



# **SAM Labs**

# **Lesson Plans**

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**COMPUTER SCIENCE**  
**MATHEMATICS**  
**DESIGN & TECHNOLOGY**  
**SCIENCE**  
**CITIZENSHIP**  
**HISTORY**





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# Civic Engagement

COMPUTER SCIENCE  
DESIGN & TECHNOLOGY  
CITIZENSHIP



This Lesson Plan has Twitter content.  
Not suitable for children under 13 years  
of age.

# Key information

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## SUBJECTS

Computing, Citizenship, Design & Technology.

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## RECOMMENDED PRIOR KNOWLEDGE

Basic understanding of SAM, and the SAM Blocks used in the project.  
Basic understanding of Twitter.

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## KEY STAGE

Key Stage 3

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## GROUP SIZE

4-5 students

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## OUTCOMES

- To understand the design thinking process.
  - To produce a civic campaign on a topic of importance.
  - To share the concepts of the campaign externally using SAM.
  - To reflect and evaluate the feedback form sharing the campaign.
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## TIME REQUIRED

Suggestion for 2 one hour sessions:

### Session 1

15 minutes introduction and to build the SAM Space for Tweeting.  
45 minutes to work on the civic engagement campaign.

### Session 2

30 minutes to review any twitter activity and adapt the campaign as appropriate.  
15 minutes to present the campaign to the class for reflection and peer review.  
10 minutes extension activity.  
5 minutes reflection and plenary.

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## LEARNING OBJECTIVES

See Curriculum Alignment (next page).

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## MATERIALS REQUIRED

- Computer or Tablet
  - SAM Space Education app
  - 1 SAM Tray
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# Curriculum alignment

## NATIONAL CURRICULUM STANDARDS

### Computing - Key Stage 3

- Design, use and evaluate computational abstractions that model the state and behaviour of real-world problems and physical systems.
- Understand several key algorithms that reflect computational thinking (for example, ones for sorting and searching; use logical reasoning to compare the utility of alternative algorithms for the same problem).
- Undertake creative projects that involve selecting, using, and combining multiple applications, preferably across a range of devices, to achieve challenging goals, including collecting and analysing data and meeting the needs of known users.
- Create, re-use, revise and re-purpose digital artefacts for a given audience, with attention to trustworthiness, design and usability.
- Understand a range of ways to use technology safely, respectfully, responsibly and securely, including protecting their online identity and privacy; recognise inappropriate content, contact and conduct and know how to report concerns.

<https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study>

### Design & Technology - Key Stage 3

- Use research and exploration, such as the study of different cultures, to identify and understand user needs.
- Identify and solve their own design problems and understand how to reformulate problems given to them.
- Develop specifications to inform the design of innovative, functional, appealing products that respond to needs in a variety of situations.
- Develop and communicate design ideas using annotated sketches, detailed plans, 3D and mathematical modelling, oral and digital presentations and computer-based tools.
- Select from and use specialist tools, techniques, processes, equipment and machinery precisely, including computer-aided manufacture.
- Analyse the work of past and present professionals and others to develop and broaden their understanding.
- Investigate new and emerging technologies.
- Test, evaluate and refine their ideas and products against a specification, taking into account the views of intended users and other interested groups.
- Understand developments in design and technology, its impact on individuals, society and the environment, and the responsibilities of designers, engineers and technologists.

<https://www.gov.uk/government/publications/national-curriculum-in-england-design-and-technology-programmes-of-study>

# Curriculum alignment

## **Citizenship - Key Stage 3**

- The precious liberties enjoyed by the citizens of the United Kingdom.
- The roles played by public institutions and voluntary groups in society, and the ways in which citizens work together to improve their communities, including opportunities to participate in school-based activities.

<https://www.gov.uk/government/publications/national-curriculum-in-england-citizenship-programmes-of-study>

# 01



BEFORE THE CLASS

## Summary

This project builds on knowledge gained in the KS3 lesson 'Twitter Battle'.

During this project, students will design a civic campaign that will get them to think about local or national issues. They can use technology to potentially help solve the problems. These may include things such as:

- The environment
- Future workforce
- Transport issues
- Issues that concern the students

Try to guide the students to pick issues that they can prototype possible solutions to with the SAM blocks available to them.

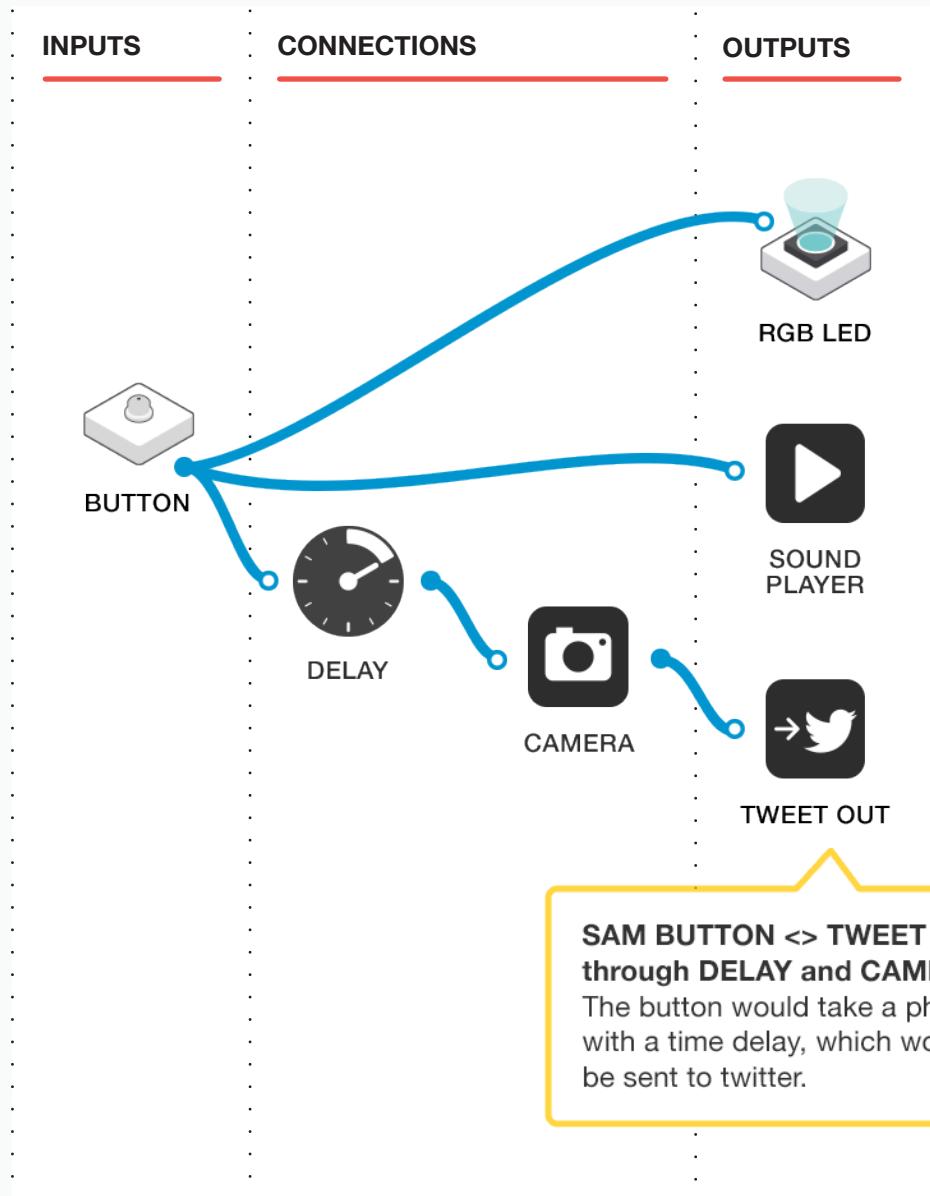
The students will share the ideas with the global community for feedback and discussion using Twitter, to help them guide and design the campaign.

The students will:

- Consider relevant hashtags (#) and Twitter IDs (@) to share their campaign ideas.
- Review and reflect on the feedback and adapt their campaign.

The students will use a range of SAM blocks to tweet about the campaign during the design stages.

Here is an example of what the students might create to help them tweet images about their campaign.





# 02



BEFORE THE CLASS

## Final checklist

The following contains everything you need to prepare your SAM Labs environment before commencing the project. Please ensure you read each section carefully to ensure you have a problem free lesson.

### DOWNLOAD THE APP

You can download the SAM Education app for OSX or Windows at <https://www.samlabs.com/app>.

### SAM LOG IN

Create a SAM account if you don't already have one. SAM accounts are free and allow you to save your inventions to the cloud and download and modify them later, you can even share them with others.

### CHARGE YOUR SAM BLOCKS

Even though the blocks can be used while tethered, they were designed as rechargeable devices that can be used a fair way away from your system or where they can't be plugged in. You can tell they are fully charged when they change colour from red to green.

**Handy Tip:** you can click on a block in the SAM space to see how much charge is left.

### ADDITIONAL RESOURCES

For SAM support <https://www.samlabs.com/support>.

# 03



DURING THE CLASS

## Activity stages

- 1 Explain to the students that they will work in small groups to design a civic engagement campaign, and that they are going to share this with the global community to help influence and guide how the final campaign will look.

**Q:** Have you used Twitter before?

**Q:** Describe what Twitter is in 140 characters! If you use Twitter, who do you follow?

**Q:** Are there any topics or feeds you follow?

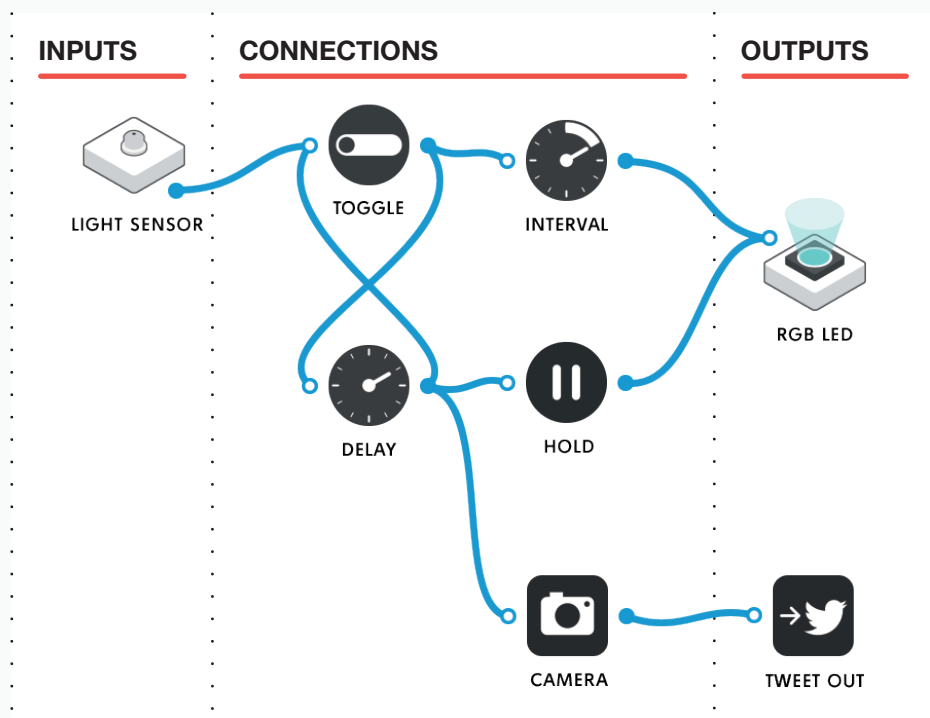
- 2 Revisit the The Tweet Out and Tweet In blocks that were introduced in the lesson 'Twitter Battle', and explore the solution that they came up with to track and count tweets. Show the students a simple program on SAM Space which allow for tweets to be sent from an appropriate account. The students can expand on this program during the lesson.

**Q:** What other options would be useful to include in your tweets to help engage the global audience so that they respond?

- 3 Here is an example of what the students might create to help them tweet about their campaign, to include images and video etc.



Turn on the SAM Light Sensor and SAM LED Light, and drag these onto the canvas, along with the SAM Sound Player, SAM Photo Booth, SAM Message and SAM Tweet Out blocks.



Assemble the graph as shown, and configure the following blocks:

- Check the light sensor is acting as a button (see “Tips and Tricks” later for more details)
- Connect the Twitter block to a twitter account.
- Set the Interval block to 250 milliseconds.
- Set the Delay block to 5 seconds.
- Set the Hold block to 2 seconds.

### How does this work?

*It is an extremely effective “how to code” exercise to trace through the graph and figure out what it does before reading the explanation. It’s suggested that you do this before the class to make it clear in your own head, and then take the class through it as a class exercise.*

1. The light sensor, when covered, will trigger the toggle, turning it on.
2. The toggle will activate the Interval and Delay blocks.
  - a. The Interval block will begin pulsing its quarter-second pulses, which will cause the light to start flashing.
  - b. The Delay block will start counting down to five seconds. After five seconds, it will activate the Hold block, the Camera block, and also the weirdly connected Toggle block.
    - i. The Camera block will take the photo.
    - ii. The Hold block will activate the light and wait for the configured time before turning it off again (2 seconds).
    - iii. The backwards connection to the Toggle block will cause the whole system to switch off and wait for the button to be pressed again.

Put simply, when the button is pressed the light will begin flashing for five seconds. After five seconds, the light will turn on for two seconds while a photo is taken and tweeted. The button can then be pressed again to repeat the process.

Take this opportunity to talk to the students about responsible and safe use of social media.

**Q:** How is this creation potentially dangerous?

**Q:** What could be the consequence if you tweet a picture of somebody without their permission in a ridiculous posture?

- 4 Now that the system has been built, the students can start to design their campaign. Guide their discussions to fit in with the remit of KS3 subject content (see previous section on Curriculum Alignment).

**Q:** What issues are relevant to young people in today?

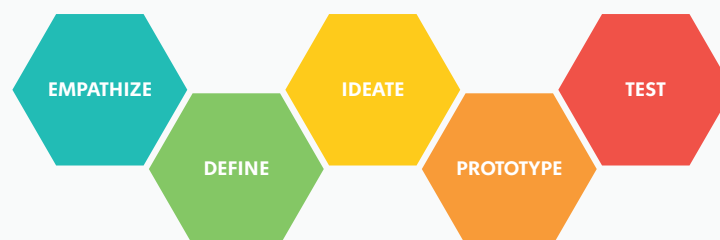
**Q:** Are these local, national or global problems?

**Q:** How could you assess the impact of the problem?

**Q:** Could technology be used to help solve the issues?

**Q:** How could this be communicated to people?

- 5 Once the students have decided on their topics for their campaigns, explain the design thinking process.



Work through each of the design thinking stages with the students, and encourage them to tweet and share ideas to the community to help guide their planning.

**Q:** Are text-based tweets enough?

**Q:** Would tweeting photos or videos be beneficial to help explain your ideas?

**Q:** Could you design graphical content to help explain issues?

## GAINING EMPATHY

- 6 The first stage of this process is to develop an empathy for a problem, which involves investigating the issues and listening to the needs of the people involved in the problem that you are trying to solve.

**Q:** Who does the issue affect? What are their problems?

**Q:** Is there anyone else involved in the issue?

This human element is fundamental to the design thinking approach. At this stage, a lot of research is needed to fully understand the aspects of the issues.

## DEFINING THE PROBLEM

- 7 During this stage, we pull together all the insights collected during the empathise stage, and began to analyse the information to define the core problems that the campaign is aimed at. Here we start to define a human-centred problem.

**Q:** Can you use the global community through Twitter to help define the problem?

## IDEATE

- 8 Now we have identified the problem, we can start to plan how we might address it, and this session is about developing as many ideas as possible. Each of these ideas should be explored, as some of them could end up contributing to the final solution.

**Q:** What are the skills within your group?

**Q:** Can you use these different skills to generate different solutions and ideas for your campaign?

**Q:** Will tweeting your ideas help to develop them with responses from the global community?

## PROTOTYPE

- 9** This stage involves developing a solution to the problem. This could involve sketching, building with the SAM Blocks or creating videos presenting your ideas.

**Q:** Do you need to test the final outcomes, or can you test small elements of the campaign?

## TEST

- 10** The final stage of the process is to test out your ideas with other people. Use your Twitter account to share the results with the global community and get some feedback. Don't forget to find appropriate hashtags.

**Q:** What was the response to your project?

**Q:** Was the feedback what you expected?

- 11** Now the the design thinking process is complete, ask the students to record and reflect on the process that they have been through. The students can present their campaigns to the class.

**Q:** How did the feedback from the Twitter community help to guide and develop your campaign?

# 04



DURING THE CLASS

## Extension activity

If some groups complete the task, they can be challenged further. Using the feedback from the class presentations, and having seen the campaigns of their peers, are there any other options for the students to develop their own campaigns? Did you see anything that they could use in their campaign, or could they use different SAMs blocks that hadn't been considered before?

**Q:** Could this be expanded further?

**Q:** Can we develop the engagement with the campaigns further?

**Q:** Could we promote the ideas by creating a video presentation showcasing the process and the outcomes, and share this to the Twitter community too?

**Q:** Are there any other ways that the campaign outcomes can be spread further to amplify the message?



TOPIC INFORMATION

## What do you need to know?

Make sure you have registered a Twitter account and paired it with SAM Space before the session. Students can use the same log on, unless they wish to use their own Twitter account.





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# Logical Thinking

COMPUTER SCIENCE

# Key information

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## SUBJECTS

Computing.

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## RECOMMENDED PRIOR KNOWLEDGE

Basic understanding of SAM, and the SAM blocks used in the project.  
An understanding of basic Boolean Logic.

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## KEY STAGE

Key Stage 3

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## GROUP SIZE

2-3 students

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## OUTCOMES

- To build a camera with logic based controls.
  - Understand AND and OR logic.
  - Practice teamwork and collaborate to navigate through problems.
  - Reflect on and review the process, their product and that of their peers.
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## TIME REQUIRED

***NB: This project may go over two sessions, depending on the time needed to be given to each stage, and the experience of the students.***

### **Suggestion for a 1 hour session:**

Introduction to concept - 5 minutes.  
Activity Stages - 40 minutes.  
Extension activity - 10 minutes.  
Reflection and Plenary - 5 minutes.

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## LEARNING OBJECTIVES

See Curriculum Alignment (next page).

