. Attach a Lego base to even the weight.		*Using lego add a base to allow the weight to be distributed.*
Step 3. Add the Tilt Sensor and the RGB LED to the red Car Controller accessory.		*The controller will act as our block to secure the alert system in place.*
Step 4. Using elastic bands secure the controller to the heel of the DC Motor.		*This is where the base comes in and needs to be secure, adding blu tack to hold it to the desk/surface may help keep in place.*
Step 5. Drag a Key Press block, Toggle block, Interval block and DC Motor block to the workspace.		*This will create a system to simulate an earthquake.*
Step 6. Connect the Key Press block to the Toggle, the Toggle to the Interval block and Interval to DC Motor.		*Edit the settings of the Key Press block to be a letter or alternative character so that it is activated separately to the earthquake alert system running alongside it*
Step 7. Set the Interval block to 250 milliseconds.		*Set the Interval block to 250 milliseconds.* *Is this time setting effective? How often will this occur in one minute?*
Step 8. Test your system.		*Turn on the earthquake alert system and activate the earthquake simulator and see how the simulated tremors affect the alert system.*

Extension Ideas:

- **Computing**:
  - Can you increase the magnitude of the earthquake through the Interval block?
  - Build a platform on top of the motors. Build a structure and test your alert system.
- **Geography/Science**:
  - Explore where earthquakes occur most. Measure and model the intensity of an earthquake at a fault line versus 100 miles away.
  - What is being used as early warning systems in different countries e.g. earthquake-proof bed? (https://www.youtube.com/watch?v=slQwB0uCZkc)
- **Science/Math**:
  - What scale is used to measure the magnitude of an earthquake?
  - How does the magnitude of an earthquake relate to the damage it can cause?

Checks for understanding: *What is the output in the SAM Earthquake Alert? What is the outer layer of the earth called?*

Tidy Up / Exit Ticket — 4 minutes

Reinforcing the learning objectives of the lesson, students can reflect on key takeaways by completing and submitting an exit ticket.

Reduce, Reuse, Recycle

Overview

During this lesson, students will learn to recycle, working collaboratively to estimate, measure and sort recyclable and non-recyclable objects. They will integrate and exhibit learning by building a SAM Recycling Machine. Students will create a pictograph of their results.

Key Information

Level 1: (Ages 7-9) US Grades 2 or 3 Time: 45/90 minutes

Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➔ Explain the importance of recycling to the environment.
- ➔ Draw a scaled pictogram to represent data.
- ➔ Create a SAM Recycling Machine that counts and logs data.
- ➔ Explore how machines can help us to complete everyday tasks.

Lesson Topics

Earth Science
- ➔ What recycling is and how it works
- ➔ Recyclable and non-recyclable materials

Math
- ➔ Measure and estimate lengths in standard units

Design and Technology
- ➔ Generate, develop, model and communicate ideas through talking, drawing and mock-ups

Computing
- ➔ Inputs, outputs, abstraction, debugging

Scientific Thinking
- ➔ Asking relevant questions and using different types of scientific enquiries to answer them

English Language Arts
- ➔ Use information gained from illustrations and text to demonstrate understanding
- ➔ Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 2-3 topic or subject area

Materials required

➔ SAM Labs Kit ➔ Student Workbook ➔ Ruler

➔ Plastic bottles, plastic lids, paper, polystyrene, cardboard to be sorted.

Reduce, Reuse, Recycle

Warm Up — 5 minutes

What is recycling?

Objective: Explain the importance of recycling to the environment

Procedures: *"Today we are going to investigate what materials we can recycle and create pictographs to demonstrate the impact of recycling"*

- What are the 3 R's of recycling - reduce, reuse, recycle
  - Reduce - think about what you are throwing away! Would someone else like what you are throwing away?
  - Reuse - reusing things can delay or avoid something being thrown away, you can reuse paper that has been used on one side as a notepad or for drawings.
  - Recycle - if you can not reduce or reuse your trash put it in your recycling bin.
- Students are given a variety of materials to inspect. These could include any common materials such as cotton wool, paper clips, paper, plastic rulers, metal rulers, nails, etc.
- Students work together to sort the objects into three groups: objects they think can be recycled, objects they think cannot be recycled and objects they are unsure about.
- Discuss the reason behind their choices. Why are they unsure about some of the objects?

Link forward: If we were at a large recycling center, how could we determine the recyclable objects from non-recyclable?

Mini-lesson — 10 minutes

How can data help us to achieve our recycling goals?

Objective: Identify what is needed to design a machine that counts accurately

Procedures: ***"****Currently in the USA we only recycle 34% of our trash. How can we use machines to improve this percentage?"*

- Awareness is a big part of the issue. How can we make people more aware of the problem?
- Direct students to the graphs in their workbooks. What kind of graph can best convey the data?
- Design a pictograph.
- How can machines help us to track and improve recycling?
  - Machines can be built to focus on tasks such as tracking data. They can be programmed to have a focus.
  - Each part of a program carries out a task, as we'll see shortly.
  - If we program the machine to count, make a sound or flash a light, then that's what it will do. (8 minutes)

At the end of the mini-lesson, students can match or define keywords in their workbooks. (2 minutes)

Keywords:

- Reduce
- Reuse
- Recycle
- Log
- Environment

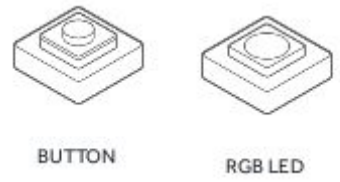
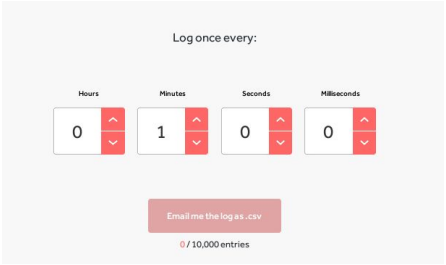
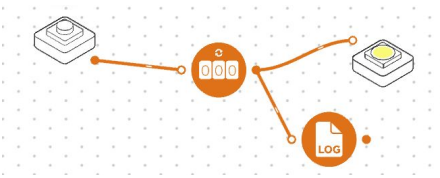
Let's Discuss: *What are the 3 R's of recycling? In your workbook or with a partner, record, discuss, or share one way we can recycle more of your household trash.*

Link forward: Link to creating a machine that can count objects.

