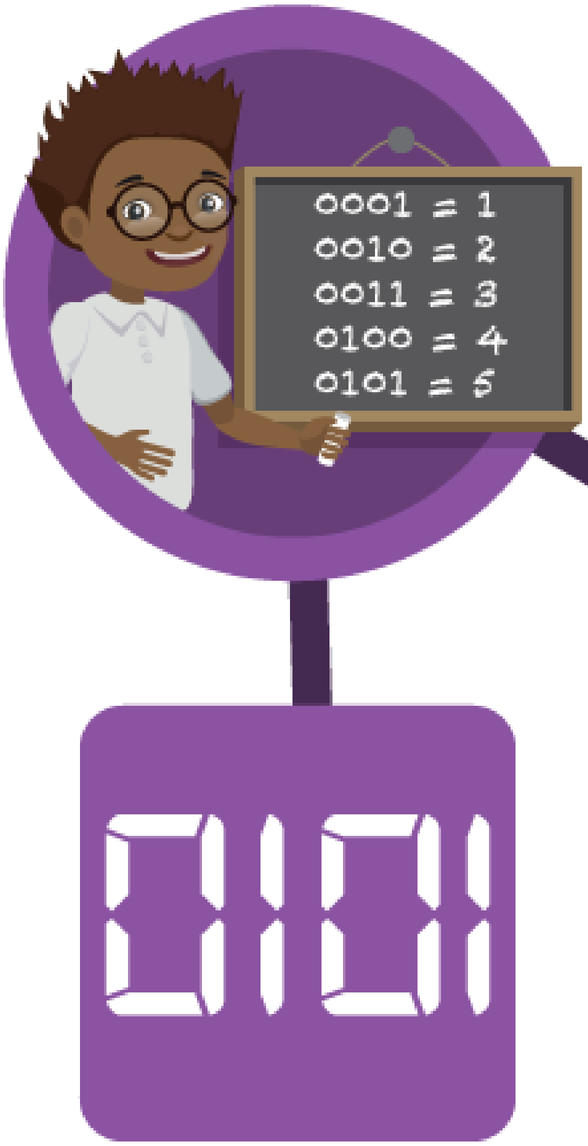
purple mash

Computing

Scheme of Work

Unit 6.8 - Understanding Binary



Year Group: 6
Understanding Binary
Lessons: 4

From 2simple

Year 6 – Medium Term Plan

Please note that all plans and resources can also be found within Purple Mash in the Teacher section at Computing Scheme of Work Year 6, unit 6.8 page.

Lesson	Aims Examine how whole numbers are used as the basis for representing all types of data in digital systems through:	Success Criteria Children have an understanding of binary as a number system and its purpose and application in computing.
1	• Recognising that digital systems represent all types of data using number codes that ultimately are patterns of 1s and 0s (called binary digits, which is why they are called digital systems). • Understand that binary represents numbers using 1s and 0s and these represent the on and off electrical states respectively in hardware and robotics.	• Children can explain how all data in a computer is saved in the computer memory in a binary format. • Children can explain that binary uses only the integers 0 and 1. • Children can relate 0 to an 'off' switch and 1 to and 'on' switch.
2	• Recognising that the numbers 0, 1, 2 and 3 could be represented by the patterns of two binary digits of 00, 01, 10 and 11 • Representing whole numbers in binary, for example counting in binary from zero to 15, or writing a friend's age in binary.	• Children can count up from 0 in binary. Some may need visual aids to help them. • Children can relate bits to computer storage.
3	• Representing whole numbers in binary, for example counting in binary from zero to 15, or writing a friend's age in binary. • Exploring how division by two can be used as a technique to determine the binary representation of any whole number by collecting remainder terms	• Children can convert numbers to binary using the division by two method. • Children can check their own answers using the converter tool.
4	• Representing the state of an object in a game as active or inactive using the respective binary values of 1 or 0	• Children can make use of a variable set to 0 or 1 to control game states.

Differentiation

Understanding binary relates closely to mathematics concepts. Some of the learning objectives do require mathematical operations. The emphasis in the unit is on Computing but children who struggle with understanding Mathematical concepts and performing mathematical operations are likely to find the work more challenging. Content is differentiated within lessons to use as required.

Several of the resources are 2Code files so experience of using 2Code is useful to understand the coding more deeply and develop their own adaptions to the code.

Lesson 1 - What is binary?

Aims

Examine how whole numbers are used as the basis for representing all types of data in digital systems through:

- Recognising that digital systems represent all types of data using number codes that ultimately are patterns of 1s and 0s (called binary digits, which is why they are called digital systems).
- Understand that binary represents numbers using 1s and 0s and these represent the on and off electrical states respectively in hardware and robotics.

Success criteria

- Children can explain how all data in a computer is saved in the computer memory in a binary format.
- Children can explain that binary uses only the integers 0 and 1.
- Children can relate 0 to an 'off' switch and 1 to and 'on' switch.

Resources

Unless otherwise stated, all resources can be found on the main unit 6.8 page. From here, click on the icon to set a resource as a 2do for your class. Use the links below to preview the resources; right-click on the link and 'open in new tab' so you don't lose this page.

- 2Connect example file; Computer Inputs (this file is only visible with a teacher login – have a look at this prior to the lesson as a prompt for step 2).
- Presentation – What is binary?
- Example 2Question branching (binary) database – set this as a 2Do for your class
- Database Puzzler - Print a question sheet for each child.

Activities

1. Open a blank 2Connect file and add the node 'Computer Inputs' to the centre.

> To add a node, simple click on the blank page and then type. Nodes can be edited by clicking on them to select them and then clicking on the button that appears

2. Ask children to suggest all the devices that can input data into a computer. 2Connect to list all inputs that the hardware of a computer receives. Prompt the children into thinking of devices that they might not have considered such as those on the example.