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## MATERIALS REQUIRED

- SAM Space Education app
  - 1 SAM Tray
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# Curriculum alignment

## NATIONAL CURRICULUM STANDARDS

### Computing - Key Stage 3

- Design, use and evaluate computational abstractions that model the state and behaviour of real-world problems and physical systems.
- Understand several key algorithms that reflect computational thinking [for example, ones for sorting and searching]; use logical reasoning to compare the utility of alternative algorithms for the same problem.
- Understand simple Boolean logic [for example, AND, OR and NOT] and some of its uses in circuits and programming; understand how numbers can be represented in binary, and be able to carry out simple operations on binary numbers [for example, binary addition, and conversion between binary and decimal].
- Understand a range of ways to use technology safely, respectfully, responsibly and securely, including protecting their online identity and privacy; recognise inappropriate content, contact and conduct and know how to report concerns.

<https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study>

# 01

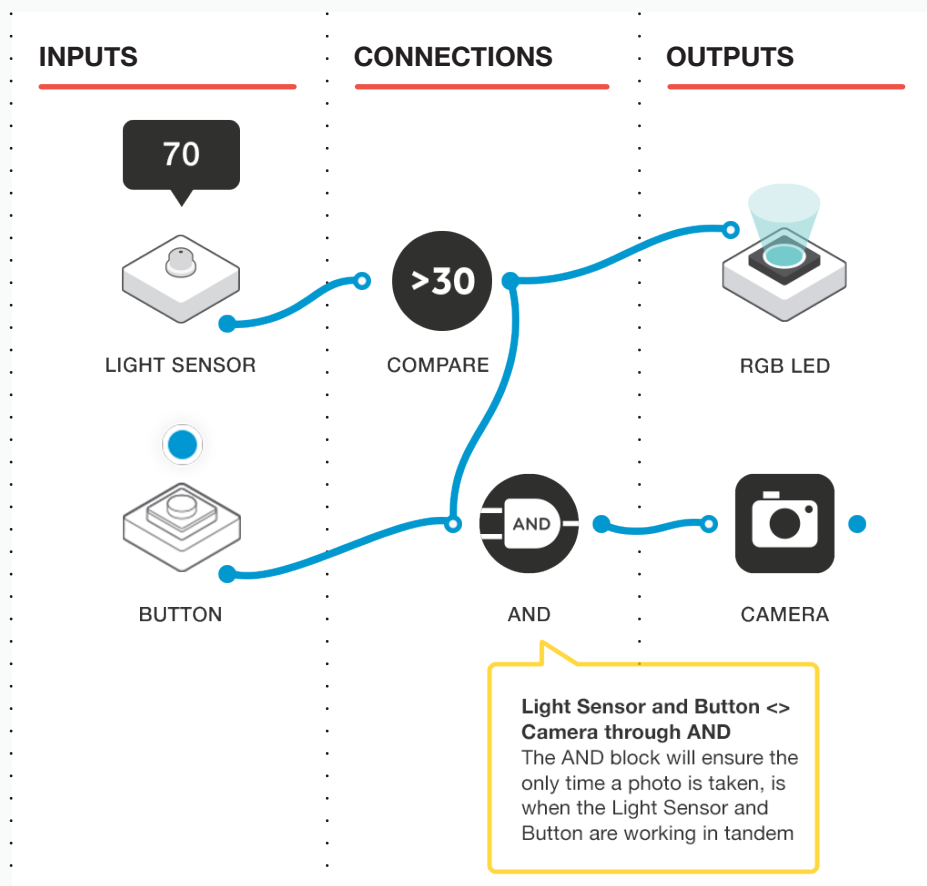


## BEFORE THE CLASS Summary

This lesson focusses on the core processes behind Boolean logic, and students will develop an understanding of the AND and OR processes. The students will build a system in the SAM Space that will make use of these processes to help control a camera. The camera will be developed by the students further as they explore the various SAM blocks.

The initial camera will involve a light sensor that will illuminate the RGB LED block when it measures that there is sufficient light to take a picture, and then the button can be pressed to take the photo. If there is not enough light, the RGB LED will not illuminate so the button will not work and no photo will be taken.

At this stage, the camera in the SAM Space may look like this:



However, this is only the first stage and the students can develop and build on this starting point design.

Please ensure that the hardware blocks are charged and paired to the computer before starting this lesson.

# 02



BEFORE THE CLASS

## Final checklist

The following contains everything you need to prepare your SAM Labs environment before commencing the project. Please ensure you read each section carefully to ensure you have a problem free lesson.

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### CHARGE YOUR SAM BLOCKS

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**Handy Tip:** you can click on a block in the SAM space to see how much charge is left.

### ADDITIONAL RESOURCES

For SAM support <https://www.samlabs.com/support>.

# 03



## DURING THE CLASS

# Activity stages

- 1 Introduce the plan for the project, and tell the students that we will explore some aspects of Boolean Logic to help us create a camera system. The initial camera will assess the ambient light levels, and if there is enough light, it will illuminate an LED to tell us that the system is able to take a photograph by pressing a virtual button in the app.

**Q:** Why is a camera that monitors the light levels useful?

**Q:** What blocks might we need to use to achieve this?

- 2 Ask the students to explore the following blocks and to try and create their own design in the SAM Space to create a camera with these features:

- Light sensor
- RGB LED
- Button (a virtual one in the app - see the “tips and tricks” section at the end for more info).
- Comparison
- Camera
- They can use the supplied red chassis for holding their light and light sensor blocks.

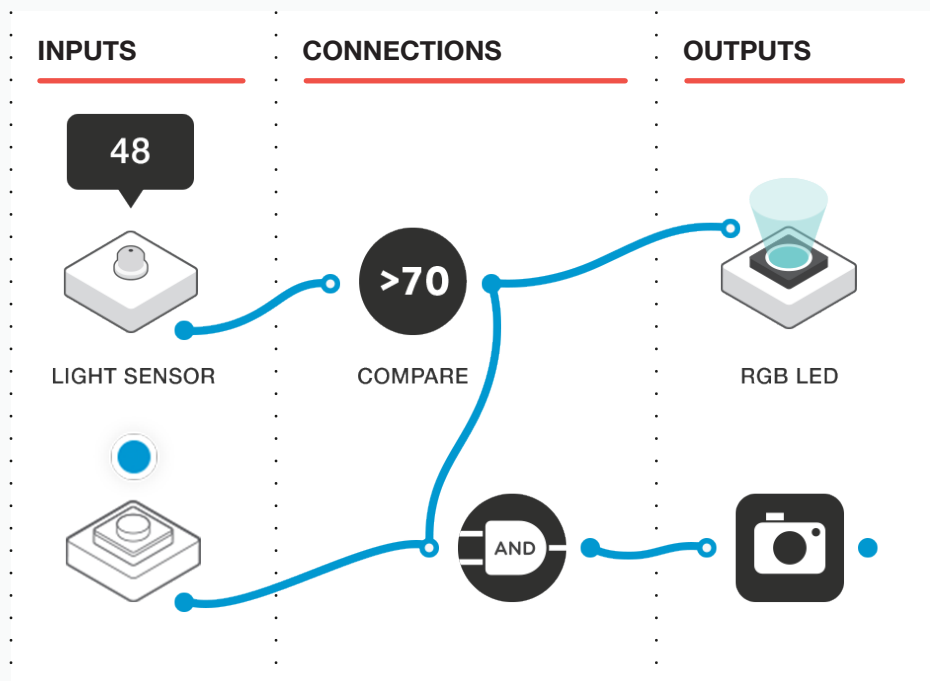
**Q:** Why are we using a comparison block?

Explain that the comparison block can be used so that the light goes on when the light level is high enough.

**Q:** Why are we using an AND block?

The AND block will send a “true” value only when all of its input values are “true”. That is, it only tells the camera to take the picture when the light level is correct AND the button is being pressed.

The solution may look something like this:



3

Here the light sensor is detecting an ambient light level of '48', and the comparison is set to trigger the light when the sensor senses a light level greater than '30'. Are these the best settings for the filter?

**Q:** Does the camera work as expected, and the RGB LED come on when you increase the ambient light allowing you to take a photograph?

Now we want to expand the camera to make the notification from the RGB LED more useful to the user. Currently the RGB LED illuminates white when there is enough ambient light to take photograph.

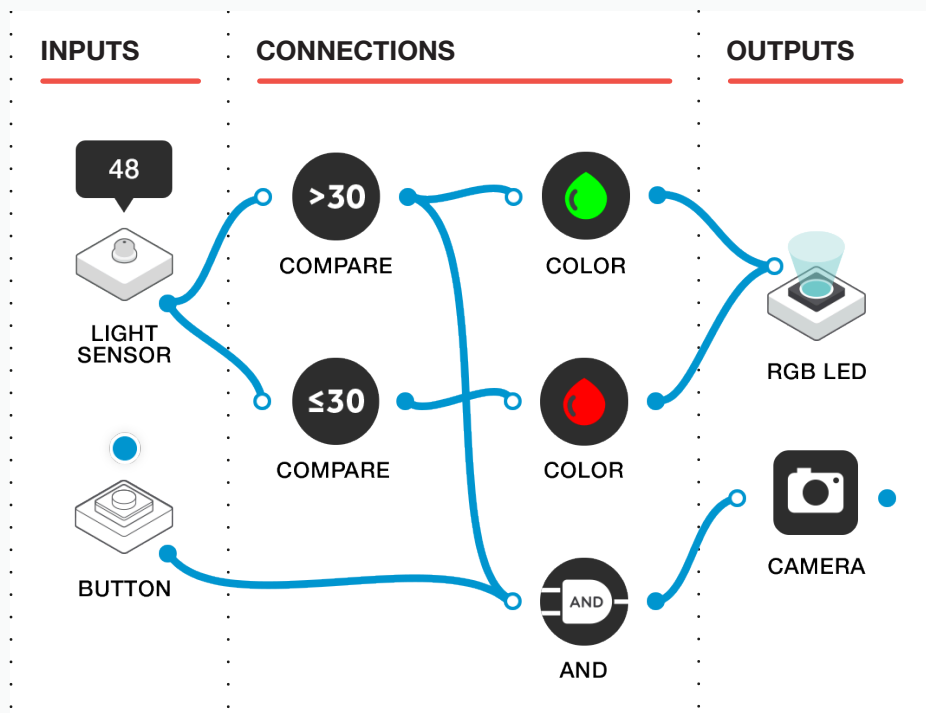
**Q:** How could we make this notification more user friendly?

**Q:** Could we change the colour?

Suggest that we could create a design where the RGB LED is illuminated red when there is not enough available light, but turns green when there is enough light. Allow the students to explore this. There are many solutions, using either a second filter block and two colour blocks, or possibly two comparison blocks with two colour blocks.



A possible solution to this problem is:



- 4 Here we have two comparison blocks set to different comparisons. When the light level is low (between a range of 0 and 30) the lower comparison works, triggering the red color block to set the LED's colour to red.

When the light level is higher (greater than 30) the green block is triggered to set the LED colour.

**Q:** In this example here, are these the best values?

**Q:** What happens when the ambient light level is exactly 30?

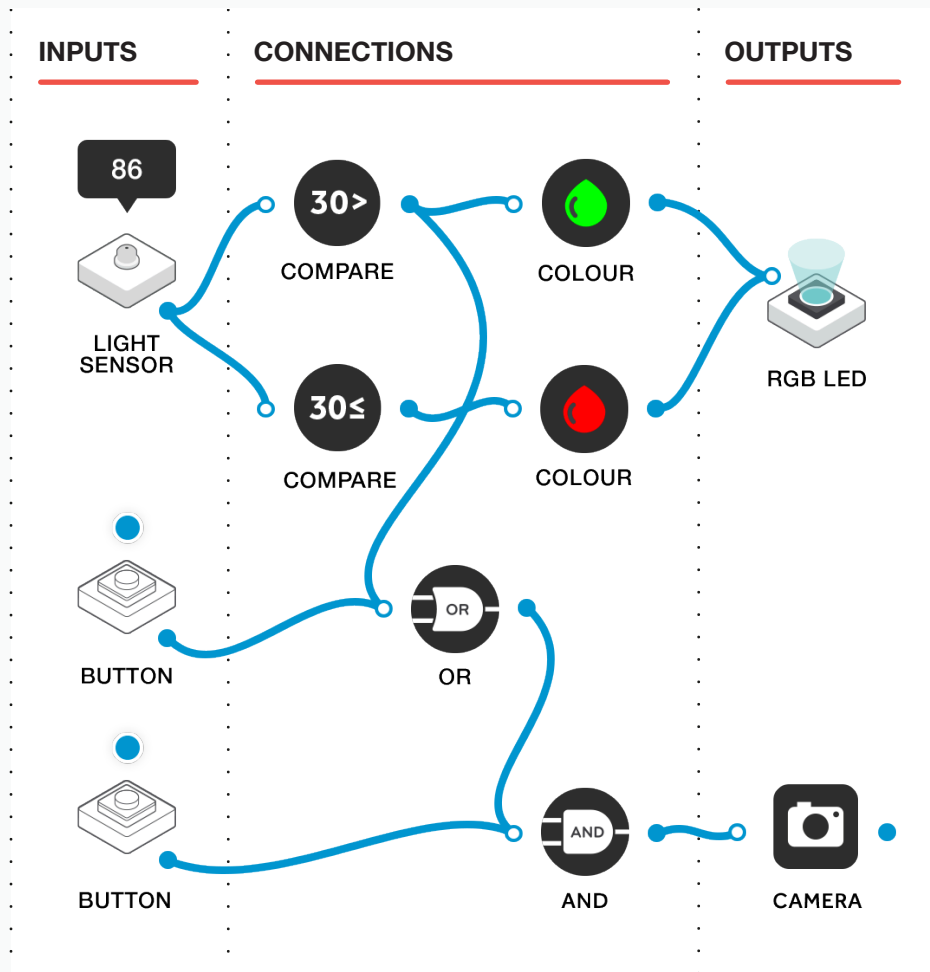
**Q:** Is there a way to disable the camera if the light level gets too high? What would be the purpose of this?

To ensure that the photo can only be taken when the light levels are high enough (i.e. the RGB LED is illuminated green), we need the system to only take a picture when the button is pressed AND the light level matches the green-connected filter. As the red-connected filter is not connected, no photo can be taken when the light level is low.

Now we can expand this camera to include an OR block, which will give the children the ability to override the light-sensing functionality. Ask the students to think about including an override button so that the photo will be taken if the light is bright enough OR if the override button is pressed.

To do this, we will include another virtual button as well as introducing an OR block.

The solution may look like:



**Q:** Under what circumstances would we want to override the brightness sensing?

**Q:** Can you think of other systems where we occasionally need to override built-in safeguards?

The OR block here allows the “is it bright enough?” signal to come either from the light sensor and its “green” comparison, or from the override button being pressed.

Note that this solution with two virtual buttons will work on tablets where you can press both buttons simultaneously. For desktop-style computers, you may need to use a physical button block from either the Classroom or Team kits.

5

Ask the students to work on fine tuning and expanding the camera setup.

**Q:** Can you fine tune the filter settings to improve the camera performance?

**Q:** What do you want to do with the photographs that are being taken?

You should find the photos in your Android or iOS device's gallery. In the desktop versions of SAM Space, the images will be in the Pictures folder of the logged-in user's profile.

**Q:** Could you add a Twitter block to automatically tweet the photos that you take?

**Q:** Why might this be useful?

**Q:** Why might this be dangerous?

# 04



DURING THE CLASS

## Extension activity

**Q:** How can we expand the camera system further?

**Q:** Are there any other features that we can integrate into the camera?

Suggest that the students could look at adding the Sound Player block so that an audio file (music or a voice message) is played when a photograph is taken.

**Q:** How could the Sound Player block be used?

**Q:** Could two sound player blocks and filters be used instead of, or alongside, the RGB LED to give audible guidance on the light levels?

Ask the students to present their additions to the group for peer review.

**Q:** Could this be expanded further?

There are three other logic blocks available in the SAM Space, NAND, NOR and XOR.

**Q:** Could these be plugged into the camera in place of the AND and OR block?

**Q:** What would that do?

### REAL-WORLD APPLICATIONS

Using Boolean Logic has many real world applications, especially within the fields of product design. It will determine how many devices work, and is a key part of how user friendly devices and software is.

### RECORDING THEIR WORK

Ensure the students have completed their student packs, recording their thoughts and solutions.

**Other options:** Create an e-book / poster / video, etc. to explain what they have done.



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# Photosynthesis

COMPUTER SCIENCE  
SCIENCE (BIOLOGY)

# Key information

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## SUBJECTS

Computer Science and Science (Biology).

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## RECOMMENDED PRIOR KNOWLEDGE

Basic understanding of SAM, and the SAM blocks used in the project.  
Basic understanding of photosynthesis.

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## KEY STAGE

Key Stage 3

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## GROUP SIZE

2-3 students

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## OUTCOMES

- Understand what affects the rate of photosynthesis.
  - Create a counter system with built-in time facility.
  - Practice teamwork and collaborate to navigate through problems.
  - Reflect on and review the process, their product and that of their peers.
- 



## TIME REQUIRED

***NB: This project may go over two sessions, depending on the time needed to be given to each stage, and the experience of the students.***

### **Suggestion for a 1 hour session:**

Introduction to concept - 5 minutes.  
Build the SAM system - 10 minutes.  
Activity Stages - 30 minutes.  
Extension activity - 10 minutes.  
Reflection and Plenary - 5 minutes.

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## LEARNING OBJECTIVES

See Curriculum Alignment (next page).

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## MATERIALS REQUIRED

- 1 SAM Tray
  - Tank or glass container (a large beaker may also work)
  - Pondwater
  - Pondweed
  - Lamp
  - Ruler
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# Curriculum alignment

## NATIONAL CURRICULUM STANDARDS

### Computing - Key Stage 2

- Design, write and debug programs that accomplish specific goals, including controlling or simulating physical systems; solve problems by decomposing them into smaller parts.
- Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.
- Use technology safely, respectfully and responsibly; recognise acceptable/unacceptable behaviour; identify a range of ways to report concerns about content and contact.

<https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study>

### Number - Multiplication and Division

- Solve one-step problems involving multiplication and division, by calculating the answer using concrete objects, pictorial representations and arrays with the support of the teacher

### Science (Biology) - Key Stage 3

- The reactants in, and products of, photosynthesis, and a word summary for photosynthesis.
- The dependence of almost all life on Earth on the ability of photosynthetic organisms, such as plants and algae, to use sunlight in photosynthesis to build organic molecules that are an essential energy store and to maintain levels of oxygen and carbon dioxide in the atmosphere.
- The adaptations of leaves for photosynthesis.