Reduce, Reuse, Recycle

Worked Example — 7 minutes

Design a SAM Recycling Machine that can count objects and log results

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 1 Button/Virtual Button • 1 RGB LED block		*In this example, I'm using a Button block. If you don't have a Button block, you can use a Virtual Button or a Light Sensor (as a button).*
Step 2. Connect the Button to the RGB LED. Add a Counter block between them.		*This now connects the blocks and will count every time you touch the sensor while you are sorting your trash.*
Step 3. Add a Log Findings block to the output of the Counter. Adjust the settings to log data once a minute.		*The Log Findings block will email you with the data, if you ask all the pupils to input the same email address you will then be able to collect the data from the entire class to look at later. Make sure the brightness of the RGB LED is set to full.*
Step 4. Sort your trash! Press the Button every time you have something you can recycle.		*Every group should have a shoe box full of trash, and two bags to sort it into, one bag for items which can be recycled, one bag for items which can't.*

Reduce, Reuse, Recycle

Challenge 1

7 minutes

Create a SAM Recycling Machine that resets

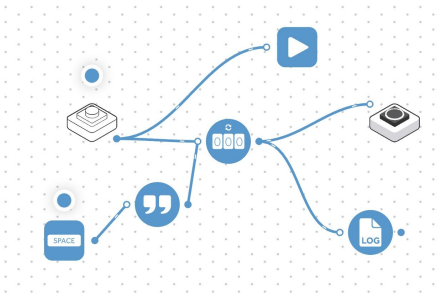
Instructions	Workspace	Notes for Teachers
Step 1. Drag a Key Press and Text block onto the workspace.		*Your Key Press is now your second input.*
Step 2. Connect the Text block to the Counter and the Key Press.		*The Key Press and Text block can be used to reset our system.*
Step 3. Program the Text block to say 'reset' all in lowercase.		*This will send a reset command to the counter and reset the counter. This can be used to count the second set of data, or to restart if they think they have made a mistake.*
Step 4. Test your system.		*If you press the Button it will add one to the Counter. If you press your Key Press it will reset the Counter.*

Checks for understanding: *Does the Counter increase when you press the Button? What is one reason that is it helpful to track the amount we recycle?*

Reduce, Reuse, Recycle

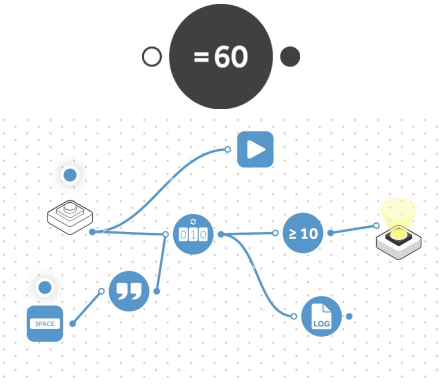
Challenge 1 - Debug it — 5 minutes

Can we make it more exciting to recycle?

Instructions	Workspace	Notes for Teachers
Step 1. Drag a Sound Player block onto the workspace. Choose 'joy' from the Emotions sound set.	 	*We are going to add the sound as a second output, which will encourage people to recycle.*
Step 2 Connect the Sound Player block to the Button block. Test your system.	 	*When you press the button (input) the counter will increase, the RGB LED will light up and the 'joy' sound will play.* *You will also be collecting data using the log function which you will use to create your graphs.*

Challenge 2 — 7 minutes

Make the RGB LED light up when you have reached your recycling target

Instructions	Workspace	Notes for Teachers
Step 1. Drag a Compare block onto the workspace. Connect it between your Counter and RGB LED.	 	*This will send a signal to the RGB LED to light up when it reaches a specific number.*
Step 2. Program your Compare block to '≥ 10' (or whatever your recycling target might be).	 	*This means that the RGB LED will light up when you have recycled 10 objects, if each student group is given 20 objects to sort. This gives them a recycling target of 50%.*
Step 3. Download your 'Log Findings' data. Present your results to the class.	 	*Your data will be accessible to you on your device.*

Extension Ideas:

- **Science/Design Technology**:
  - Can you design something which will remind you to recycle when you open your trash can?
  - Can you design a trash can that would make it easier for people to recycle?
- **ELA:**
  - Can you design a poster to encourage people to recycle more, explaining the effects of trash on the environment?
  - Can you write a persuasive essay to implement a recycling initiative across your whole school?

Checks for understanding: *Why is it important to have accurate data? How does the Log Findings block work?*

Tidy Up / Exit Ticket — 4 minutes

Reinforcing the learning objectives of the lesson, students can reflect on key takeaways by completing and submitting an exit ticket.

Interactive Storybook

Overview

During this lesson, students will write a creative story and work collaboratively to create an interactive element to their story. Their storybook can be used to encourage reluctant or younger readers to explore literature.

Key Information

Level 1: (Ages 7-9) US Grades 2 or 3 Time: 45/90 minutes

Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➜ Plan a simple system which plays sounds..
- ➜ Write a short piece of fiction for a given audience and explore onomatopoeia.
- ➜ Develop a program that plays specific sounds to match the story.
- ➜ Use trial and error to debug a system.

Lesson Topics

English Language Arts
- ➜ Write a story for a given audience.
- ➜ Participate in collaborative conversations.

Computing
- ➜ Inputs, outputs, debugging

Scientific Thinking
- ➜ Asking relevant questions and using different types of scientific enquiries to answer them

Design and Technology
- ➜ Generate, develop, model and communicate ideas through talking, drawing and mock-ups

Materials required

- SAM Labs Kit
- Student Workbook
- Highlighters
- Post-its
- Blue tack
- Headphones
- “Dear Zoo” by Rod Campbell (or another book of your choosing)

Interactive Storybook

Warm Up — 5 minutes

What makes a storybook interactive?

Objective: Consider how we can use sound to make reading more interactive.

Procedures: *"Today we are going to look at how we could add sound to a simple story in order to make it more interactive."*

- Read or listen to the story "Dear Zoo" by Rod Campbell (*or a story of your choosing*)
  - https://www.youtube.com/watch?v=glSomYasZBA
- *What sounds do you think we could add to this story?*
- Name the animals and identify the sounds in SAM Space.
- What is onomatopoeia? What other onomatopoeic words can you think of?
- Option to explore other examples of interactive storybooks in stations.

Link forward: How can we design a system that plays a sound that matches the words?

Mini-lesson — 10 minutes

Write your interactive storybook

Objective: Write a story which will utilize the sounds in the SAM Space app.

Procedures: *"We know that there are sounds in SAM Space app which we can use to make our stories interactive. Which sounds are you going to use to write your story? Identify 5 sounds."*

- Students work in small groups exploring the SAM Space app, selecting 5 sounds which they can combine into a story.
- Using a writing frame, plan and write a simple story.
- Edit your story to highlight where your sounds are included.
- Include at least one sound on each page of your storybook.

Let's Discuss: *What is the meaning of the word interactive? In your workbook or with a partner, record, discuss, or share an example of how else you could make your story fun and interactive.*

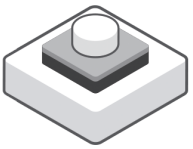
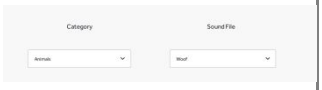
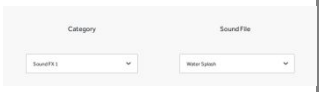
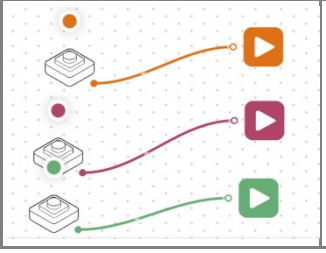
Link forward: Link to designing a program which plays a sound when you read the designated word.

Interactive Storybook

Worked Example

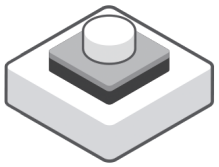
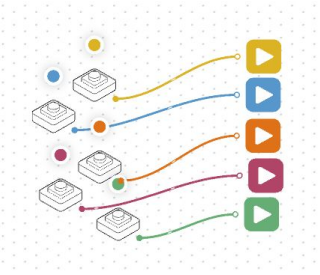
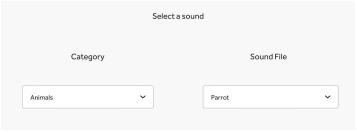
7 minutes

Design a program which plays a sound for a designated word

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 3 Button/Virtual Button blocks		*The buttons will be the input devices. When you press the button the sound will play. Alternatively, students can use a Key Press and label it to differentiate between sounds.*
Step 2. Drag 3 Sound Player blocks onto the workspace. Connect each Button to a Sound Player.		*The Sound player blocks will be the output, you need to tell them what sound to output when the button is pushed.*
Step 3. Choose the settings icon of the Sound Player. Set the first Sound Player block to play your first selected sound.		*If you wanted to write this as a class, you could use Dear Zoo as your inspiration, choosing the 'lion roar' sound effect found in the Animals Category.*
Step 4. Set the second Sound Player block to your next sound.		*For the dog, you can choose 'woof' in the Animals Category.*
Step 5. Set the third Sound Player block to play your third sound and so on.		*This sound effect is found in the Sound FX1 Category and is called Water Splash.*
Step 6. Test your system.		Do the buttons play the correct noise, do you know when to press the buttons?

Challenge 1 — 7 minutes

Design a program for your interactive storybook

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 2 additional Buttons/Virtual Button blocks		*The expectation for the story is that there are at least 5 sounds and so we need an input for each sound.* *If pupils are using laptops/Chromebook, they could use the Key Press block instead of a button and program each sound to a given key.*
Step 2. Drag 2 additional Sound Player blocks onto the workspace.		*The students should have already planned out in their workbooks which 5 sounds they are going to use in their stories, so encourage them to choose these sounds initially.* *If they want to change the sounds, this is called debugging the system--as they are improving it.*
Step 3. Connect your Buttons to the Sound Player blocks.		*Read the story and test the buttons, do they play the sounds which match your story- could you do anything else?*
Step 4. Program your sounds in the remaining Sound Players. Test your system.		*Do the sounds match your story, could you use any other tool instead- could you use the notes to create the sound?* *If you have a Buzzer block, try connecting the Buzzer with the Note block - see what sounds you can create.*
Step 5. Read your story to a partner. Encourage them to join in, pressing the Buttons in the correct places.		

Checks for understanding: *What is your input, what is your output? How have you made your storybook interactive?*

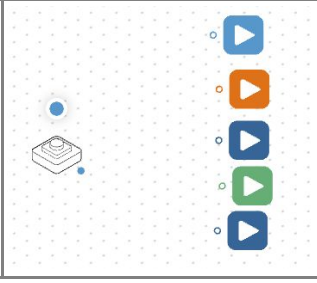
Challenge 1 - Debug it — 5 minutes

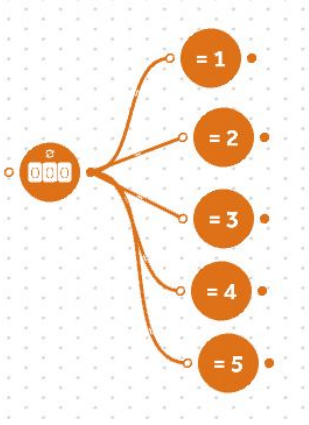
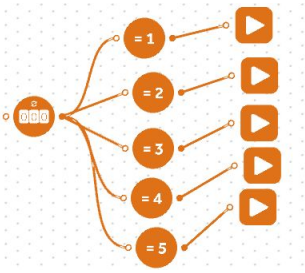
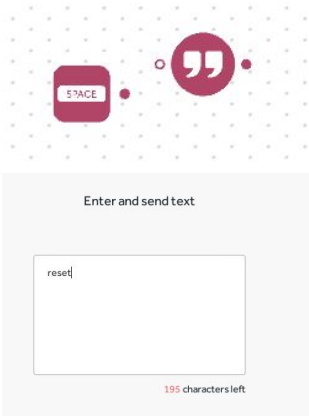
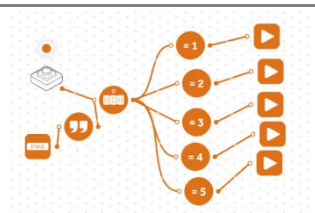
How do you know which Button to press for each sound?