<https://www.gov.uk/government/publications/national-curriculum-in-england-science-programmes-of-study>

# 01



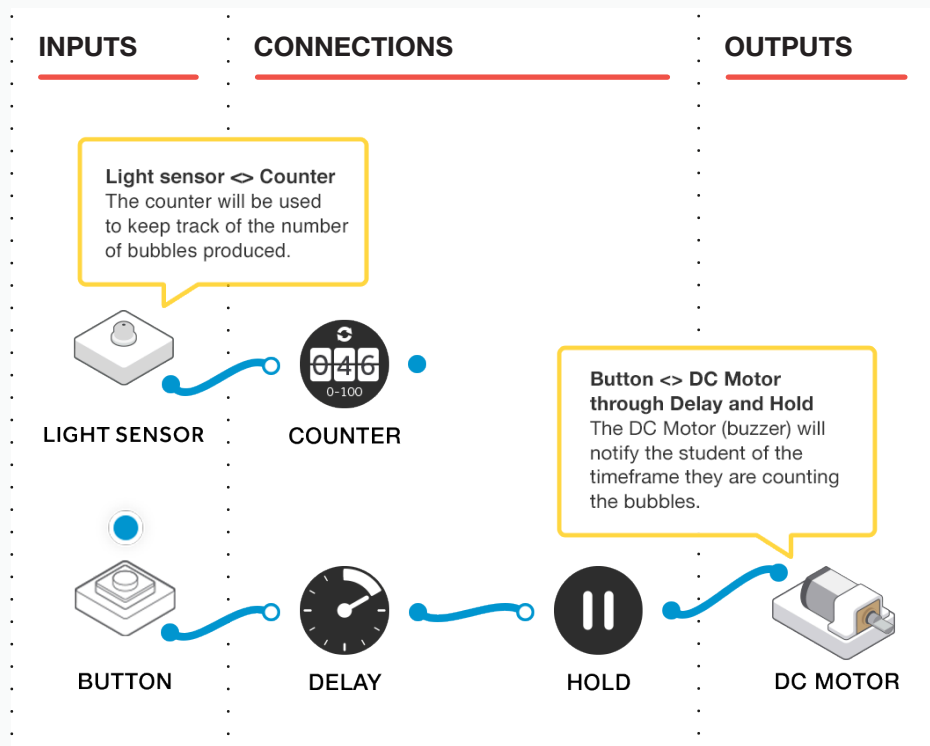
## BEFORE THE CLASS Summary

This lesson examines the impact of the changes in light on the rate of photosynthesis, the process whereby plants use the energy from light to generate chemical energy that can be used by the plant. As a byproduct of this process, oxygen is produced.

The students will set up a glass tank containing water and pondweed, and shine a lamp on this to simulate sunlight. The students should be able to see the plant creating oxygen as it releases bubbles into the water.

Using SAM Labs blocks, the students will create a counter to help them keep track of the number of bubbles released by the pond weed, as well as a timer to ensure that all the experiments run for the same timeframe.

The final SAM Space created by the students may look like this:





# 02



BEFORE THE CLASS

## Final checklist

The following contains everything you need to prepare your SAM Labs environment before commencing the project. Please ensure you read each section carefully to ensure you have a problem free lesson.

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**Handy Tip:** you can click on a block in the SAM space to see how much charge is left.

### ADDITIONAL RESOURCES

For SAM support <https://www.samlabs.com/support>.

# 03



## DURING THE CLASS

# Activity stages

- 1 Introduce the topic and explain to the students that we are going to measure the rate of photosynthesis using pondweed over a set time. We are also going to explore what could impact the rate of photosynthesis.

**Q:** How much do you already know about photosynthesis, what is it?

**Q:** How might we be able to measure the rate that a plant photosynthesises?

**Q:** What could impact on the rate of photosynthesis in plants?

- 2 Explain the process of photosynthesis to the students, and importantly that oxygen is a byproduct of this process. By using plants that live underwater, we can actually see the oxygen being released by the plant in the form of bubbles.

**Q:** How can we use these bubbles to record the rate of photosynthesis?

Thus, we need to build a system that will not only let us count the number of bubbles produced by the plant, but also create a timer so that we can repeat the experiment under different conditions, but keep the time factor constant.

- 3 Challenge the students to create a simple counter, along with a timer that can be set to 1 minute. We want a Counter so that every time the plant releases a bubble, we can have the programme record it so that we can keep track of how much oxygen is released.

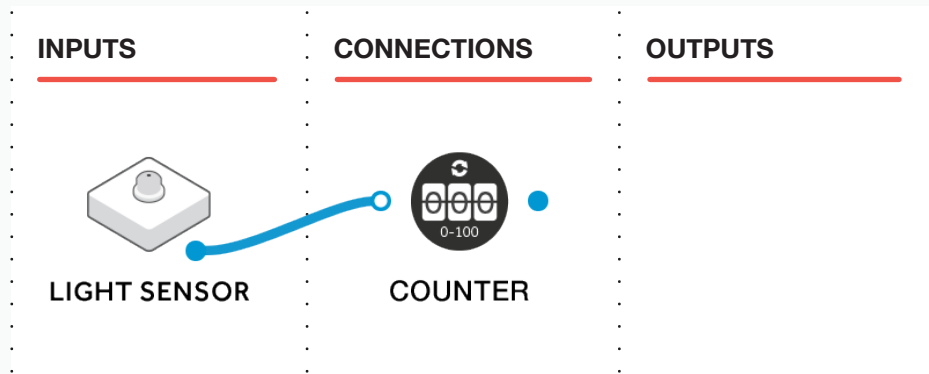
**Q:** What SAM blocks would you need to create this system?

**Q:** How would you connect them together?

The students may come up with various solutions, but a simple setup could be created by using the light sensor in their tray as a button to register a bubble, and a spiny-buzzer for when the timer runs out. A sleeping SAM button used as a virtual button in the app can be used to start the timer. See the Tips and Tricks section at the end for more information on these two items.

Ensure that these blocks are charged and paired to the computer.

- 4 Drag the light sensor to the SAM space along with a Counter block and connect the two.



- 5 For the timer, we are going to create a parallel programme in the same space unconnected to the counter, so that the two can run independently.

Drag a Sleeping SAM Button block and the motor block from your spiny-buzzer to the SAM Space. Add a “Delay” block set to one minute, and a “Hold” block set to two seconds.

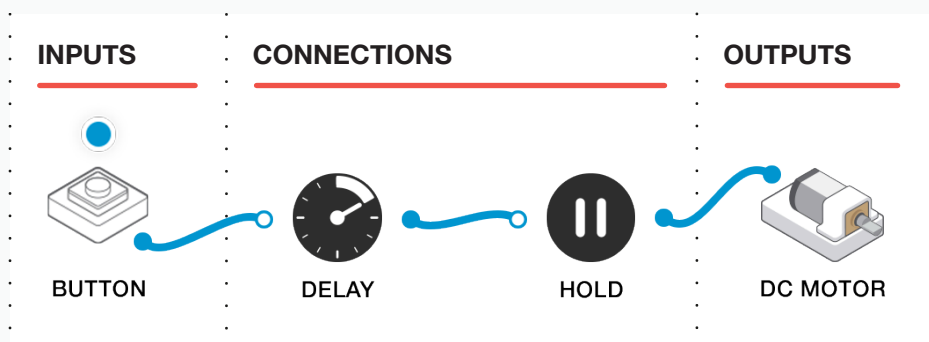
Looking at the below SAM code:

1. When the button is pressed, it will trigger the Delay block which will start counting down its configured delay.
2. When its delay runs out, it will trigger the Hold block. The Hold block will trigger the motor on your spiny-buzzer, and keep it triggered (so the motor keeps going) for the configured time.

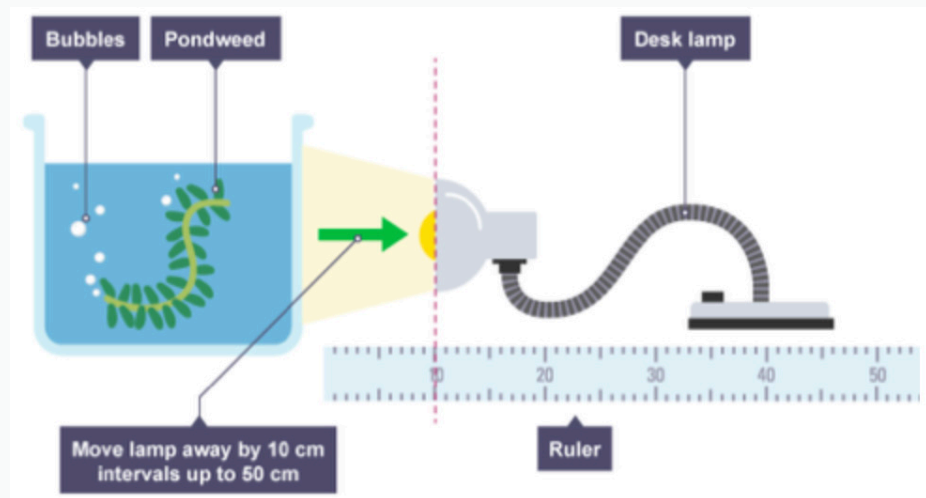
This setup gives us a timer that will buzz and spin when our time runs out, which will stay consistent across experiments. We now have an accurate time period in which to count the bubbles being released from the plant.

Double click the delay block to set the time parameter to 1 minute.

Now, if we connected the motor, we would only get a very short sound that related to how long the button had physically been pressed for, albeit after a delay of 1 minute. So we need to add a hold block before we attach the buzzer.



6 Now we're ready to set up the experiment:



Place the pondweed in the tank and shine the lamp directly onto it from a distance of 10 cm from the tank.

Once it is set up, leave the lamp shining on the pondweed for at least 5 minutes so that the plant can acclimatise to the lighting conditions.

**Q:** Why is it important to let the plant acclimatise to the lighting conditions?

7 Ask the students to use their SAM Space set up to time a one minute period, and use their counter to log the number of bubbles they see being released from the plant within that time period.

**Q:** How many bubbles were released by the plant in a 1 minute time period?

**Q:** Can you create a table to record this?

8 Now that we have one reading, move the lamp further away from the tank to a distance of 20cm.

Don't forget to leave the plant for a few minutes under the new lighting conditions to acclimatise to the changes.

Repeat the test and add the results to your table.

9 Repeat the test several more times, each time moving the lamp another 10cm from the tank with the final test being done with the lamp at a distance of 50cm from the tank.

The student table of results may look like:

Lamp Distance from the Tank (cm)	Number of bubbles released by plant
10	
20	
30	
40	
50	

- 10 Ask the students to examine their results and present their findings to the group for peer review.

**Q:** What do the results tell you?

**Q:** Were these what you expected?

**Q:** Were there any discrepancies in the results, can you account for these?

**Q:** Was there anything you could have improved in the test or the set up?

# 04



DURING THE CLASS

## Extension activity

**Q:** Are there any other conditions that could be changed?

Repeat the test to see how the results changed.

We could assess the impact of pollution on the water, and see if this made any difference. How could we make the water dirtier, for example?

**Q:** Could this be expanded further?

Can we present our findings in a more useful way, by creating graphs which would help to assess any correlations in the results.

### RECORDING THEIR WORK

Ensure the students have completed their student packs, recording their thoughts and solutions.

**Other options:** Create an e-book / poster / video, etc. to explain what they have done.



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# Board Games

COMPUTER SCIENCE  
DESIGN & TECHNOLOGY

# Key information

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## SUBJECTS

Computer Science, Design & Technology.

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## RECOMMENDED PRIOR KNOWLEDGE

Basic understanding of SAM, and the SAM blocks used in the project.  
Basic Design & Technology principals.

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## KEY STAGE

Key Stage 3

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## GROUP SIZE

3 - 4 students

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## OUTCOMES

- Come up with a possible solution for a board game, using prototypes to develop the best design possible, and then evaluate it.
  - Practise teamwork and collaborate to navigate through problems.
  - Reflect on and review the process, their product and that of their peers.
- 



## TIME REQUIRED

This project is designed to run over a number of lessons to allow the students to work on and create their own board game using the SAM Labs STEAM kit.

The suggested duration is 5 one hour lessons.

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## LEARNING OBJECTIVES

See Curriculum Alignment (next page).

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## MATERIALS REQUIRED

- Computer or Tablet
  - SAM Space Education app
  - A selection of blocks based on the students requirements
  - Pizza box
  - Additional materials required by the students to design their board game
-



# Curriculum alignment

## NATIONAL CURRICULUM STANDARDS

### Computing - Key Stage 3

- Design, use and evaluate computational abstractions that model the state and behaviour of real-world problems and physical systems.
- Undertake creative projects that involve selecting, using, and combining multiple applications, preferably across a range of devices, to achieve challenging goals, including collecting and analysing data and meeting the needs of known users.
- Create, re-use, revise and re-purpose digital artefacts for a given audience, with attention to trustworthiness, design and usability.
- Understand a range of ways to use technology safely, respectfully, responsibly and securely, including protecting their online identity and privacy; recognise inappropriate content, contact and conduct and know how to report concerns.

<https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study>

### Design & Technology - Key Stage 3

#### Design

- Identify and solve their own design problems and understand how to reformulate problems given to them.
- Develop specifications to inform the design of innovative, functional, appealing products that respond to needs in a variety of situations.
- Apply computing and use electronics to embed intelligence in products that respond to inputs [for example, sensors], and control outputs [for example, actuators], using programmable components [for example, microcontrollers].

<https://www.gov.uk/government/publications/national-curriculum-in-england-design-and-technology-programmes-of-study>

# 01



BEFORE THE CLASS

## Summary

This project is split across several lessons and gives the students time to develop their own ideas for a board game that is enhanced with electronic components. The students may take ideas from their favourite traditional board games and develop these using their knowledge of the SAM Labs STEAM kit, or develop entirely new board games.

The students will have the time and freedom to explore, experiment, trial and build their board games with a variety of different sensors.

During this project, the students will gain a valuable insight into the design and prototyping processes involved in developing a product.

The students will need access to all the usual materials found within a Design & Technology classroom, and if one is available, they may even choose to use a 3D printer. They will possibly also need access to standard art and modelling supplies too.

It will be useful to have a supply of flat-pack 'pizza style' boxes that can form the base of the board game and house the electronics inside it.

Consider dividing the class into larger teams than usual, so that each team can have access to two SAM group trays. If you own larger SAM kits, the bonus blocks could come in handy with this project!

# 02



BEFORE THE CLASS

## Final checklist

The following contains everything you need to prepare your SAM Labs environment before commencing the project. Please ensure you read each section carefully to ensure you have a problem free lesson.

### DOWNLOAD THE APP

You can download the SAM Education app for OSX or Windows at <https://www.samlabs.com/app>.

### SAM LOG IN

Create a SAM account if you don't already have one. SAM accounts are free and allow you to save your inventions to the cloud and download and modify them later, you can even share them with others.

### CHARGE YOUR SAM BLOCKS

Even though the blocks can be used while tethered, they were designed as rechargeable devices that can be used a fair way away from your system or where they can't be plugged in. You can tell they are fully charged when they change colour from red to green.

**Handy Tip:** you can click on a block in the SAM space to see how much charge is left.

### ADDITIONAL RESOURCES

For SAM support <https://www.samlabs.com/support>.

# 03



## DURING THE CLASS

# Activity stages

### PLANNING

- 1 Ask pupils to think about a favourite board game that they may have played and how it might be improved by adding light, sound or movement. Discuss how light, sound, music and movement of pieces could enhance a game to make it more engaging and fun.

**Q:** How might modern technology allow for a game to be improved?

**Q:** Could you create a completely new modern board game using technology?

Ask the students to share their ideas for peer discussion.

- 2 Put the students in small groups of 2 - 3 children and ask them to think of ideas about improving a board game of their choice, focusing on how they might use the SAM blocks to create the improvements. They can open the SAM Space Education App and use this to help them think through ideas and explore the different elements they could add. It is important at this point not to give them too much structure and allow them to explore.

**Q:** Which SAM Blocks would be useful in your board game design?

**Q:** How would you use these?

**Q:** Would they enhance the gameplay or be a fundamental feature of the game?

- 3 Ask the students to storyboard their ideas, so that they can plan how the game would be played. Use large sheets of paper so that the students can start drafting out ideas for the game, illustrating where and how the SAM blocks might be used.

**Q:** How would the SAM blocks be connected to the game?

**Q:** Would they be embedded into the board, or separate?

**Q:** What would be the role of the blocks within the context of the game?

Ask each group of students to present their storyboard for class discussion and peer review to help refine their ideas.

## DESIGN AND DEVELOPING AN IDEA

- 4 Discuss how the SAM blocks could be used to prototype their ideas. Explore the meaning of prototyping and the processes involved in designing, creating, prototyping and evaluating designs. Ask the students to imagine their job was to develop board games but they had been briefed to work with emerging technologies to make them feel more relevant for the 21st Century. At this point, mention some of the limitations of bluetooth - for example, its proximity to the board and the need to pair.

**Q:** How might you address the limitations of bluetooth? Could you embed the SAM Blocks physically into the board?

Working in the SAM Space, start experimenting with connecting the blocks together so that they do what you want them to do within the context of your game designs. Build on the knowledge that the students already have of the SAM hardware and software blocks.

- 5 In their small groups, ask the students to build their design ideas and storyboard plans into a physical board game design. Give each pair a flat packed pizza box which they will need to assemble. Explain they can paint, use felt tips or print off designs to create their boards.

Ask them to think about how they will attach or embed the SAM blocks to work with their board game designs.

## CREATING THE GAME

- 6 Over the next few lessons allow the students to create their board games using whatever materials have been agreed upon. If the school has a 3D printer, some pupils may wish to design game pieces and print off their designs to use in their games. The SAM blocks can be attached to the inside of the pizza box and small holes can be cut into the box to allow sensors to pop through.

Ask the students to test the blocks and how they will work, before they attach them to their board games.

**Q:** Should you test your ideas with other people in the class?

**Q:** Is the gameplay improved by use the SAM Blocks that you have decided on?

**Q:** Do they make the game more fun, or do they enhance the game rules?

## GETTING FEEDBACK AND IMPROVING THE PROTOTYPE

- 7 Remind the students that the task is to come up with a design which enhances the game by adding something extra using technology. An example may be that by using a light sensor and a SAM LED Light the game is improved when a player's piece lands on the square containing the light sensor (which detects the light being blocked) and the light comes on with either a red or a green light randomly. The red light means the player has to go back to the start point whereas the green light allows them to take an extra two steps along the board.