Instructions	Workspace	Notes for Teachers
Step 1. Create a label for your sound on a Post-it.		*At this point you could encourage the students who are reluctant readers to focus on the keywords and practice reading them.*
Step 2. Label your blocks so the reader knows which Button produces each sound.		*At this point it might be useful to headphones for the pupils so they can hear their sounds and not get distracted by each others' sounds.*

Challenge 2 — 7 minutes

Create a system which loops the sounds and has a reset function

Instructions	Workspace	Notes for Teachers
Step 1. Remove 4 Buttons so you are left with just one Button in your workspace.		*There is now one input for all the outputs. We need to create a system which orders the inputs so the sounds play in a given order.*

Step 2. Drag a Counter block into your workspace and program it to reset after '5'.		*This will count the number of times you press the button - or input into the system and then send a message to the correct output.* *The counter will reset to 0 after the button has been pressed 5 times and it will then play the first sound again.*
Step 3. Drag 5 Compare blocks onto your workspace. Set the Compare blocks so they read =1, =2, =3, =4, =5. Connect them all to the Counter block.		*This now tells the Compare block to look at the Counter block and then it will know which block to send the message onto.*
Step 4. Connect the output of the Compare block to the input of the Sound Player blocks.		*Ask the students to ensure that their sounds are in the correct order in their workspace, otherwise the sounds won't match their story.* *As they can now have as many sounds as they want, students can add as many Sound Player and Compare blocks as they need for their story.*
Step 5. Drag a Key Press block and Text block onto your workplace. Click on the settings icon of the Text block. Type the word 'reset' into the field.		*This is going to act as a reset, so you can reset your system.*
Step 6. Connect the Key Press block to the Text block. Connect the output from the Text block to the input of the Counter.		*Why do we need a reset?* *What is your input, what is your output? What message is being sent between the blocks?*
Step 7. Connect the Button to Counter block. As you read a word, press the Button. Test your system.		*Is there a way of playing the sound twice- can you have it so that two different Compare blocks connects to the same Sound Player block?*

Extension Ideas:

- **ELA:**
  - Can you create illustrations and additional interactive elements for your story eg. lift the flaps.
  - Can you write a second story for a given audience and create different sound effects for the story.
- **Science**:
  - Why do animals make different noises (e.g. a dog barking, a snake hissing)? What are they communicating?
- **Computing**:
  - How can lighting be added to your system to enhance your story?
- **Geography**:
  - Explore how sounds can help distinguish geographical location

Checks for understanding: *Why is it important to test your program throughout the development stage? What is an onomatopoeia?*

Tidy Up / Exit Ticket — 4 minutes

Reinforcing the learning objectives of the lesson, students can reflect on key takeaways by completing and submitting an exit ticket.

Overview

During this lesson, students will learn about algorithms, events, actions and the use of 'if/then' to define a system flow. Students will integrate and exhibit learning by designing and creating a system to alert others when the SAM Safe box has been opened.

Key Information

Level 1: (Ages 7-9) US Grades 2 or 3 Time: 45/90 minutes

Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➜ Construct an algorithm for a given problem
- ➜ Discuss the use of 'Event' and 'Action' within programming to define the input and output
- ➜ Create a SAM safe that has actions set when the event - the box opening - is triggered
- ➜ Modify the system to capture a picture of the person opening the SAM safe

Lesson Topics

NGSS ETS1 Engineering Design

- ➜ Generate questions and develop a model to solve a need, revising to improve the system comparing the effectiveness

Computing

- ➜ Inputs, outputs, abstraction, debugging

English Language Arts

- ➜ Participate in collaborative conversations

Scientific Thinking

- ➜ Asking relevant questions and using different types of scientific enquiries to answer them

Materials required

- ➜ SAM Labs Kit
- ➜ Box with lid, or a template to construct a box
- ➜ Student Workbook
- ➜ Art supplies to decorate the box e.g. pens, pencils, stickers.

Warm Up — 5 minutes

What is an algorithm?

Objective: Construct an algorithm for a given problem

Procedures: *"What is an algorithm?"*

- An algorithm is a set of instructions.
- We use instructions every day to help us do things.
- Ask students to give you the directions to walk from point A to point B in the classroom. Follow their directions precisely.
- What was easy or hard about that task? Did they miss any key instructions?
- Option for students to work in pairs. One partner draws a simple line drawing hidden from their partner. Without showing the drawing they describe it to their partner using steps.
- How accurate was the second drawing? How could the steps have been clearer?

Link forward: Link to exploring algorithms we use in everyday life.