**Q:** How does the technology enhance your game experience?

**Q:** Could the technology be better embedded into the game design and rules?

If the students have access to a 3D printer, this lends itself to designing extra pieces for the game, added obstacles, etc.

- 8 Once the game has been created, allow different groups within the class to test the game and feed their thoughts back to the game creators to allow them to solve any issues or make changes to the game play.

## EVALUATION

- 9 When the game has been finished, ask the students to evaluate their design experience.

**Q:** Can you describe the process that you have been through?

**Q:** Can you reflect on the importance of the different stages of design, including prototyping and testing?

**Q:** How successful do you feel that the final game is?

**Q:** Is there anything that you would change?

**Q:** Could you improve on the game design?

# 04



DURING THE CLASS

## Extension activity

If some groups complete the task, they can be challenged further.

**Q:** How is the game presented, can the students create rule cards, and posters to advertise the game?

**Q:** Could they arrange challenges between groups of students?

**Q:** Can they present their game to a wider audience?

**Q:** Could this be expanded further?

### REAL-WORLD APPLICATIONS

The design process is common in most product design and development, and leads into several future career options for the students. Alongside this process, the students have developed thinking and teamwork skills, to appreciate the ideas of other and act on feedback, all of which are skills useful for future employment.

### RECORDING THEIR WORK

Ensure the students have completed their student packs, recording their thoughts and solutions.

**Other options:** Create an e-book / poster / video, etc. to explain what they have done.







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# Pi, what is it good for?

COMPUTER SCIENCE  
DESIGN & TECHNOLOGY  
MATHEMATICS

# Key information

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## SUBJECTS

Computing, Design & Technology , Mathematics.

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## RECOMMENDED PRIOR KNOWLEDGE

Basic understanding of SAM, and the SAM blocks used in the project.

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## KEY STAGE

Key Stage 3

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## GROUP SIZE

2-3 students

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## OUTCOMES

- Design a buggy to test variations in wheel size.
  - Create controlled testing conditions through coding.
  - Understand how Pi can be used to calculate wheel circumference.
  - Understand how wheel circumference impacts on distance traveled.
  - Practice teamwork and collaborate to navigate through problems.
  - Reflect on and review the process, their product and that of their peers.
- 



## TIME REQUIRED

***NB: This project may go over two sessions, depending on the time needed to be given to each stage, and the experience of the students.***

### **Suggestion for a 1 hour session:**

Introduction to concept - 5 minutes.  
Building and design stages - 20 minutes.  
Testing stage - 20 minutes.  
Extension activity - 10 minutes.  
Reflection and Plenary - 5 minutes.

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## LEARNING OBJECTIVES

See Curriculum Alignment (next page).

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## MATERIALS REQUIRED

- 1 SAM Tray
-

# Curriculum alignment

## NATIONAL CURRICULUM STANDARDS

### Computing - Key Stage 3

- Design, use and evaluate computational abstractions that model the state and behaviour of real-world problems and physical systems.
- Undertake creative projects that involve selecting, using, and combining multiple applications, preferably across a range of devices, to achieve challenging goals, including collecting and analysing data and meeting the needs of known users.
- Create, re-use, revise and re-purpose digital artefacts for a given audience, with attention to trustworthiness, design and usability.
- Understand a range of ways to use technology safely, respectfully, responsibly and securely, including protecting their online identity and privacy; recognise inappropriate content, contact and conduct and know how to report concerns.

<https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study>

### Science - Key Stage 3

- Speed and the quantitative relationship between average speed, distance and time (speed = distance ÷ time).

<https://www.gov.uk/government/publications/national-curriculum-in-england-science-programmes-of-study>

### Design & Technology - Key Stage 3

#### Number - Multiplication and Division

- Identify and solve their own design problems and understand how to reformulate problems given to them.
- Develop specifications to inform the design of innovative, functional, appealing products that respond to needs in a variety of situations.
- Apply computing and use electronics to embed intelligence in products that respond to inputs [for example, sensors], and control outputs [for example, actuators], using programmable components [for example, microcontrollers].

<https://www.gov.uk/government/publications/national-curriculum-in-england-design-and-technology-programmes-of-study>

### Maths - Key Stage 3

- Use algebra to generalise the structure of arithmetic, including to formulate mathematical relationships.
- Develop their mathematical knowledge, in part through solving problems and evaluating the outcomes, including multi-step problems.
- Calculate and solve problems involving: perimeters of 2-D shapes (including circles), areas of circles and composite shapes.

<https://www.gov.uk/government/publications/national-curriculum-in-england-mathematics-programmes-of-study>

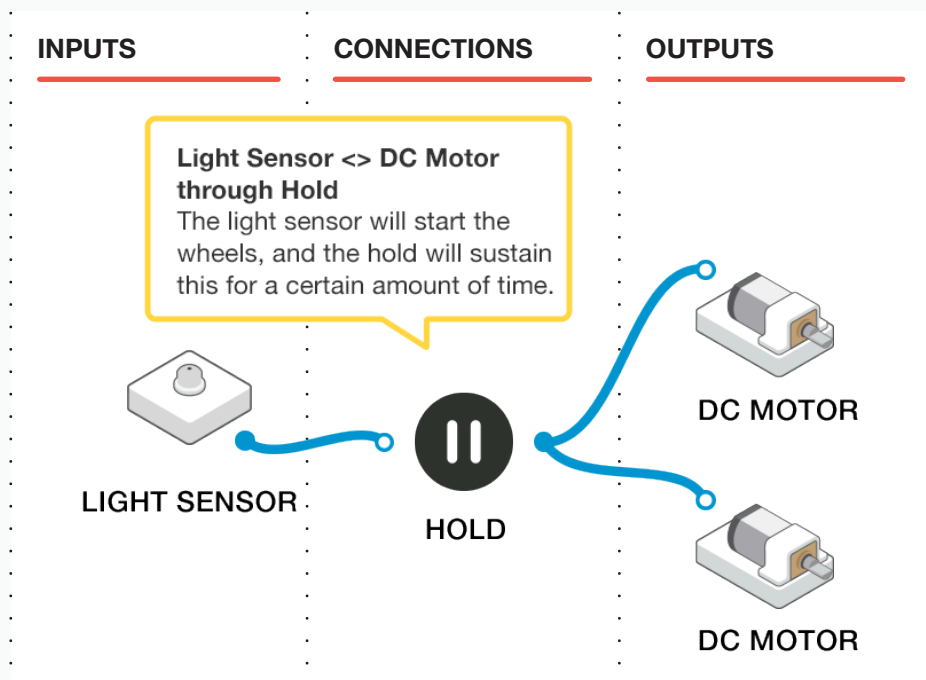
# 01

## BEFORE THE CLASS Summary

In this lesson the students will design and create their own buggy, powered by the SAM DC Motor blocks. The buggy will have a flexible design so that the wheel size can be changed, and the distance that the buggy travels in a set time can be measured to assess the impact that wheel size has on the design.

The students will use Pi to calculate the wheel circumference of the wheels, work out the number of wheel rotations in a set time period, and calculate how far the buggy will travel with different sized wheels. They will perform the test to check their calculations.

The buggy will be programmed under controlled conditions with the SAM Blocks, and below is an example solution to the final challenge.



# 02



BEFORE THE CLASS

## Final checklist

The following contains everything you need to prepare your SAM Labs environment before commencing the project. Please ensure you read each section carefully to ensure you have a problem free lesson.

### DOWNLOAD THE APP

You can download the SAM Education app for OSX or Windows at <https://www.samlabs.com/app>.

### SAM LOG IN

Create a SAM account if you don't already have one. SAM accounts are free and allow you to save your inventions to the cloud and download and modify them later, you can even share them with others.

### CHARGE YOUR SAM BLOCKS

Even though the blocks can be used while tethered, they were designed as rechargeable devices that can be used a fair way away from your system or where they can't be plugged in. You can tell they are fully charged when they change colour from red to green.

**Handy Tip:** you can click on a block in the SAM space to see how much charge is left.

### ADDITIONAL RESOURCES

For SAM support <https://www.samlabs.com/support>.

# 03



DURING THE CLASS

## Activity stages

- 1 Explain to the students that they will be exploring pi, circumferences and speed, working in small groups with a buggy designed with SAM blocks and the accessories in the team's kit. Their design has to be flexible enough to enable the use of both the included wheels and the included cogs on the two DC Motor blocks. It should have a control button that makes the buggy drive forward for a fixed amount of time.

**Q:** Using the SAM blocks and accessories, what options do you have to design your buggy?

**Q:** Is the design flexible so you can change the wheels for the cogs?

**Q:** If you drive the buggy forward, does it go in a straight(ish) line?

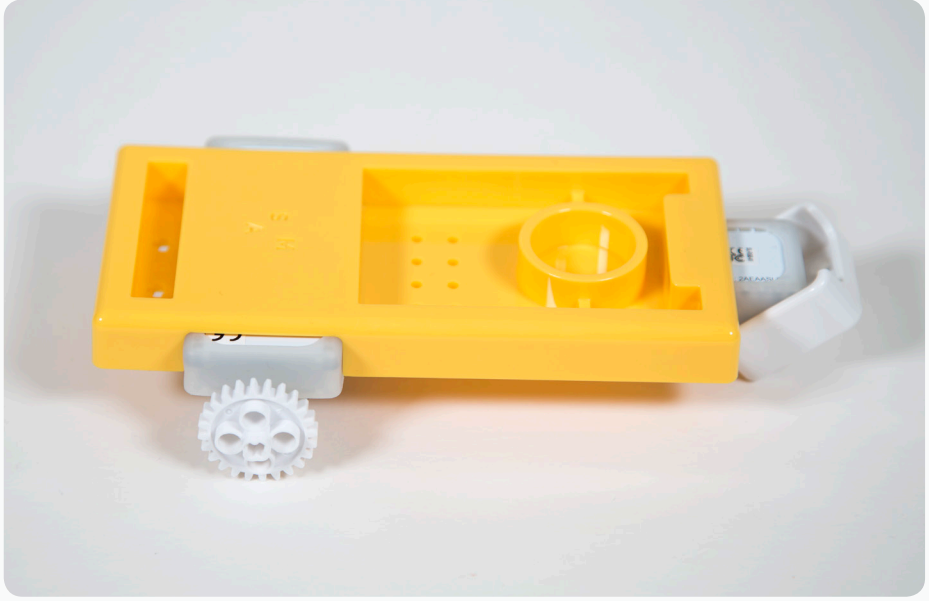
Ask the students at this design stage to hypothesise as to what effect changing the wheel size will have on the movement of the buggy.

**Q:** How might the different wheel sizes impact on the speed of the buggy, or the distance it travels?

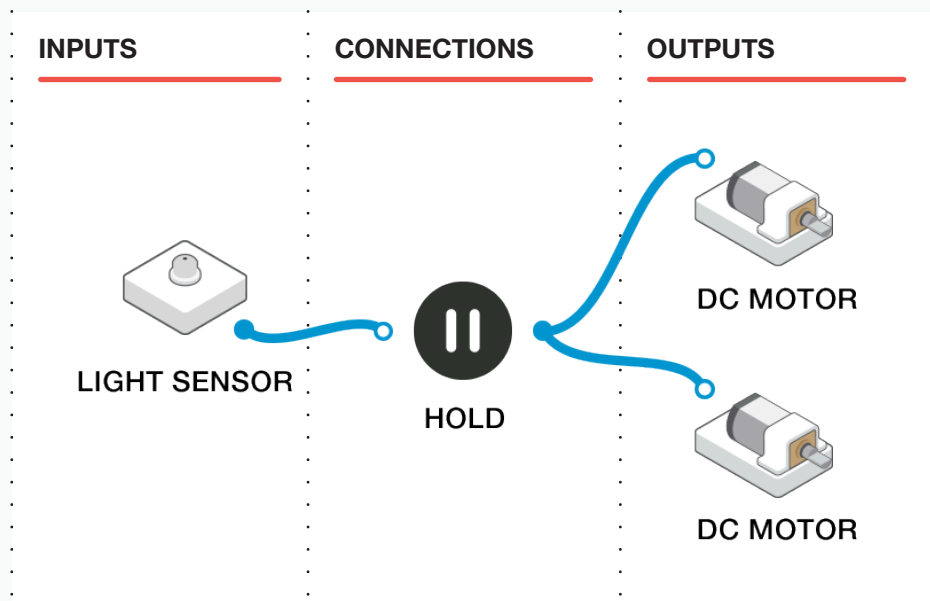
- 2 Encourage the students to create their own design for the buggy. On the next page there is a suggestion of what the students could create.

**Note that this is looking at the underside of the buggy so that you can see the blocks and accessories attached to the SAM chassis.**

**Note the use of the extra SAM light block with the LEGO(tm) jacket at the front of the buggy. This helps the buggy to travel in a straight line.**



- 3 Open SAM Space and add the SAM DC Motor blocks to the space, along with a SAM Light Sensor block in button mode (see Tips & Tricks, later). Connect these together with a Hold block as shown below.



Double click the hold block to adjust the parameters and set the hold for a duration of 5 seconds. This means that when the button is pressed the SAM DC motors will run for 5 seconds before stopping.

We also need to reverse one of the DC motors so that when they run, they will drive the buggy forwards, otherwise they will make the buggy spin around in circles (as the motors are facing opposite directions as they're attached to the buggy).

Double click one of the DC Motor blocks and set the direction in the parameters to anti-clockwise. Quickly test the buggy to check it travels in the correct direction, if not reset the DC Motor and reverse the other one.

- 4 Now it is time to test the buggy. Find a smooth, level surface and use masking tape or similar to mark a start line. Place the buggy behind the start line and cover the light sensor.

The buggy should travel forwards for 5 seconds. Accurately measure the distance the buggy has travelled and note down the results. It is worth testing this two or three times.

**Q:** Were the results from each test consistent? Does your programming of the SAM Blocks work, or is there anything you can improve? Is a 5 second run time long enough?



- 5 We now know how far the buggy will travel with the wheels that have been used over a set period of time. (In this case 5 seconds)

Ask the students to calculate the speed that the buggy is travelling. They may need some help with the formula:

**Distance in meters / time in seconds**

This will give the students the speed that their buggy has travelled in metres per second (m/s).

- 6 In order to predict how far the buggy will travel with different size wheels, we need to calculate two more things: the circumference of the wheels and the number of rotations that happen within the 5 second time period.

We can work out the circumference of a wheel using Pi, which is a constant figure of 3.142. Measure the diameter (d) of the wheel in millimeters and use the calculation below to work out the circumference:

**3.142 x diameter**

Now we know the circumference of the wheel, along with the distance it travelled within a set time period, we can calculate how many rotations (R) of the wheel occurred within that time period. To do this we need to calculate:

**Distance travelled / circumference**

- 7 With all these details, ask the students to calculate how far the buggy will travel with different size wheels. To do this, they will need to:

**Number of rotations x circumference of the new wheel**

Ask the students to create a table to record the results of the calculations, and then perform the actual test with the new wheels. Ensure that the buggy always starts from the same starting point, and that the distances are measured accurately.

They can record their results in a table similar to the one below:

Wheel size	Predicted distance travelled	Actual distance travelled

**Q:** Were your calculations accurate?

**Q:** Does a run time of 5 seconds provide enough time to accurately measure and calculate the results?

**Q:** What happens if you increase this time by altering the delay block (remembering to re do your calculations)?

# 04



DURING THE CLASS

## Extension activity

If some groups complete the task, they can be challenged further. Encourage students to think about finding other solutions to varying the wheel size.

**Q:** Can you build wheels from other materials and attach them to the buggy?

**Q:** What effect do you think bigger wheels will have on the number of times the wheels will turn in five seconds?

### REAL-WORLD APPLICATIONS

This knowledge is significant in many real world applications, most notably car and vehicle design. Similarly though, this knowledge can be important in various design areas that involve using gears and cogs.

### RECORDING THEIR WORK

Ensure the students have completed their student packs, recording their thoughts and solutions.

**Other options:** Create an e-book / poster / video, etc. to explain what they have done.





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# Probability

COMPUTER SCIENCE  
DESIGN & TECHNOLOGY  
MATHEMATICS

# Key information

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## SUBJECTS

Computing, Mathematics, Design & Technology.

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## KEY STAGE

Key Stage 3

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## OUTCOMES

- Create a system to control spinners with motors.
  - Understand the use of delays to control timings and outputs.
  - Develop a knowledge of probability.
  - Practice teamwork and collaborate to navigate through problems.
  - Reflect on and review the process, their product and that of their peers.
- 



## LEARNING OBJECTIVES

See Curriculum Alignment (next page).

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## RECOMMENDED PRIOR KNOWLEDGE

Basic understanding of SAM, and the SAM Blocks used in the project.

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## GROUP SIZE

2-3 students

---



## TIME REQUIRED

***NB: This project may go over two sessions, depending on the time needed to be given to each stage, and the experience of the students.***

### **Suggestion for a 1 hour session:**

Introduction to concept - 5 minutes.  
Activity Stages - 40 minutes.  
Extension activity - 10 minutes.  
Reflection and Plenary - 5 minutes.

---



## MATERIALS REQUIRED

- SAM Space Education app
  - 1 SAM Tray
  - 2 x A4 sheets of paper or card
  - Ruler
  - Coloured pencils
-

# Curriculum alignment

## NATIONAL CURRICULUM STANDARDS

### Computing - Key Stage 3

- Design, write and debug programs that accomplish specific goals, including controlling or simulating physical systems; solve problems by decomposing them into smaller parts.
- Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.
- Use technology safely, respectfully and responsibly; recognise acceptable/unacceptable behaviour; identify a range of ways to report concerns about content and contact.

<https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study>

### Design & Technology - Key Stage 3

#### Design

- Use research and develop design criteria to inform the design of innovative, functional, appealing products that are fit for purpose, aimed at particular individuals or groups.

#### Technical Knowledge

- Understand and use electrical systems in their products (for example, series circuits incorporating switches, bulbs, buzzers and motors).
- Apply their understanding of computing to program, monitor and control their products.

<https://www.gov.uk/government/publications/national-curriculum-in-england-design-and-technology-programmes-of-study>

### Maths - Key Stage 3

- Record, describe and analyse the frequency of outcomes of simple probability experiments involving randomness, fairness, equally and unequally likely outcomes, using appropriate language and the 0-1 probability scale.
- Understand that the probabilities of all possible outcomes sum to 1.
- Enumerate sets and unions/intersections of sets systematically, using tables, grids and Venn diagrams.
- Generate theoretical sample spaces for single and combined events with equally likely, mutually exclusive outcomes and use these to calculate theoretical probabilities.