Mini-lesson — 10 minutes

Constructing an algorithm with 'Events' and 'Actions'

Objective: Discuss the use of 'Event' and 'Action' within programming to define the input and output

Procedures: *"Some people own a safe in their homes to secure their belongings. We are going to create an alarm for our safe which will alert us if someone opens the safe without permission."*

- How is a safe designed to be secure? - Elicit responses from students.
- Most alarms work by having an input to ensure they are on, and then an output to show if the alarm has been triggered - for example if a safe is on and is then broken into, the alarm might sound a loud buzzer.
- Discuss what features an alarm might have. What inputs might it have? What might the outputs be?
- In creating our system, we need to be aware of what actions (output) happen as a result of the event (input). Event: safe being broken into; Action: alarm sounding.
- Encourage students to create sentences together to demonstrate the event/action (input/output) e.g. **If** someone opens the door of the safe **then** a red light will flash. (8 minutes)

At the end of the mini-lesson, students can match or define keywords in their workbooks. (2 minutes)

Keywords

- Algorithm
- Input
- Output
- Event
- Action

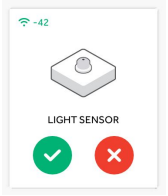
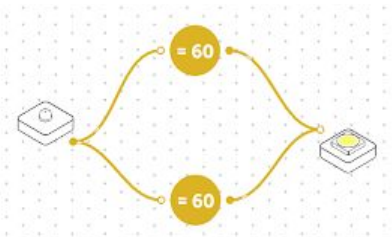
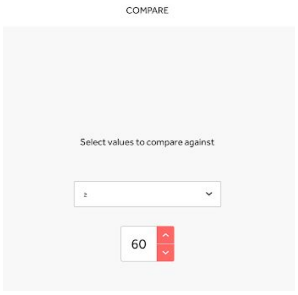
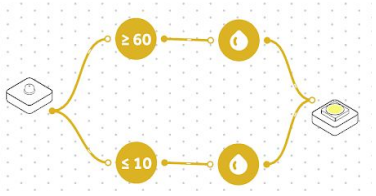
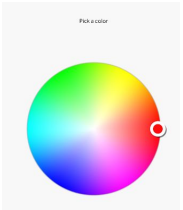
Let's Discuss: *In computing terms, what is a set of instructions called? In your workbook or with a partner, record, discuss, or share the event and action for their safe and how they will work together.*

Link forward: Link to designing an alarm system using SAM Blocks.

Worked Example

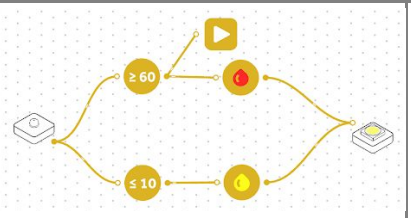
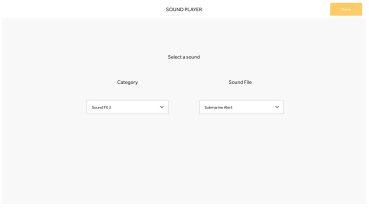
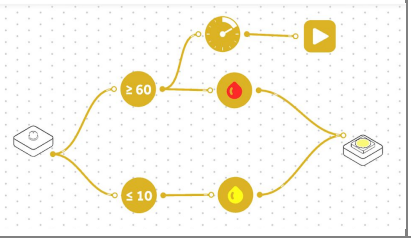
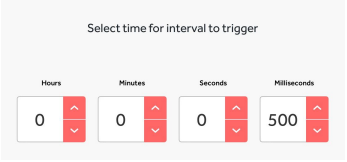
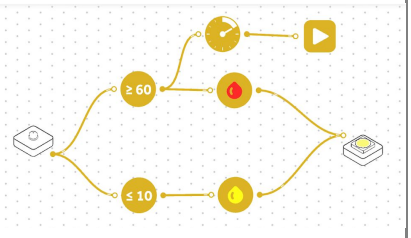
7 minutes

Design an alarm system for your safe

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 1 Light Sensor block • 1 RGB LED block		*The RGB LED is going to be our first alert. The Light Sensor values will change to indicate if the box has been opened.*
Step 2. Drag onto the workspace: • Light Sensor block • RGB LED block • 2 x Compare blocks		*The Light Sensor block will be our event (input) and the RGB LED block will be the action (output). The Compare block will be our IF and Then part to determine the action.*
Step 3. Connect the blocks in the following order: • Light Sensor block to both Compare blocks • Both Compare blocks to the RGB LED block.		*The Compare blocks will indicate the alarm is armed and trigger an alert.*
Step 4. Access the settings icon of: • The first Compare block and set it to '≥60'. • The second Compare block and set it to '≤10'.		*Ensure students understand the symbols: ≤ and ≥.* *Highlight to students that **if** the Light sensor reads less than or equal to 10 or greater than or equal to 60 **then** the light will come on.*
Step 5. Drag two Color blocks onto the workspace. Connect one between each of the Compare and RGB LED blocks.		*The Color blocks will help define the color of the light.*
Step 6. Access the settings of the Color blocks and set the Color block: • After the '≥60' Compare block to red • After the '≤10' to yellow.		*The separate colours in the system now show the different meanings of the light, according to the level read by the compare block. Yellow means the alarm is on and red means it is triggered; the safe has been opened.*
Step 7. Fix your Light Sensor inside your safe and your RGB LED outside of it. Test your system.		*Students should take the opportunity to fix the blocks strategically inside their 'safe'.* ***If** the box is closed, **then** the RGB LED is yellow.* ***If** you open the box, **then** the RGB LED turns red.*

Challenge 1 — 7 minutes

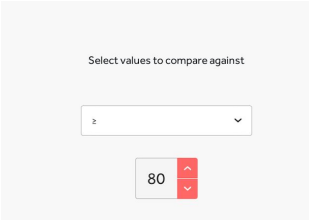
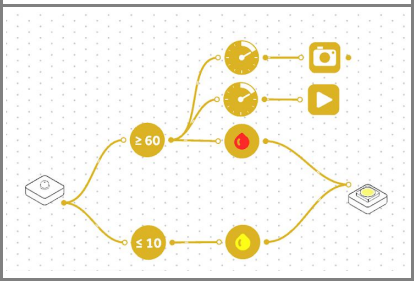
Create a SAM safe that has actions set when the event - the box opening - is triggered.

Instructions	Workspace	Notes for Teachers
Step 1. Drag onto the workspace: • Sound Player block • Interval block.		*The Sound Player block will form a second output to our system when the safe has been opened. The interval block will control the frequency of sounds.*
Step 2. Connect the Sound Player block to the output of the '≥60' Compare block.		*Students should test their system ensuring the volume on their device is turned on to hear the sound.*
Step 3. Access the settings of the Sound Player block and select a sound for your alarm.		*Encourage students to select a sound appropriate for an alert, reminding them that the design of products is very often linked to their function.*
Step 4. Connect the Interval block between the '≥60' Compare and the Sound Player blocks.		*The Interval block will trigger the sound to repeat in specific Intervals.*
Step 5. Access the settings of the Interval block and set to '500' milliseconds.		*Ensure students understand that If the Light Sensor reads above 60 or below 10, then the alarm will sound every 500 milliseconds.*
Step 6. Test your system.		*At this stage the students are encouraged to experiment with the settings on the Interval block to observe the effect of different times.* *What would the alarm sound like with a:* • *1 second interval?* • *250 millisecond interval?* • *3 second interval?*

Checks for understanding: *What does the symbol ≥ mean? What is the output of an 'event'?*

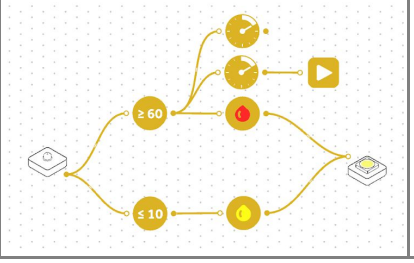
Challenge 1 - Debug it — 5 minutes

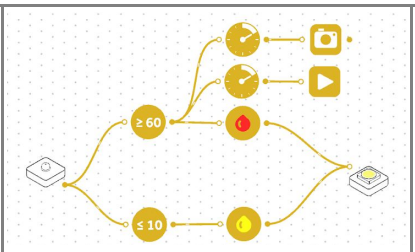
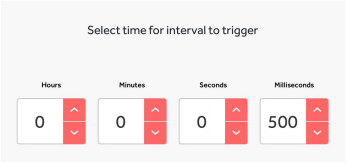
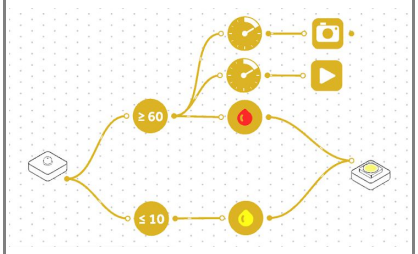
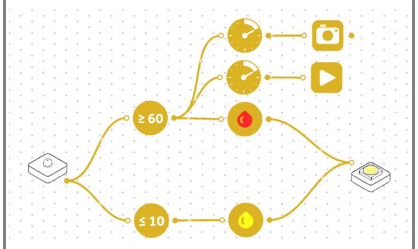
Why isn't my alarm going off?

Instructions	Workspace	Notes for Teachers
Step 1. What is the resting value of the Light Sensor?		*Classrooms will have varying amounts of light. Above the Light Sensor block on the workspace, the value will change depending on the light within the room; observe the range that it is showing when in the classroom environment.*
Step 2. Access the settings of the '≥60' Compare block and edit the number to ensure it is greater than the room resting value.		*Here the value has been increased to 80 but will need to be a number that works for the environment you are in.*
Step 3. Test your system.		*It is encouraged for the value to be tested to see the effect on the system and find the most suitable value for the student and their safe in the environment they are in.*

Challenge 2 — 7 minutes

Modify the system to capture a picture of the person opening the SAM safe

Instructions	Workspace	Notes for Teachers
Step 1. Drag onto the workspace: • Camera block • Interval block		*It is important that if it is the first time the Camera block has been used on the device you will need to grant the Camera access to take and store the photos.*
Step 2. Connect the '≥60' Compare block to the Interval block.		*The Interval block will set the Camera block to be activated when the set time is met.*

Step 3. Connect the Interval block to the Camera block.		*The Camera and the Sound Player blocks will be activated **if** the Light Sensor value reaches 60 and above when the box is opened.*
Step 4. Access the settings of the Interval block connected to the Camera block and set to 500 milliseconds.		*By setting the Interval block the camera will take a picture every 500 milliseconds and the images stored in your computer pictures folder to show the culprit.*
Step 5. Test your system.		*Set the device up next to the box, pointing the camera towards where the box is and test your system to ensure photos are taken and the light and sound is triggered when the box is opened.* *What happens if the interval time is increased or decreased? Does it improve images captured?*
Step 6. Access the photos.		*The images are stored within the pictures folder on a PC and the photos app on an iPad.* *Discuss how the addition of a camera changes the alarm for their safe.*
Step 7. Discuss the system.		*Ask the students to define the event, action and the IF/Then in the system?* ***Event**: Light Sensor* ***Action**: RGB LED* ***IF**: The Light Sensor is greater than or equal to 60 **then** the RGB LED shine red, camera takes pictures and alarm sounds* ***IF**: The Light Sensor is less than or equal to 10 **then** the RGB LED shines yellow.*

Extension Ideas:

- **Computing**:
  - How can you program the RGB LED to flash?
  - How can you reset the system after the alarm has been triggered?
  - How do you add a timer so your alarm is only active during a certain part of the day or night?
  - How can the Tilt block be added to the system as a trigger if the box is moved and not opened?
- **History**:
  - Explore how safes have evolved over history.
  - How have the materials used to make safes improved?
  - How has technology been incorporated?
- **Science**:
  - What materials are used to construct safes? Why? How do they compare?

Checks for understanding: *What is the purpose of the Interval block to the Camera block? What is the event in this system?*

Tidy Up / Exit Ticket — 4 minutes

Reinforcing the learning objectives of the lesson, students can reflect on key takeaways by completing and submitting an exit ticket.

Lesson 1.12

Round and Round

Overview

During this lesson, students will explore the requirements for rounding numbers; *when do I round up to the next 10, when do I round down*? Students will build a system to alert them which direction to round: up or down.

Key Information

Level 1: (Ages 7-9) US Grades 2 or 3 Time: 45/90 minutes

Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➜ Estimate a number's value on a number line.
- ➜ Round to the nearest 10, when less than 100.
- ➜ Build a SAM system to count up to 100 and keep track of the ones separate from the number being counted.
- ➜ Build a SAM system to alert a user when they need to round up or round down.

Lesson Topics

Math
➜ Rounding numbers to the nearest 10.