<https://www.gov.uk/government/publications/national-curriculum-in-england-mathematics-programmes-of-study>

# 01



BEFORE THE CLASS

## Summary

This lesson is concerned with probability, and testing the likely outcomes of matching colours on two spinners that are controlled via the SAM DC Motors. The students will build spinners out of motor blocks, working with triggers and delays to allow the motors to stop on a random colour each time it is triggered.

The students will make two backgrounds for their spinners, one with three colours, and one with four colours, and the cog attached to the DC motor will both make it spin and act as the pointer.

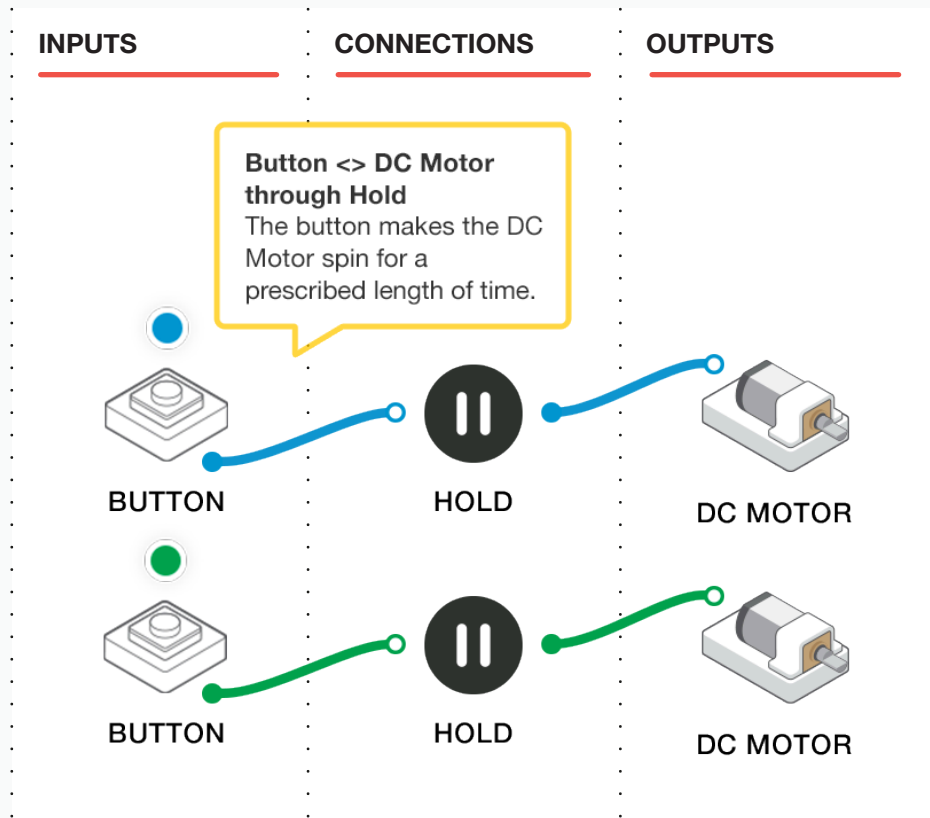
The students will create the programme in the SAM Space to control the pointer, and they will collate the results from multiple spins to assess the probability of the two spinners landing on the same colour.

The students will:

- Design the backgrounds for their spinners.
- Design a system to control the motors.
- Collate the results and compare theoretical and experimental probability.



An example of the completed project in the SAM Space may look like this:



# 02



BEFORE THE CLASS

## Final checklist

The following contains everything you need to prepare your SAM Labs environment before commencing the project. Please ensure you read each section carefully to ensure you have a problem free lesson.

### DOWNLOAD THE APP

You can download the SAM Education app for OSX or Windows at <https://www.samlabs.com/app>.

### SAM LOG IN

Create a SAM account if you don't already have one. SAM accounts are free and allow you to save your inventions to the cloud and download and modify them later, you can even share them with others.

### CHARGE YOUR SAM BLOCKS

Even though the blocks can be used while tethered, they were designed as rechargeable devices that can be used a fair way away from your system or where they can't be plugged in. You can tell they are fully charged when they change colour from red to green.

**Handy Tip:** you can click on a block in the SAM space to see how much charge is left.

### ADDITIONAL RESOURCES

For SAM support <https://www.samlabs.com/support>.

# 03



## DURING THE CLASS

# Activity stages

- 1 Explain to the students that they are going to investigate theoretical and experimental probability by recording the results of two spinners generating random choices of colours.

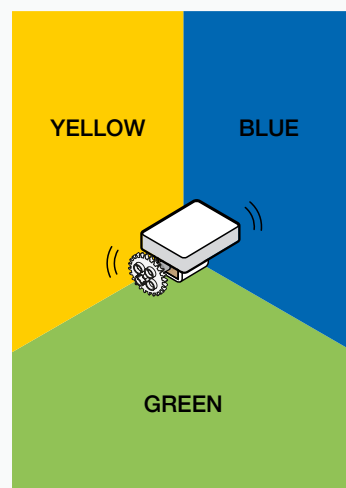
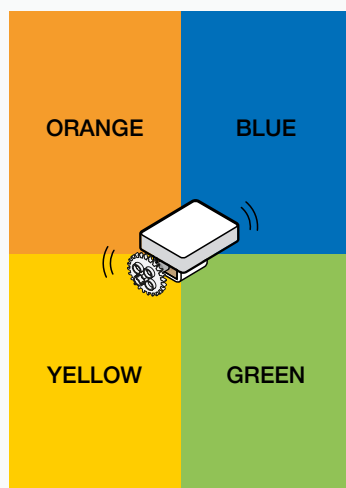
- Q:** What do you expect to happen each time we rotate a spinner?
- Q:** Will it always land on the same colour?
- Q:** What happens if there are two spinners?
- Q:** Can we predict how likely it will be that they land on the same colour?

- 2 Ask the students to create two backgrounds, one for each spinner. The backgrounds are just A4 or even A5 pages. Divide one into four equal coloured sections, and one into three equal coloured sections. The backgrounds need colouring in so that three colours on both backgrounds are the same. Show the students an example design, but they can create their own styles.

The students will need:

- Two sheets of paper
- Ruler
- Coloured pencils

An example design might be:



- 3 Each spinner will be made of a SAM motor block with the cog from the kit fitted. If you turn the motor upside down and place it on a flat surface (such as the centre of one of the spinner backgrounds laid flat on a table!) and run the motor, it spins around in a very satisfying way.

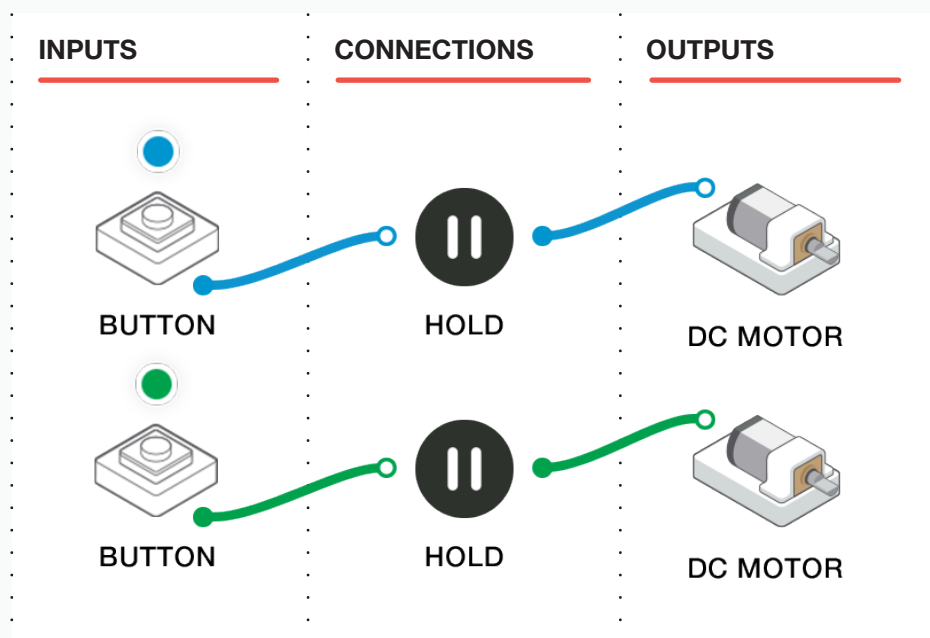
The students need to consider how we could control the DC Motor blocks to turn the spinner. Allow the students to work in the SAM Space to solve this challenge. An example might require two DC Motor blocks

Ensure that these blocks are paired to the computer, and drag them into the SAM Space.

- 4 We could simply connect each DC motor block to a virtual button block (see Tips & Tricks, later) so that it spins when the button is pressed, and stops spinning when the button is released. However, this allows for the results to be controlled with influence by the user who is pressing the button, and they may favour particular colours.

Similarly, we could insert a toggle block between the DC Motor and the Button, so that one press would start the motor, and another press would stop it.

A better option is to insert a Delay block, which the parameters can be set to allow the motor to run for a set length of time after the button has been pressed, which will allow much less influence from the person pressing the button.



Double click both delay blocks and select a time of a few seconds for each one, they do not have to run for the same amount of time. Maybe set one motor to run for 3 seconds, and one for 5 seconds. The students can vary this.

Once the SAM Space has been completed, ensure that the cogs are attached to the DC motors, and that the students place the spinners in the centre of the backgrounds they have prepared.

- 5 Ask the students to run the test with both spinners 10 times, and record the results of the colour selected by the spinner each time. They will need to create a table for this.

**Q:** How many times did each spinner land on each colour?

**Q:** How many times did they land on the same colour?

**Q:** Which colour was selected the most?

**Q:** Which colour combination between both spinners was the most common?

- 6 Can we now predict the likelihood of getting both spinners to land on the same colour?

If the students create another table, they can work out the probability for the two spinners landing on the same colour. It should look something like this:

	Blue	Green	Yellow	Orange
Blue	Yes	No	No	No
Green	No	Yes	No	No
Yellow	No	No	Yes	No

So there are 12 possible outcomes from the spins, the theoretical probability of the two spinners landing on the same colours is:

$P(\text{winning}) = 3/12$  which is the same as  $1/4$ .

- 7 Ask the students to compare the results of the experimental probability test with the two spinners, to those suggested by the theoretical probability.

**Q:** How do the theoretical probability results compare to your experimental probability results?

**Q:** Can you account for this in any way?

- 8 Ask the students to report back to the class the results of their probability experiments, and discuss the class findings:

**Q:** What do the results mean?

**Q:** Can we accurately predict the outcomes?

**Q:** Did each group get the same results?

**Q:** Did you find any problems during this experiment?

**Q:** Can you present your results using tables, graphs or Venn diagrams?

# 04



DURING THE CLASS

## Extension activity

**Q:** What would happen if each spinner had the same number of colours?

**Q:** What would happen if you added more colours to the spinners?

**Q:** Could you predict the theoretical probability of the two spinners landing on the same colours if each spinner had more colours, perhaps 5 on one and 6 on the second?

**Q:** Could this be expanded further?

**Q:** Could you consider developing the SAM space to improve how the spinner works?

**Q:** Can you think of a way to make the system more random? Either through a SAM solution, or through one involving the process of using the spinners?

### REAL-WORLD APPLICATIONS

Being able to predict the outcome of experiments is a useful real-world application in many areas, and to be able to use the theoretical probability against experimental probability is a good skill to have. Areas that this is particularly common in include:

- Trade and financial markets
- Sports results
- Reliability of goods and components
- Predicting the weather

### RECORDING THEIR WORK

Ensure the students have completed their student packs, recording their thoughts and solutions.

**Other options:** Create an e-book / poster / video, etc. to explain what they have done.







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# Quiz Champion

COMPUTER SCIENCE  
DESIGN & TECHNOLOGY  
TEACHER CHOICE  
(can be used in any curriculum area)

# Key information



## SUBJECT

Computing, Design & Technology, Teacher Choice (can be used in any curriculum area).



## RECOMMENDED PRIOR KNOWLEDGE

Basic understanding of SAM, and the SAM Blocks used in the project.



## KEY STAGE

Key Stage 2



## GROUP SIZE

2-3 students / 2 groups of students for the competitions and extension activity.



## OUTCOMES

- To create a system that will record how many questions are correctly answered in a quiz.
- To create a system that will announce a quiz 'winner'.
- Practise teamwork and collaborate to navigate through problems.
- Reflect on and review the process, their product and that of their peers.



## TIME REQUIRED

**NB: This project may go over two sessions, depending on the time needed to be given to each stage, and the experience of the students.**

### Suggestion for a 1 hour session:

Introduction to concept - 5 minutes.  
Activity Stages - 40-50 minutes.  
Extension activity - 10 minutes.  
Reflection and Plenary - 5 minutes.



## LEARNING OBJECTIVES

See Curriculum Alignment (next page)



## MATERIALS REQUIRED

- Computer or Tablet
- SAM Space Education app
- 1 SAM Tray
- A set of questions related to any given topic / revision theme etc.

The students may use Other SAMs if needed in their projects.

# Curriculum alignment

## NATIONAL CURRICULUM STANDARDS

### Computing - Key Stage 2

- Design, write and debug programs that accomplish specific goals, including controlling or simulating physical systems; solve problems by decomposing them into smaller parts.
- Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.
- Use technology safely, respectfully and responsibly; recognise acceptable/unacceptable behaviour; identify a range of ways to report concerns about content and contact.

<https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study>

### Design & Technology - Key Stage 2

#### Design

- Use research and develop design criteria to inform the design of innovative, functional, appealing products that are fit for purpose, aimed at particular individuals or groups.

#### Technical Knowledge

- Understand and use electrical systems in their products (for example, series circuits incorporating switches, bulbs, buzzers and motors).
- Apply their understanding of computing to program, monitor and control their products.

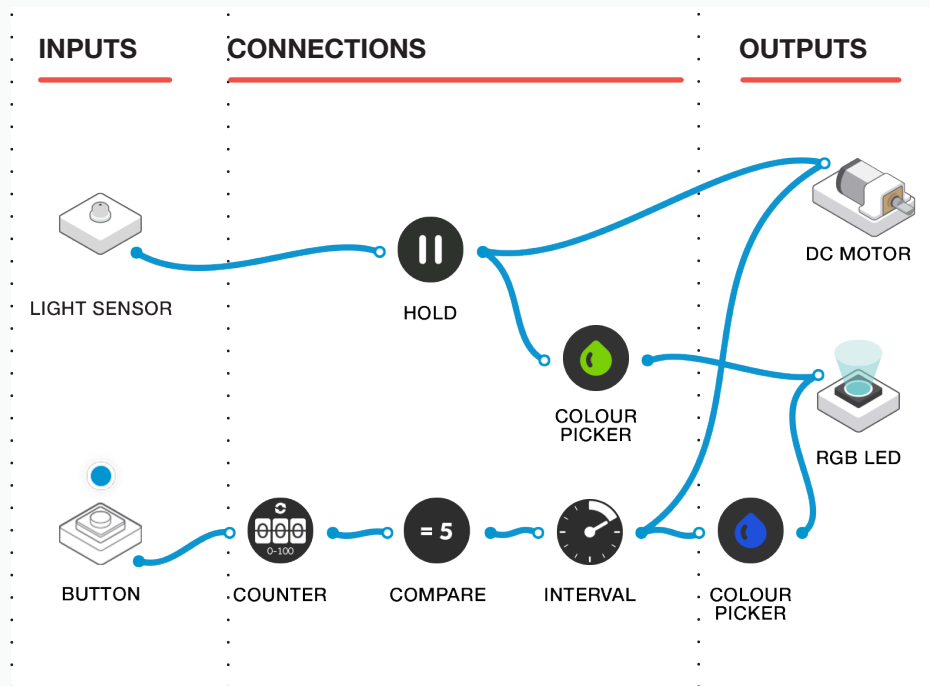
<https://www.gov.uk/government/publications/national-curriculum-in-england-design-and-technology-programmes-of-study>

# 01



## BEFORE THE CLASS Summary

During this project, students will think about quizzes and quiz shows, and create and program a system that will allow the number of correct answers to a curriculum quiz to be recorded. They will then use SAM space and SAM blocks to create a system that will allow for competition, and signal when there is a 'winner'.



# 02



BEFORE THE CLASS

## Final checklist

The following contains everything you need to prepare your SAM Labs environment before commencing the project. Please ensure you read each section carefully to ensure you have a problem free lesson.

### DOWNLOAD THE APP

You can download the SAM Education app for OSX or Windows at <https://www.samlabs.com/app>.

### SAM LOG IN

Create a SAM account if you don't already have one. SAM accounts are free and allow you to save your inventions to the cloud and download and modify them later, you can even share them with others.

### CHARGE YOUR SAM BLOCKS

Even though the blocks can be used while tethered, they were designed as rechargeable devices that can be used a fair way away from your system or where they can't be plugged in. You can tell they are fully charged when they change colour from red to green.

**Handy Tip:** you can click on a block in the SAM space to see how much charge is left.

### ADDITIONAL RESOURCES

For SAM support <https://www.samlabs.com/support>.

# 03



## DURING THE CLASS

# Activity stages

During these stages, students will create a “buzzing-in” and scoring system. Each team with a set of SAM blocks will make one system.

During the quizzes, two teams will need to play against each other.

- 1 Have a discussion with the students about quizzes.

**Q:** What examples of quizzes do you know about?

**Q:** Have you seen any quiz shows on television?

Ask them what many quiz shows have in common. Draw out that the majority use a system whereby the contestants have to “buzz in” in order to answer questions. Also that contestants score points, and that the person with most points is generally the winner.

- 2 Tell the students that during this project, they will create a buzzing-in and scoring system so that they can take part in their own quizzes.

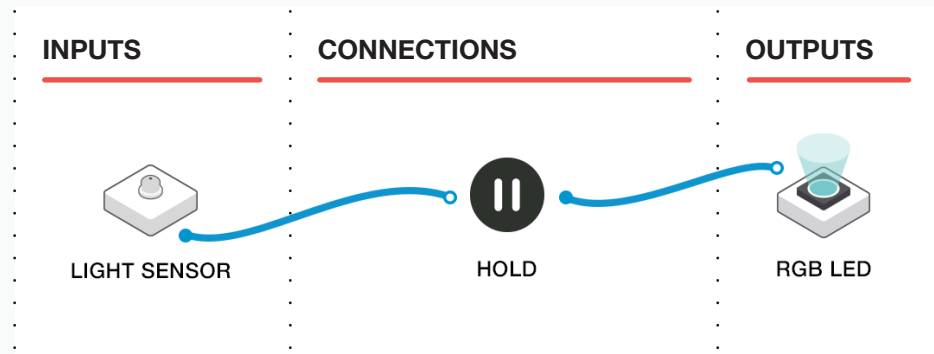
**Q:** What features could your system have?

**Q:** How might you record the number of correct answers?

**Q:** How might your system announce a ‘winner’?

- 3 Show, or remind, the students how to connect SAM blocks using SAM Space, and give them an example of using a Light Sensor to signal a response to a question.

The example below uses a Light Sensor in button mode (see Tips & Tricks later) to illuminate an RGB LED. It also uses a Hold block to illuminate the RGB LED for a set number of seconds (in this case 2 seconds).



- 4 Send the students away to devise their own system that two contestants can use to play a quiz.

**Q:** How might the questioner be able to tell which contestant wants to answer?

**Q:** Are there other ways of creating a system like this using different SAM Blocks?

**NB:** they may use motors, RGB LEDs, or combinations.

- 5 After having them share their creations, tell the students that in order for the questioner to know how many correct answers have been given, they will need to introduce to their programs some form of scoring system.

**Q:** What might you use to keep count of the scores?

**Q:** Will the contestants, or someone else, be responsible for recording correct answers?

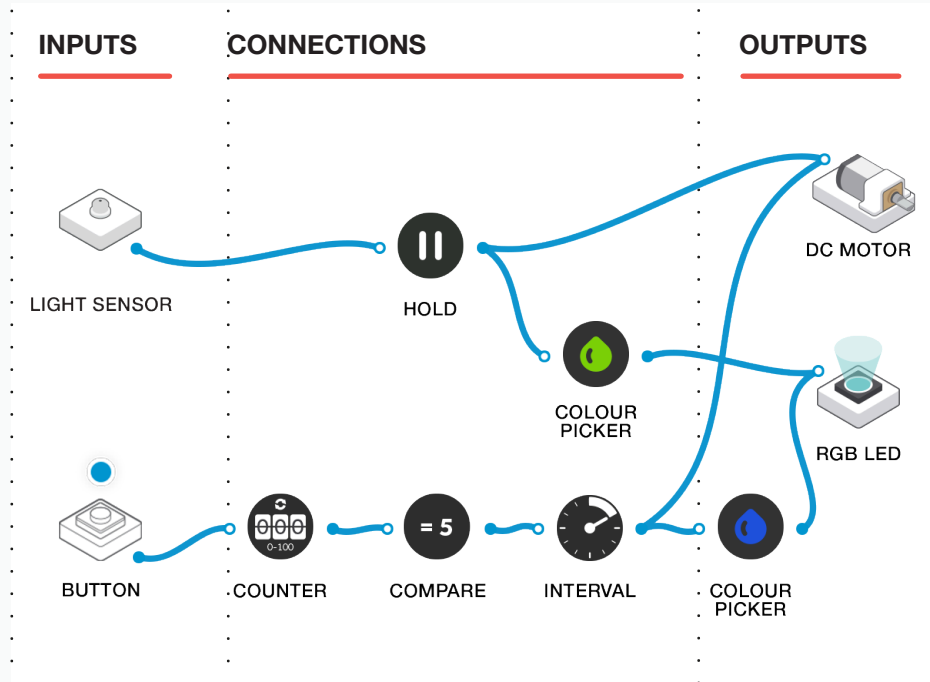
**Q:** Will you put a limit on the amount of correct answers, so that there is a 'winner'?

**Q:** How might your system show this?

**NB:** Remind the students that they only have the blocks available to their team, and so the system they devise will need to use the same light for both "I want to answer!" and "This team won!" They could differentiate with different flashing patterns or colours. Also, a motor with a wheel attached makes a great visual attention grabber!

6 An example solution is presented below.  
The solution has two inputs:

- A light sensor that the team waves a hand over to signal they wish to answer a question.
- A virtual button on the team's device that the judge presses to signal a correct answer.



The team has a signalling device made up of a motor and a light inserted into a pink block holder as follows. Note how the motor has one of the provided cogs on it to make it extra buzzy!





The Light Sensor (in button mode) detects when it is covered, and triggers the other blocks to make the motor buzz and the light turn on to indicate they want to answer.

If they answer correctly, the judge taps their virtual button which increases their counter. If their counter reaches five, their buzzy-machine will start whipping around in celebration with the light flashing.

- 7 Finally, have the students devise their own set of questions based on a current class topic. Hold a competition amongst the class, and ensure that all students experience every aspect of the project (programmers, questioners, scorekeepers, etc).



# 04



DURING THE CLASS

## Extension activity

Students can now be challenged to make the buzzing devices more sophisticated, with extra motors, sounds playing and so on.

If you have the larger SAM kits, you will have other blocks available - can those be used to make things even more interesting?

They may need to join with other groups and use multiple computers/tablets to construct their solutions.

Can they extend their programs so that teams can play against each other, or have more than two competitors?



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# Super Home for the Hearing Impaired

COMPUTER SCIENCE  
DESIGN & TECHNOLOGY  
SCIENCE

# Key information

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## SUBJECTS

Computing, Design & Technology.

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## RECOMMENDED PRIOR KNOWLEDGE

Basic understanding of SAM, and the SAM blocks used in the project.

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## KEY STAGE

Key Stage 3

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## GROUP SIZE

3-4 students

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## OUTCOMES

- Create a system to control light and sound
  - Understand the use of delays to control timings and outputs.
  - Practice teamwork and collaborate to navigate through problems.
  - Reflect on and review the process, their product and that of their peers.
- 



## TIME REQUIRED

***NB: This is Part 1 of a 2-part project. One flows into the other, but they can be taught as separate entities. Timings are approximate, depending on the time needed to be given to each stage, and the experience of the students.***

### **Suggestion for a 1 hour session:**

Introduction to concept - 5 minutes.  
Activity set-up - 30 minutes.  
Explore and modify the experiment - 10 minutes.  
Extension activity - 10 minutes.  
Reflection and Plenary - 5 minutes.

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## LEARNING OBJECTIVES

See Curriculum Alignment (next page).

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## MATERIALS REQUIRED

- SAM Space Education app
  - 1 SAM Tray
-

# Curriculum alignment

## NATIONAL CURRICULUM STANDARDS

### Computing - Key Stage 3

- Design, use and evaluate computational abstractions that model the state and behaviour of real-world problems and physical systems.
- Understand several key algorithms that reflect computational thinking (for example, ones for sorting and searching; use logical reasoning to compare the utility of alternative algorithms for the same problem).
- Undertake creative projects that involve selecting, using, and combining multiple applications, preferably across a range of devices, to achieve challenging goals, including collecting and analysing data and meeting the needs of known users.
- Create, re-use, revise and re-purpose digital artefacts for a given audience, with attention to trustworthiness, design and usability.
- Understand a range of ways to use technology safely, respectfully, responsibly and securely, including protecting their online identity and privacy; recognise inappropriate content, contact and conduct and know how to report concerns.

<https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study>

### Design & Technology - Key Stage 3

#### Design

- Use research and develop design criteria to inform the design of innovative, functional, appealing products that are fit for purpose, aimed at particular individuals or groups.

#### Technical Knowledge

- Understand and use electrical systems in their products (for example, series circuits incorporating switches, bulbs, buzzers and motors).
- Apply their understanding of computing to program, monitor and control their products.

<https://www.gov.uk/government/publications/national-curriculum-in-england-design-and-technology-programmes-of-study>

# 01



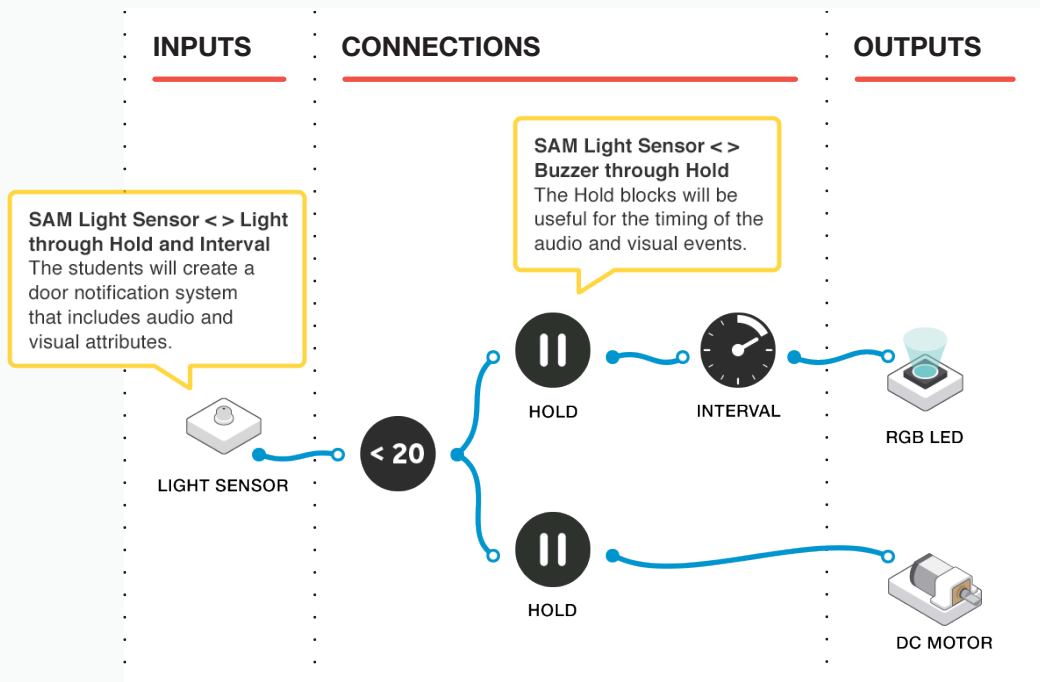
## BEFORE THE CLASS Summary

In this project, the students will investigate and attempt to solve a problem that affects the hearing impaired, that of not necessarily knowing when someone is at the front door. Traditional door bells do not meet the needs of all aspects of our society, so we need to create a system that includes a visual notification too.

The students will:

- Plan the requirements for such a system
- Design a system to work as an audible and visual door notification device
- Develop their ideas for other uses within the home

An example of the completed project may look like this:



# 02



BEFORE THE CLASS

## Final checklist

The following contains everything you need to prepare your SAM Labs environment before commencing the project. Please ensure you read each section carefully to ensure you have a problem free lesson.

### DOWNLOAD THE APP

You can download the SAM Education app for OSX or Windows at <https://www.samlabs.com/app>.

### SAM LOG IN

Create a SAM account if you don't already have one. SAM accounts are free and allow you to save your inventions to the cloud and download and modify them later, you can even share them with others.

### CHARGE YOUR SAM BLOCKS

Even though the blocks can be used while tethered, they were designed as rechargeable devices that can be used a fair way away from your system or where they can't be plugged in. You can tell they are fully charged when they change colour from red to green.

**Handy Tip:** you can click on a block in the SAM space to see how much charge is left.

### ADDITIONAL RESOURCES

For SAM support <https://www.samlabs.com/support>.

# 03



## DURING THE CLASS

# Activity stages

- 1 Explain to the students that they are going to create a device to support the hearing impaired, and how they may not know if someone is at the front door. Ask them to consider what the problems might be, and how they could attempt to solve this problem with the use of SAM Blocks.

**Q:** How do we usually know if a visitor is at the front door, and how may this be a problem for hearing impaired people? What solutions could you offer?

- 2 The students will establish that as well as an audible doorbell type system, they will need to include a visual indicator, which can be in the form of a flashing light. Open SAM Space and introduce the students to the following blocks:

- Light sensor: acts as a hand-wave activated button (see “Tips and Tricks”, later)
- DC Motor Block: for making a spinny-buzzer (see “Tips and Tricks”, later)
- RGB LED

Ensure that each block is paired to the computer.

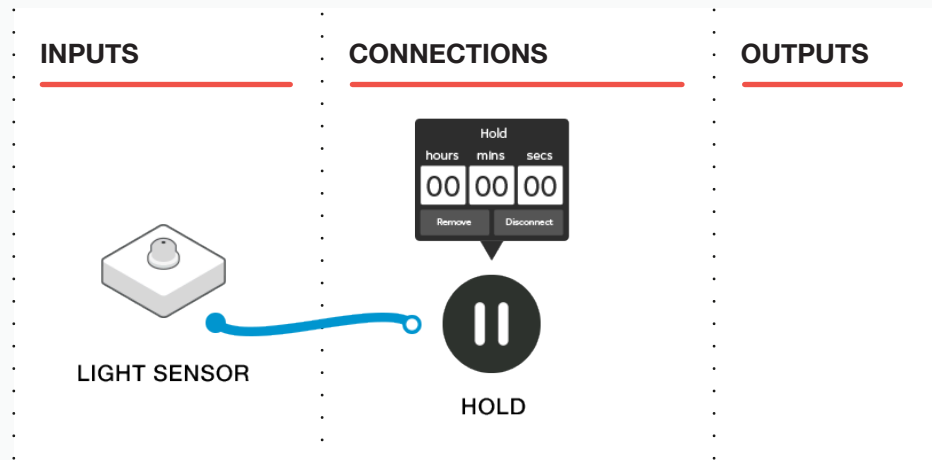
- 3 To control these, we’re going to need two more software blocks:
  - Hold
  - Interval

Challenge the students to start planning and creating their systems using these blocks.

**Q:** How do you want the buzzer to respond? Should it make one long sound, or several short sounds? What about the RGB LED - should it flash?



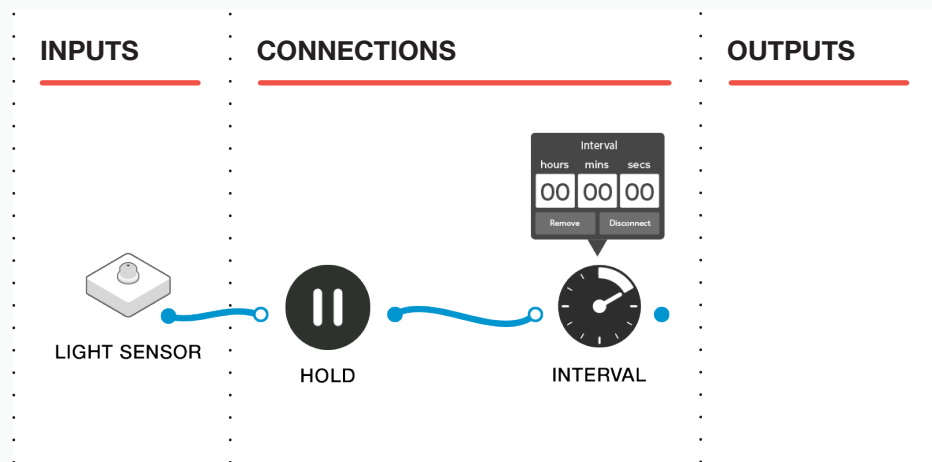
- 4 To build a solution, drag a light sensor and Hold block to the SAM Space and connect the two together. Set the Light sensor to Button mode.



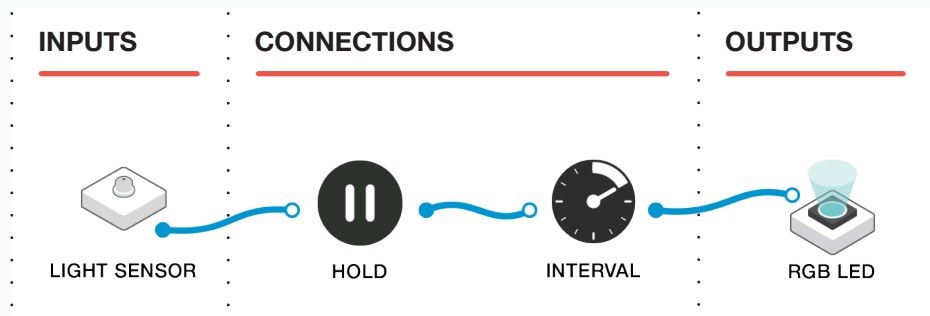
Edit the Hold block's parameters and set it to 10 seconds. Now, when a hand is waved over the light sensor, the hold block will send an output signal for the configured 10 seconds. If you want to change the length of time that the RGB LED is lit up, then alter the parameter on this Hold block.

- 5 If we now connect the RGB LED to the output of the delay block, it will illuminate for 10 seconds every time the light sensor is tapped. However, we can add another block that will make the RGB LED flash instead of just light up.

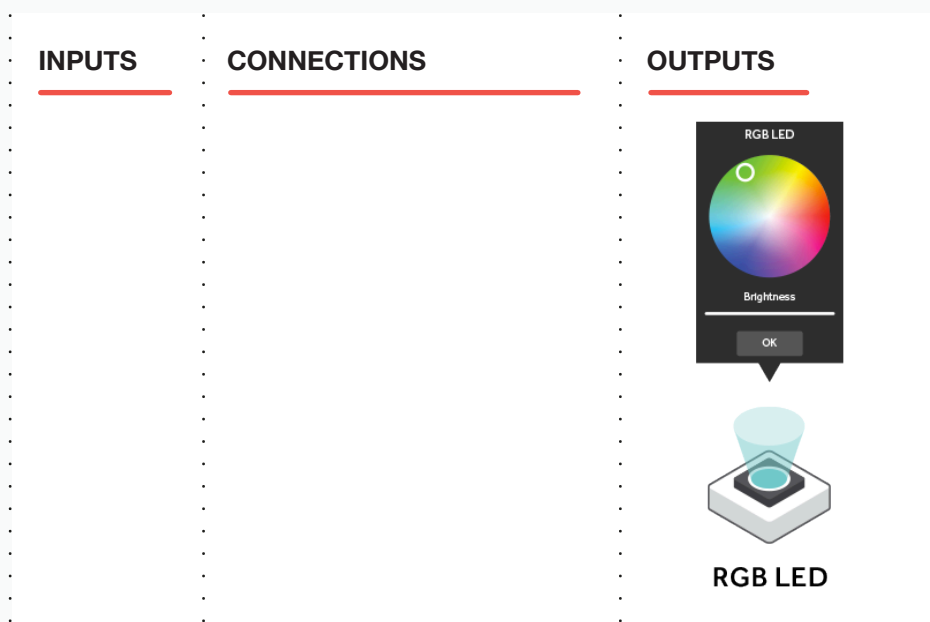
Add the Interval block to the SAM space and double click it to edit the parameters, with a setting of 500ms. If you want to change the speed of the flashing RGB LED, experiment with different delay settings. Maybe try 1 second?