Computing
Inputs, outputs, abstraction, debugging.

Design and Technology
Define a problem and design a solution.

English Language Arts
Participate in collaborative conversations.

Materials required

➜ SAM Labs Kit ➜ Meter Ruler with 10s marked ➜ Sticky arrows ➜ Student Workbook

Round and Round

Warm Up – 'What is it worth' — 5 minutes

Where should the number go?

Objective: To estimate about where on a number line a number sits.

Procedures: "As I count from 1 to 100, there are times when I am closer to 1 group of 10 than another. Let's look at some numbers and decide which 10 is closest."

- Display number stick (meter stick with each 10 cm highlighted somehow virtual or real) and have students predict about where the following numbers would be: 36, 83, 79, 11, 45 and 62.
- Students discuss in teams where they think the numbers go and use sticky arrows to indicate their suggestion.
- Question how they know they are correct:
    - There are 3 tens, so it's in the 30s, and there are 6 ones, so it's a bit past the middle.
    - There are 8 tens, so it's in the 80s, and there are 3 ones, so it's a bit before the middle.
    - Etc.

Link forward: How can I use where a number lies on a numberline, to decide how to round a number to the nearest 10?

Mini-lesson — 10 minutes

Round up or down?

Objective: To explain when I round to the next 10 and when I stay with the current 10.

Procedures: *"Let's figure out a way to decide which 10 is closer to the numbers we have looked at."*

- Go back to the descriptions of where the numbers are located on the number line.
- Start with 40, when you get to 45, stop and discuss where this is - establish it is in the 'middle' or 'half-way'. Establish that:
    - All numbers before 45 are closer to 40, so round down
    - All numbers after 45 are closer to 50, so they round up
- Draw two hands on the board and invite students to do the same.
- For the left hand, label the left-most finger 0 and move through to 4 on the right-most finger.
- For the right hand, label the left-most finger 5 and the right-most finger 9.
- "This will be our guide for rounding. How many fingers are listed on the left hand? (5) How many on the right? (5)"
- Draw attention to the numbers on the two hands and the ones place for the numbers.
- "When the ones were like the numbers on the left hand, I rounded down. When the ones were like the numbers on the right hand, I rounded up. Does anyone have any suggestions for 45?"
- Explore why 45 rounds up, even though it is in the middle: 40, through to 44, rounds to 40; 45, through to 49, rounds to 50. 5 numbers round up and 5 numbers round down.
- "Why might it be nicer to work with a number like 80 than 79?" Record ideas. (8 minutes)

At the end of the mini-lesson, students can match or define keywords in their workbooks. (2 minutes)

Keywords

- Tens
- Half way
- Ones
- Round

Let's Discuss: *Why does a number with a 5 in the ones place round up? In your workbook or with a partner, record, discuss, or share an example of how you would explain rounding to someone in your family.*

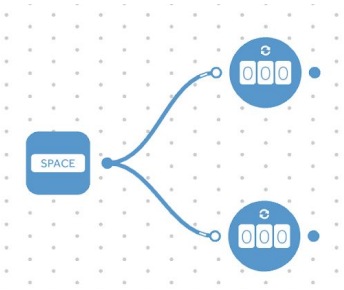
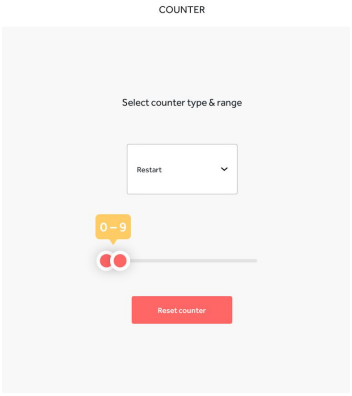
Link forward: Link to creating a system to remind students when a number rounds up and when it rounds down.

Round and Round

Worked Example

7 minutes

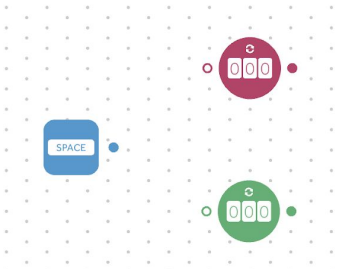
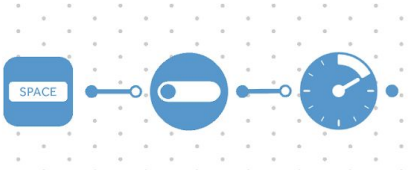
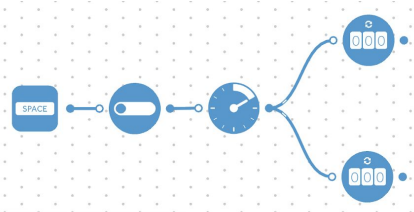
Design a counter than keeps track of the ones in a number and keeps track of the whole count.

Instructions	Workspace	Notes for Teachers
Step 1. Drag a Key Press block onto the workspace.		*The Key Press block will start and stop this system.*
Step 2. Drag 2 Counter blocks onto the workspace.		*1 of the Counter blocks will be the number being counted and the other Counter block will be the ones.*
Step 3. Connect the Key Press block to both of the Counter blocks.		*This will move the Counter blocks 1 for each key press.*
Step 4. Open the settings for bottom Counter blocks. ● Set to range 0 - 9.		*This will keep track of the number being counted and the value of the ones place for that number.* *The second Compare block will remain set at the default, 0-100.*

Round and Round

Challenge 1 — 7 minutes

Make the Counter blocks more automatic.