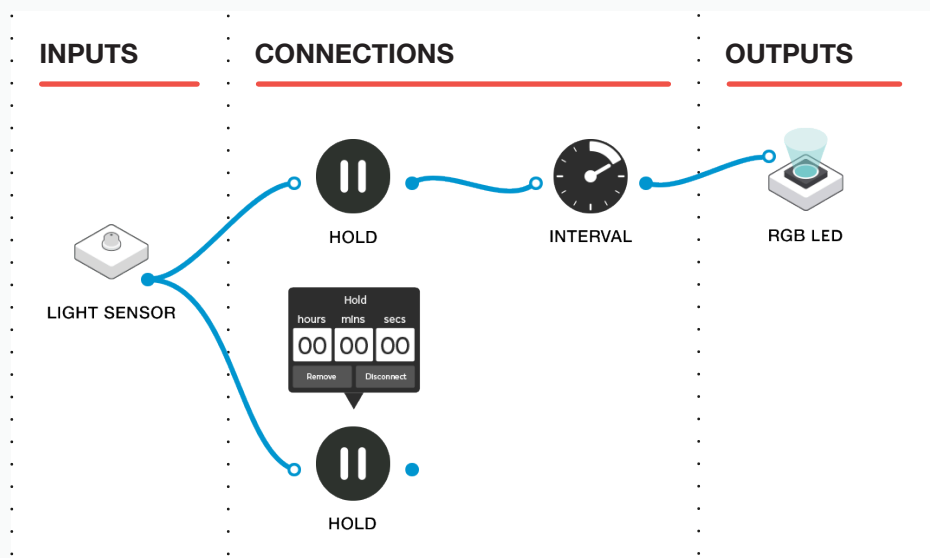
6 Now we can connect the RGB LED to the end of this sequence.



Double clicking on the RGB LED will allow you to change the parameters, and here you can set the colour of the light.

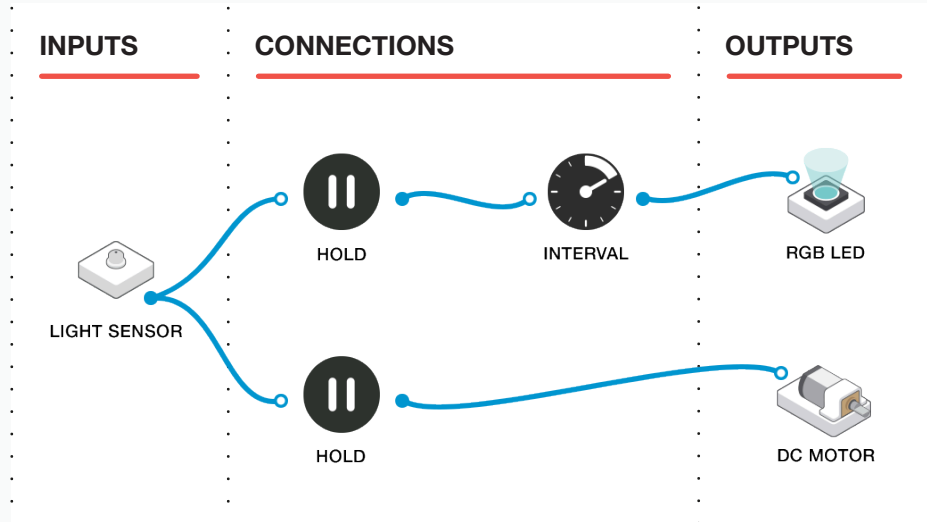


7 We're nearly there! Now we need to add our spiny buzzer (see Tips and Tricks later). As with the RGB LED, we can control the length of time the the motor spins with a Hold block.



Double click the Hold block and set the parameters to 2 seconds, which will be how long the motor will spin for. Edit this parameter if you want to change the length of time that the motor spins.

Finally connect the Motor block to the delay.



**8** Now you're ready to test the system, and adjust an parameters as necessary.

**Q:** Does it work? What were your difficulties in designing this system?

**Q:** What does changing the parameters do, does it make the system more effective or user friendly?

**Q:** Is there anything you can change to the system?

# 04



DURING THE CLASS

## Extension activity

Encourage students to think further about their design. Are there any other SAM blocks we could use in this system to enhance the functionality of the door notification system? If you have access to a SAM Button, the system could be extended with a button that one presses to deactivate the buzzer.

Are there any other ways in which the system could be developed or expanded?

**Q:** Could this be expanded further?

**Q:** Are there any other uses for this type of system around the home?

**Q:** Could the system be developed to meet these different needs, such as home security?

### REAL-WORLD APPLICATIONS

This system could be developed to work as it was intended, as a commercial product, serving as a door notification system for the hearing impaired. The system could be developed further for other uses around the home, such as home security.

### RECORDING THEIR WORK

Ensure the students have completed their student packs, recording their thoughts and solutions.



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# Super Light Logging

COMPUTER SCIENCE  
DESIGN & TECHNOLOGY  
SCIENCE

# Key information

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## SUBJECTS

Computing, Science, Design & Technology.

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## RECOMMENDED PRIOR KNOWLEDGE

Basic understanding of SAM, and the SAM blocks used in the project.

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## KEY STAGE

Key Stage 3

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## GROUP SIZE

3-4 students

---



## OUTCOMES

- Capture and log data over time.
  - Create a variable data source with automation.
  - Practice teamwork and collaborate to navigate through problems.
  - Reflect on and review the process, their product and that of their peers.
- 



## TIME REQUIRED

### Suggestion for a 1 hour session

- Introduction to concept - 5 minutes.
  - Activity set-up - 15 minutes.
  - Explore and modify the experiment - 15 minutes.
  - Present the outcomes - 10 minutes.
  - Extension activity - 10 minutes.
  - Reflection and Plenary - 5 minutes.
- 



## LEARNING OBJECTIVES

See Curriculum Alignment (next page).

---



## MATERIALS REQUIRED

- SAM Space Education app
  - 1 SAM Tray
-

# Curriculum alignment

## NATIONAL CURRICULUM STANDARDS

### Computing - Key Stage 3

- Design, use and evaluate computational abstractions that model the state and behaviour of real-world problems and physical systems.
- Understand several key algorithms that reflect computational thinking (for example, ones for sorting and searching; use logical reasoning to compare the utility of alternative algorithms for the same problem).
- Understand a range of ways to use technology safely, respectfully, responsibly and securely, including protecting their online identity and privacy; recognise inappropriate content, contact and conduct and know how to report concerns.

<https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study>

### Design & Technology - Key Stage 3

- Understand and use the properties of materials and the performance of structural elements to achieve functioning solutions.
- Understand how more advanced electrical and electronic systems can be powered and used in their products [for example, circuits with heat, light, sound and movement as inputs and outputs].
- Apply computing and use electronics to embed intelligence in products that respond to inputs [for example, sensors], and control outputs [for example, actuators], using programmable components [for example, microcontrollers].

<https://www.gov.uk/government/publications/national-curriculum-in-england-design-and-technology-programmes-of-study>

### Science - Key Stage 3

- Analysis and evaluation
- Present observations and data using appropriate methods, including tables and graphs.
- Interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions.
- Present reasoned explanations, including explaining data in relation to predictions and hypotheses.
- Evaluate data, showing awareness of potential sources of random and systematic error.
- Identify further questions arising from their results.

<https://www.gov.uk/government/publications/national-curriculum-in-england-science-programmes-of-study>

# 01



## BEFORE THE CLASS Summary

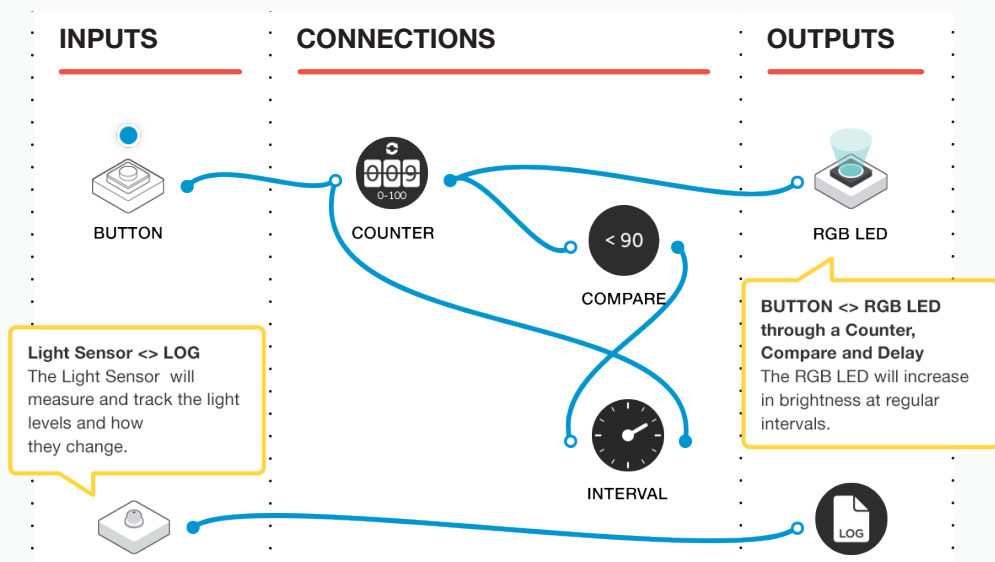
During this project, the students will explore creating a data source and focus on developing their understanding of standardised testing, and modifying environments that might affect the outcomes.

They will create a variable light source that can be automated to increase in brightness at regular intervals. They will also use a light sensor to measure the light levels and how these change over time, including recording and logging the data. The students will also be given the opportunity to explore working with the light in different conditions, and assess how this affects the data that is logged.

The students will:

- Hypothesise as to what they expect the results might look like.
- Design and build a system to increase light levels, and log the results.
- Investigate the data produced.
- Present their findings.

Below is an example of what the final solution may look like:





# 02



BEFORE THE CLASS

## Final checklist

The following contains everything you need to prepare your SAM Labs environment before commencing the project. Please ensure you read each section carefully to ensure you have a problem free lesson.

### DOWNLOAD THE APP

You can download the SAM Education app for OSX or Windows at <https://www.samlabs.com/app>.

### SAM LOG IN

Create a SAM account if you don't already have one. SAM accounts are free and allow you to save your inventions to the cloud and download and modify them later, you can even share them with others.

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**Handy Tip:** you can click on a block in the SAM space to see how much charge is left.

### ADDITIONAL RESOURCES

For SAM support <https://www.samlabs.com/support>.

# 03



DURING THE CLASS

## Activity stages

- 1 Explain to the students that they are going to create a variable light source in this experiment to create a controlled environment. The light will run a sequence from very dim to very bright over a period of time. They will also build a means of testing how bright the light is and log the data under different conditions.

**Q:** Why is it important to have an automated controlled environment to measure the data?

**Q:** How might this be useful when exploring different conditions or environments?

**Q:** What type of things could vary the brightness of the ambient light?

- 2 Once the students have an understanding of why it is important to run this experiment in a controlled manner, so the settings remain constant as they change the conditions or environment, we can start building in the SAM Space. Open the SAM Space and introduce the students to the following blocks:

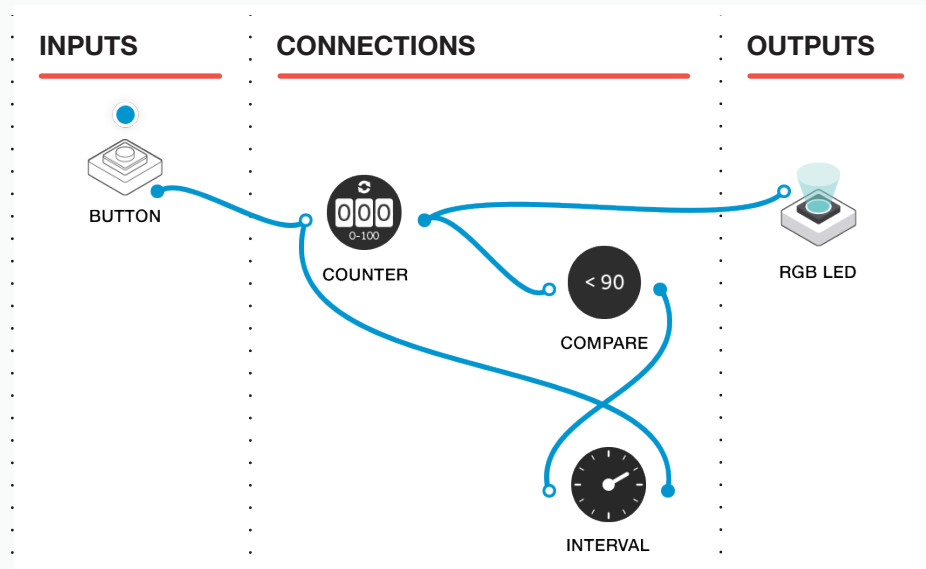
- Button (a virtual one if you have no physical available; see “Tips and Tricks” later)
- RGB LED
- Light sensor

Ensure that these are paired to the computer.

We need to create an automated system that will control the brightness of the RGB LED. To do this we need three more blocks:

- Counter
- Compare, with the comparison set to “< 90”
- Delay, with the delay set to 5 seconds.

Connect these together as below, this will allow us to press the button block, which starts the system automatically brightening the RGB LED.



- 3 Pressing the button will make the counter increase its value. The counter's value (now 1) is then sent to the RGB LED, which lights it up very dimly.

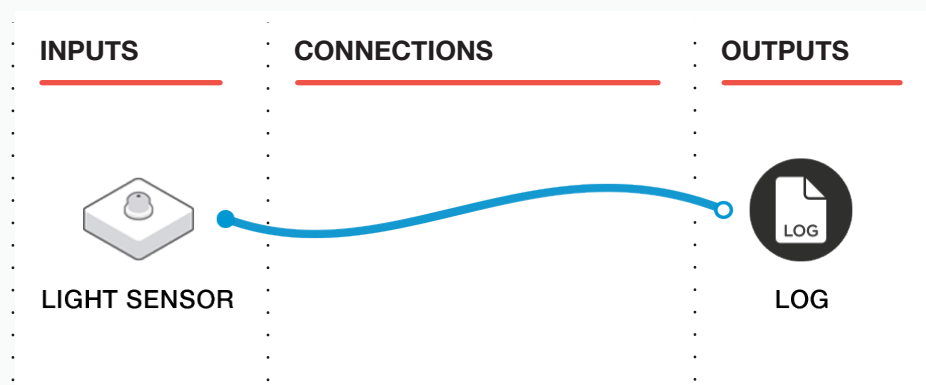
While you can press the button to further increase the counter (and thus the brightness), the system will now do it automatically.

The counter's value is sent to the comparison block. If it is less than 90, the comparison will pass it on to the interval block. While the interval block is receiving a value it will continue to update the counter every 5 seconds.

This increases the counter (brightening the light), and keeps the whole loop running until the counter reaches 90.

At that point, the comparison block will stop sending the value on to the interval block, and the LED will stop getting brighter, and the counter will not be updated. The loop will stop.

- 4 We now need to add the Light Sensor block to capture the brightness and log the data. Connect the blocks as below:



- 5 Double click the Log Block to edit the parameters and set it to log the data once every 5 seconds, which should match the changes in brightness of the RGB LED.

Using the red controller chassis in your kit, fix the RGB LED block and the Light Sensor block facing each other. Start with the two blocks at a distance of about 2cm apart.

Press the button to start the automated loop, and the RGB sensor should illuminate. You will see on the screen that the Light Sensor block is giving you a numerical read-out that correlates with the brightness of the RGB LED.

Double clicking on the log block will allow the students to email themselves the data as a CSV file (comma separated values) which should be easily opened in any spreadsheet application, such as Microsoft Excel.

- 6 Ask the students to review and examine the data.

**Q:** Does the data match what you expected (ie. the light sensor increased its value as the RGB LED got brighter)?

**Q:** How can you present this data in a way that is easy to read?

- 7 Direct the students to repeat the experiment several times, but to change the distances between the light sensor block and the RGB LED block. They need to plan this in a logical way and ensure that they measure the distances to keep the logs accurate.

**Q:** What happened to the light levels as the distances between the blocks increased? Can you suggest any explanations for these changes?

**Q:** What part might ambient light play in the experiment?

- 8 Ask the students to consider the control of the environment in which they are running the experiment, which might explain any inconsistencies in the data that they are recording.

**Q:** How could you control the environment further to ensure that the test results are comparable?

**Q:** Could you provide the same conditions every time, irrespective of ambient light in the room?

- 9 Ask the students to prepare and present their findings for peer discussion. This may involve creating graphical representation of the logged data.

**Q:** What could you have done to develop the environment for your experiment further?

**Q:** How might this have helped with the results?

# 04



## DURING THE CLASS

# Extension activity

Encourage the students to think about different environmental conditions for the experiment. They will have already considered placing the blocks in a sealed dark environment, such as a cardboard box, but what other things could they test that might change the results?

**Q:** Changing the size of the cardboard box, does a large environment give different results to a very small closed environment?

**Q:** What about the colour inside the box, does a white box effect the results differently to a black box?

**Q:** What about placing coloured pieces of transparent plastic (filters) in front of the RGB LED?

**Q:** Could you change the environment in any other way?

**Q:** Could this be expanded further?

**Q:** Could we measure different light sources?

**Q:** What happens if we use two RGB LEDs?

**Q:** Could we measure the light in other areas, rather than creating our own?

**Q:** What is the ambient light level in the rooms we work in, and does this vary throughout the day?

## REAL-WORLD APPLICATIONS

Understanding the need for creating experiments in controlled environments is fundamental to a lot of disciplines, and being able to log the data accurately helps with things such as product design and testing.

## RECORDING THEIR WORK

Ensure the students have completed their student packs, recording their thoughts and solutions.

**Other options:** Create an e-book / poster / video, etc. to explain what they have done.



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# What Happens in the Dark?

COMPUTER SCIENCE  
DESIGN & TECHNOLOGY

# Key information



## SUBJECTS

Computing, Design & Technology.



## RECOMMENDED PRIOR KNOWLEDGE

Basic understanding of SAM, and the SAM Blocks used in the project.



## KEY STAGE

Key Stage 3



## GROUP SIZE

3-4 students



## OUTCOMES

- To capture and log data over time.
- To use automation to perform repetitive tasks.
- Practice teamwork and collaborate to navigate through problems.
- Reflect on and review the process, their product and that of their peers.



## TIME REQUIRED

This project needs to go over two sessions, as the program needs to be set up in the first session, left over night, and the outcomes reviewed in the second session.

### Session 1:

Introduction to concept - 10 minutes  
Activity Stages - 40 - 50 minutes  
Extension activity - 10 minutes  
Reflection and Plenary - 5 minutes

### Session 2:

Introduction and recap - 10 minutes  
Collect and analyse the data - 25 minutes  
Present the outcomes - 10 minutes  
Extension Activity - 10 minutes  
Reflection and Plenary - 5 minutes



## LEARNING OBJECTIVES

See Curriculum Alignment (next page)



## MATERIALS REQUIRED

- SAM Space Education app
- 1 SAM tray



# Curriculum alignment

## NATIONAL CURRICULUM STANDARDS

### Computing - Key Stage 3

- Design, use and evaluate computational abstractions that model the state and behaviour of real-world problems and physical systems.
- Understand several key algorithms that reflect computational thinking [for example, ones for sorting and searching]; use logical reasoning to compare the utility of alternative algorithms for the same problem.
- Understand a range of ways to use technology safely, respectfully, responsibly and securely, including protecting their online identity and privacy; recognise inappropriate content, contact and conduct and know how to report concerns.

<https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study>

### Design & Technology - Key Stage 3

- Understand and use the properties of materials and the performance of structural elements to achieve functioning solutions.
- Understand how more advanced electrical and electronic systems can be powered and used in their products [for example, circuits with heat, light, sound and movement as inputs and outputs].
- Apply computing and use electronics to embed intelligence in products that respond to inputs [for example, sensors], and control outputs [for example, actuators], using programmable components [for example, microcontrollers].

<https://www.gov.uk/government/publications/national-curriculum-in-england-design-and-technology-programmes-of-study>

### Science - Key Stage 3

#### Analysis and evaluation

- Present observations and data using appropriate methods, including tables and graphs.
- Interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions.
- Present reasoned explanations, including explaining data in relation to predictions and hypotheses.
- Evaluate data, showing awareness of potential sources of random and systematic error.
- Identify further questions arising from their results.

# 01



## BEFORE THE CLASS Summary

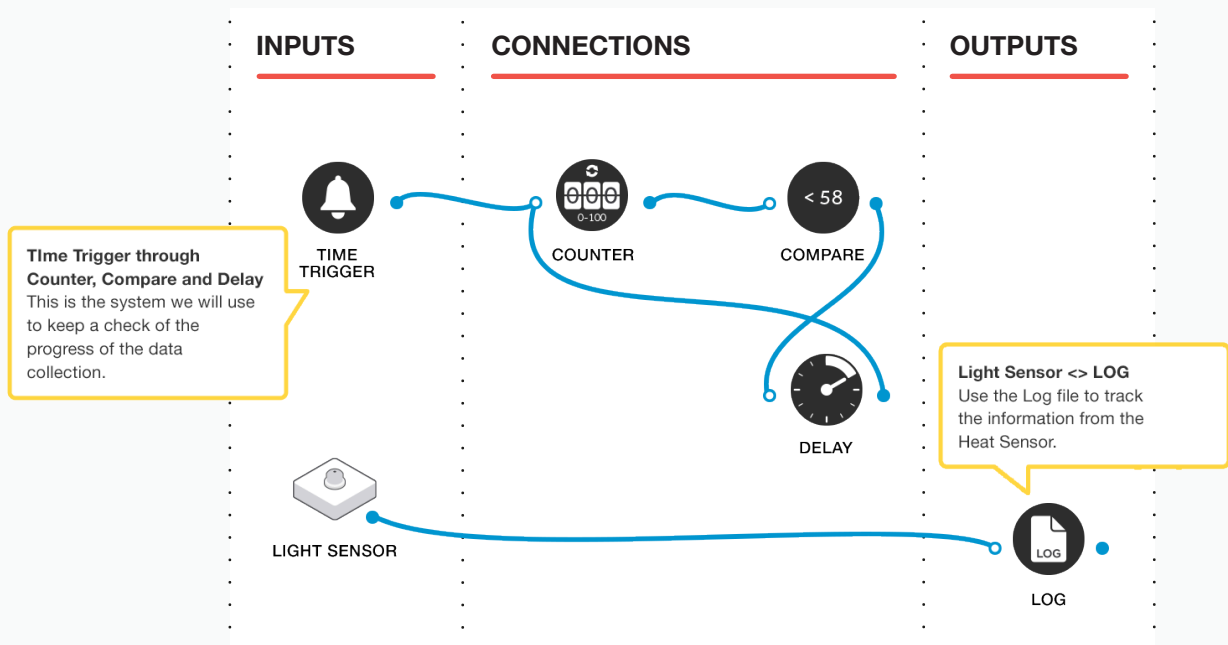
This project focuses on designing and creating a flexible logging system using a range of SAM Blocks that will automate the process of recording light levels overnight, so that the rate of light change at dawn and dusk can be explored. The system will be set up to take a reading every 15 minutes so the data can be examined and presented in various ways.

The students will:

- Hypothesise as to what they expect the results might look like.
- Design and build an automated system that will record light values.
- Investigate the data produced
- Present their findings

Below is an example of what the SAM space could look like.

*Note: As we'll be leaving the SAM Space set up overnight to log the data, it is advisable to keep the sensor plugged in to a power source to ensure that it doesn't run out of battery before the project has ended.*



# 02



BEFORE THE CLASS

## Final checklist

The following contains everything you need to prepare your SAM Labs environment before commencing the project. Please ensure you read each section carefully to ensure you have a problem free lesson.

### DOWNLOAD THE APP

You can download the SAM Education app for OSX or Windows at <https://www.samlabs.com/app>.

### SAM LOG IN

Create a SAM account if you don't already have one. SAM accounts are free and allow you to save your inventions to the cloud and download and modify them later, you can even share them with others.

### CHARGE YOUR SAM BLOCKS

Even though the blocks can be used while tethered, they were designed as rechargeable devices that can be used a fair way away from your system or where they can't be plugged in. You can tell they are fully charged when they change colour from red to green.

**Handy Tip:** you can click on a block in the SAM space to see how much charge is left.

### ADDITIONAL RESOURCES

For SAM support <https://www.samlabs.com/support>.

# 03



DURING THE CLASS

## Activity stages

- 1 Explain to the students that they are going to explore what happens to light levels at dawn and dusk, and look for unexpectedly bright periods overnight. We are going to build an automated system to help us find out more details.

**Q:** What do you think happens to light levels at various parts of the night?

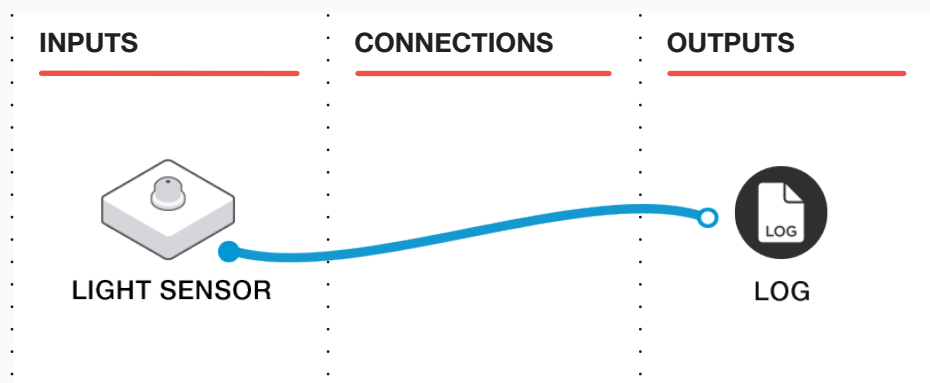
**Q:** Can you think of anything that might cause unexpected bright periods?

**Q:** Why do we need to build a system that automates recording the light levels?

- 2 Once the students have established their expectations about how light levels change overnight, we can start exploring the SAM Blocks that will help us to monitor these two factors. We will be working with the Light Sensor.

**Q:** What external factors could influence the results collected by the sensor?

Open the SAM Space and introduce the students to light sensor blocks. Connect the block to a Log block (which you can find in the behaviours section). The log block writes all values that it receives to a simple text file.



- 3 Double clicking the log block allows you to set how often readings are recorded from the sensors connected to it. Ask the students to consider how often a reading should be taken, but every 15 minutes is a good option. Double click the log block to set this parameter.

**Q:** How often should a sensor's reading be saved?

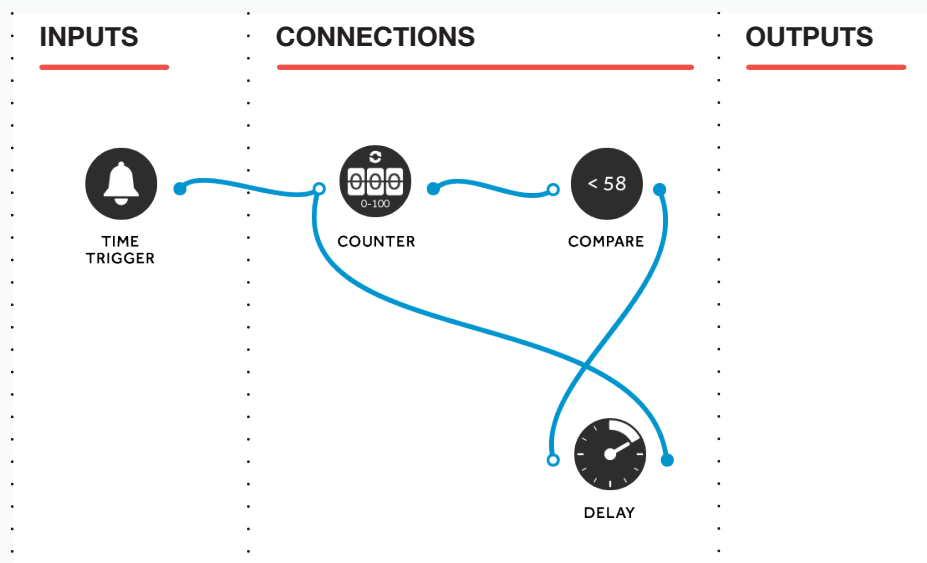
**Q:** How much data will this create if you left it running overnight?

**Q:** Is this manageable?

**Q:** Is there enough data to draw useful conclusions?

Now, we want to build a system that will let us keep track of the progress of the data collection. We'll build a counter that will count upwards overnight. In the morning we will be able to tell that the system ran all night by the value on the counter.

Add the following SAM Blocks and connect them together as follows: Time Trigger, Counter, Compare, Delay.



- 4 We need to edit the parameters of these blocks so that the counter can count up to some value less than 100 in about 9 hours, and then stop. If it goes over 100, it will “roll over” back to zero! You can do this by double clicking on each block and adjusting their values accordingly.

Delay block - set the delay time to 15 minutes

Compare block - set this to a value of <58 (we'll explain why in a moment)

Time Trigger - set this to start an hour before dusk.

- 5 When the Time Trigger block reaches 5pm, it will output a '1', which will be registered on the Counter block. This will cause the comparison block to trigger the delay block (1 being less than 58). After 15 minutes, the Delay block will send a signal to the counter, which will add an increment to the counter (setting it to 2). The loop will then continue. This loop will allow us to check the overnight progress of our log, with the counter increasing by a value of one every 15 minutes, which will match our logged data.

We set a value of  $< 58$  so that the counter will stop when it reaches 58. If the block counts to 58 in 15 minute intervals, that will give us about 14.5 hours. If the counter block contains the number "58" in the morning, we'll know the system ran correctly all night.

**Q:** Based on the time intervals for logging your data, what values do you need to set the parameters to so that the data is logged throughout the night?

**Note:** as we suggested earlier, it is a good idea to ensure that the sensor block is connected to a power source so that it lasts throughout the night. Similarly, the computer needs to be plugged into a power supply too, and all energy saving options that might cause the computer to 'sleep' need to be disabled.

The light sensor block can be positioned somewhere appropriate overnight. Placing it into the red controller in the students tray can make it easier to find in the morning!

- 6 In the morning, use the Log Block's configuration popup to email the data as a CSV file (comma separated values). This file should open in most spreadsheet applications, such as Microsoft Excel, for the data to be viewed and analysed.

**Q:** Is there a correlation between the data recorded from the light sensor and the times recorded in the log file?

**Q:** Is this what you expected, or different?

- 7 Ask the students to present their findings to their peers for discussion.

# 04



DURING THE CLASS

## Extension activity

If some groups complete the task, they can be challenged further. Encourage the students to consider presenting their data as a graph, asking them to think about visual ways of displaying the data.

**Q:** Are there other ways you could present the data?

**Q:** How could you show the data from multiple nights side by side, over time to make it easy to spot the correlations?

**Q:** Could this be expanded further?

**Q:** Could we repeat the task and put loggers in different areas of the school?

**Q:** Are some areas lighter than others over night?

**Q:** Why might this be?

### RECORDING THEIR WORK

Ensure the students have completed their student packs, recording their thoughts and solutions.

**Other options:** Create an e-book / poster / video, etc. to explain what they have done.



NEED SOME HELP?

# SAM Tips & Tricks

The following sections describe how to do really useful things with SAM Labs that you can use in your solutions.

## SPINNY-BUZZER

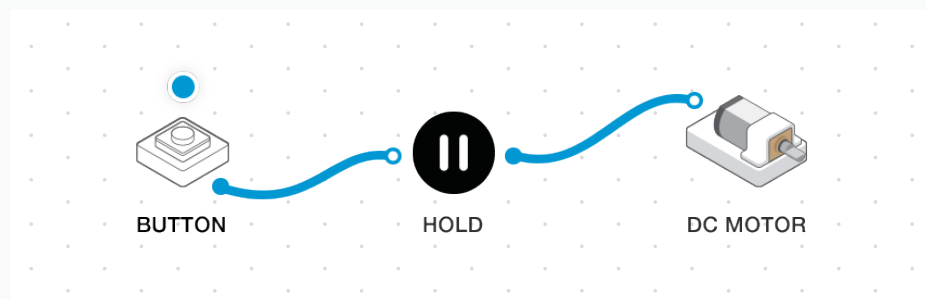
If you need a Buzzer Block, but you only have a motor

A loud buzzy buzzer is often needed in your projects to alert you that something's happened. However, the SAM Trays don't have buzzers... What to do?!

Take a SAM motor block from your tray, and fit one of the included cogs onto it. Then, place it upside down on a desk like so:



Use the following SAM code, with the "Hold" block set to how long you want your buzzer to sound.



If you press the button on your tablet, you'll get a fantastic spiny buzzer! For added effect, fit the motor into the pink chassis in your tray and also include a flashing LED light.

If you need the buzzer to be triggered by something other than a button (such as a timer, or a counter) then just hook the Hold block up to the output of whatever needs to trigger the buzzer, instead of the button as shown above.



## LIGHT SENSOR AS A BUTTON

If you need a button, but your SAM Tray only contains a light sensor

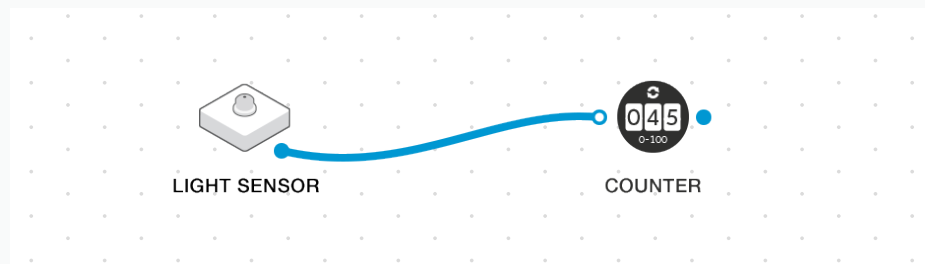
Each SAM Tray contains a light sensor rather than a button. This is because light sensors are super useful for all sorts of fun things, whereas a button is a bit single purpose!

Sometimes, though, you just need a button to make something happen. So what do you do?

Use a light sensor! With the latest version of the SAM Space App, the light sensor will simulate a button by default.

So, drag your light sensor to the canvas. Whenever you tap the light sensor (blocking out its light), it will behave just like a button that's been pressed! It shows this by showing "True" or "False" above it, depending on if it's "pressed" or not.

With a program like the following, when you put your hand over the light sensor you'll see the counter click up:



## LIGHT SENSOR AS A LIGHT SENSOR

For when you want your creation to react to changing light levels

As the above section describes, the light sensor will by default act like a button - when you cover it, it'll behave like a button that's been tapped, and output a "true" value.

In some cases, though, you do want a light sensor!

In this case, do the following:

- Tap the light sensor block in SAM Space (or click it in the Windows version)
- Tap the cog icon
- Use the dropdown to choose the "sensor (0 - 100)" option
- Tap "Done"

The light sensor will now output values of 0 to 100, where 0 is dark and 100 is the maximum.

## VIRTUAL BLOCKS

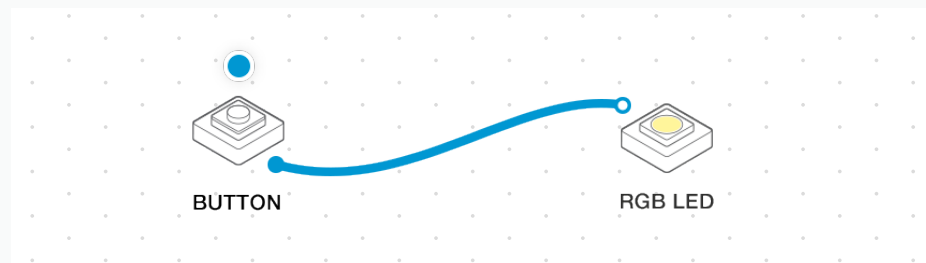
### If you need a button, but you don't have any physical input blocks

Some activities need more than one way to input into the system. Each SAM Tray only contains one input device, however - the light sensor! What do you do if you need a button, but you're already using the light sensor for something else?!

Use a Virtual Button and interact with it through the app, of course!

Scroll to the "Sleeping Blocks" section of the toolbar in SAM Space, and drag one of the "wireframe" style buttons on to the canvas. You'll see the button will have a little virtual button hovering above it - if you press that, that will "press" the button for you, and your program will work.

For example, the following SAM code shows a sleeping button connected to a sleeping light:



You see the green blob above the button? Hold it! You'll see the light light up as follows:



You can use both the sleeping button and slider in this way, just as if they were real blocks.