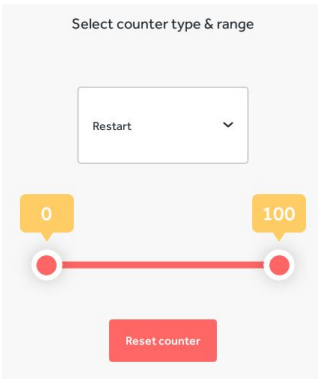
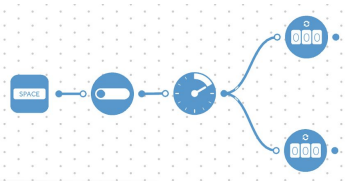
Instructions	Workspace	Notes for Teachers
Step 1. Disconnect the Key Press block from the 2 Counter blocks.		*These blocks have been disconnected because there will be other blocks that are going to go between them, to automate things.*
Step 2. Drag a Toggle block onto the workspace.		*This will keep the Key Press button set to on.*
Step 3. Connect the Key Press block to the Toggle block.		*Now, when you press the Key Press block, the system will stay on until you turn it off.*
Step 4. Drag an Interval block onto the workspace.		*This will make an event occur every time your set time occurs.*
Step 5. Connect the Toggle block to the Interval block.		*This keeps the Interval block active until it is turned off.*
Step 6. Connect the Interval block to both of the Counter blocks.		*In this instance, the Interval block will determine how quickly the Counter block changes.*

Checks for understanding: *If I round to the nearest ten what is in the ones place? How do we decide when to round up and when to round down to nearest ten?*

Round and Round

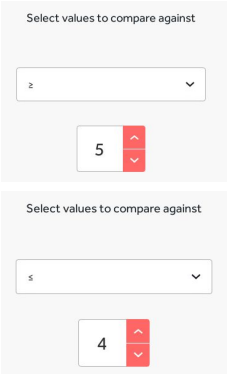
Challenge 1 - Debug it — 5 minutes

Why do the ones not match up with the number being counted?

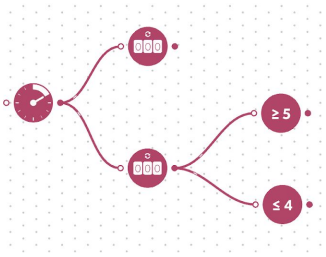
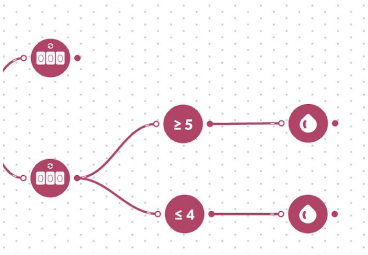
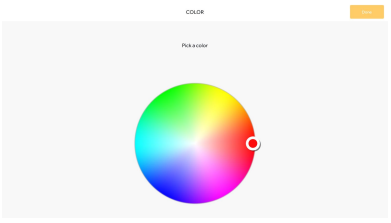
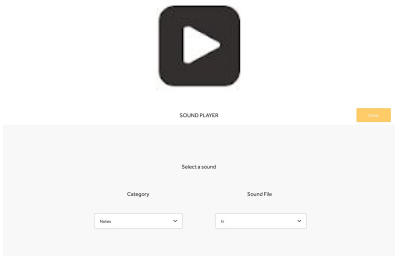
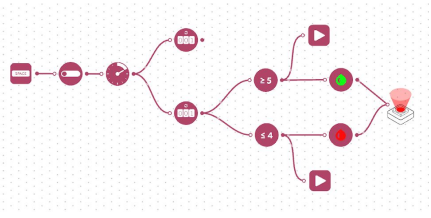
Instructions	Workspace	Notes for Teachers
Step 1. Open the Settings icon for the Counter blocks to check settings.		*You have to ensure that one of the Counter block's settings remains untouched, 0 - 100, while the other is 0 - 9, not 0 - 10. Discuss with the students why the computer counts 11 each time it counts to 10 after the first time.*
Step 2. Remove any direct connection between the Key Press block and the Counter blocks.		*If this was not done properly, one of the Counter blocks will receive an extra count every time the Key Press block is pressed.*

Challenge 2 — 7 minutes

Design an alert to tell students when to round up and when to round down, depending on the value of the ones place.

Instructions	Workspace	Notes for Teachers
Step 1. Drag 2 Compare blocks onto the workspace.		*These will be used to compare with the value of the ones Counter block.*
Step 2. Access the settings; • 1st Compare block set to ≥5 'greater than and equal to 5'. • 2nd Compare block set to ≤4 'less than and equal to 4'.		≥ defines 'greater than and equal to' ≤ defines 'less than and equal to' *1st Compare block - rounding up: when the ones value is 5, 6, 7, 8 or 9, we round up.* *2nd Compare block - rounding down: when the ones value is 0, 1, 2, 3 or 4, we round down.*

Round and Round

Step 3. Connect the output of the bottom Counter block, that is set to 0 - 9, to both inputs of the Compare blocks.		*These are the values that are crucial for rounding: an extension could use <5 rather than <= 4 and discussion could be had around what that means.*
Step 4. • Drag 2 Color blocks onto the workspace. • Connect 1 Color block to each of the Compare blocks.		*The Color blocks will give a different alert depending on the value of the ones place.*
Step 5. Change the color settings: • The Color block connected to the ≥ 5 Compare block to green. • The Color block connected to the ≤4 Compare block to red.		*The green light is then green for 'go' for numbers that round up.* *The idea behind the red light is 'stop' remain at the ten you are at.*
Step 6. Drag 2 Sound Player blocks onto the workspace. • Connect one to the ≥5 Compare block and set it the note 'ti' • Connect the other to the ≤4 Compare block and set it the note 'do'.		*This is in addition to the visual warning.* *Sounds located in the 'Notes' drop down category.* *When the number rounds up, the systems will play a high note and when the number rounds down, the system will play a low note.*
Step 7. Test the system to ensure that the lights and sounds change with the count.		*Make sure students can talk through the different parts of the system. Try discussing in the order you created this system.*

Extension Ideas:

- **Computing**:
  - Can you think of a way to make the rounding up and rounding down sound more exciting?
- **Math**:
  - Can you apply this understanding to round to the nearest 100?

Checks for understanding: *Why does one Counter block have two Compare blocks and the other Counter block have none? Why do both Sound and Light blocks connect to the Compare blocks?*

Tidy Up / Exit Ticket — 4 minutes

Reinforcing the learning objectives of the lesson, students can reflect on key takeaways by completing and submitting an exit ticket.