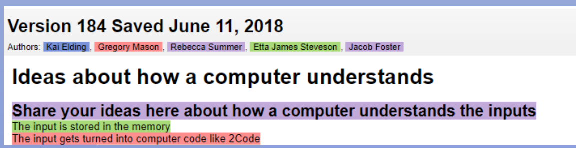
3. Ask the class whether anyone has any idea how a computer understands the inputs coming into it? For example, when a person types the letter ‘A’ on a keyboard, what does the computer do to store the ‘A’. When someone uploads a photo, how is it stored?

You could open a collaborative 2Write on the whiteboard in mode so children can all contribute their ideas at the same time.

To do this, open 2Write, give the file a name and save it in the class folder.

Children should find the same file by clicking on ‘Work’, navigating to the class folder and opening it.

All comments are automatically saved in different colours by pupil in real time and you can find out who wrote each by clicking on the Timeslider button



4. Use the children’s suggestions to explain that everything needs to be translated into something that can be stored by the position of tiny switches inside the computer as the inside of the computer is electronic.
5. Open the What is binary? presentation and discuss each slide using the notes below.
6. Note: There are some difficult concepts to understand.
7. If you have a technician in school, they could come and show the children the inside of a computer, so children can make a connection between the concepts of binary as a system and the physical storage in a machine.

Slide 1) The decimal system

Slide 2) The binary system

Slide 3) Why computers need binary

Slide 4) Morse code; activity to translate your name into code

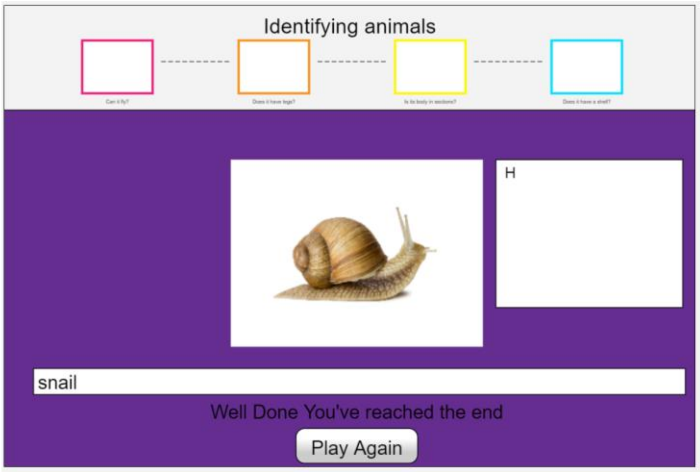
Slide 5) Translating so a computer can understand

Slide 6) Early computers

Slides 7 & 8) Bits, nibbles and bytes; how binary takes up memory space

8. Explain that the children will now be doing a puzzle activity using a **binary database** which is sometimes called a branching database. In this puzzle, you will be translating 0s and 1s into answers to questions.
9. Have a look at the tree view of the example database and show children how to ‘play’ the database (by clicking on the play button).
10. Look at the question sheet. The answers to the questions can be found using the binary code on the tree starting from the first digit. If it is 1 then answer yes, if it is 0 then answer no until you reach the answer.

11. The letters are found by looking in the notes section of the eventual answer. This example shows that the snail is the letter 'H'



12. Once they have solved the puzzle, there is space on the sheet for children to make up their own binary puzzle.

Lesson 2 - Counting in binary

Aims

Examine how whole numbers are used as the basis for representing all types of data in digital systems through:

- Recognising that the numbers 0, 1, 2 and 3 could be represented by the patterns of two binary digits of 00, 01, 10 and 11
- Representing whole numbers in binary, for example counting in binary from zero to 15, or writing a friend's age in binary.

Success criteria

- Children can count up from 0 in binary. Some may need visual aids to help them.
- Children can relate bits to computer storage.

Resources

Unless otherwise stated, all resources can be found on the main unit 6.8 page. From here, click on the icon to set a resource as a 2do for your class. Use the links below to preview the resources; right-click on the link and 'open in new tab' so you don't lose this page.

- Binary Number cards – print on card if possible.
- Whiteboard to write on with pens.
- Counting in bits activity set as a 2do for the class
- 2Code Convert from Binary program. In the resource (and in the computing section binary folder) folder there are 2 copies of this program, one that opens in play mode to use and one that opens in code mode to see the code.
  Link to play mode version https://www.purplemash.com/app/code/examples/2Code_binary_to_denary
  Link to code version https://www.purplemash.com/app/code/examples/2Code_binary_to_denary_code

Activities

1. Review the presentation from last lesson if you wish.
2. Remind children that computers only understand binary and that everything is translated into binary to be stored on the computer.
3. Now we are going to investigate counting in binary to see how a computer stores numbers.
4. Ask five children to stand at the front of the class and give each one a number card to hold up. Can the children find a pattern in the sequence? What would be the next number card?
5. These cards represent a binary number with 5 **bits**. A bit can be 'on' or 'off' and the children holding them are operating the switches for their bit. To turn a switch off, turn the card over so the rest of the class cannot see the number. Ask all the 'switchers' to turn their bits off. Explain that to a computer this represents zero.
6. Ask the number 1 switcher to turn 'on'; can the children suggest what number this is to the computer. Answer = 1.
7. Next turn 1 off and turn 2 on. What does this make? (2)
8. Turn 1 and 2 on. What is this? (3)

9. Turn 4 on and the others off; can children see that this makes the number 4? How could you make 5?
10. Start from 1 again and write on the board:

1 =	1

11. Move to 2, then 3-5

1 = 1	or	00001
2 = 10	or	00010
3 = 11	or	00011

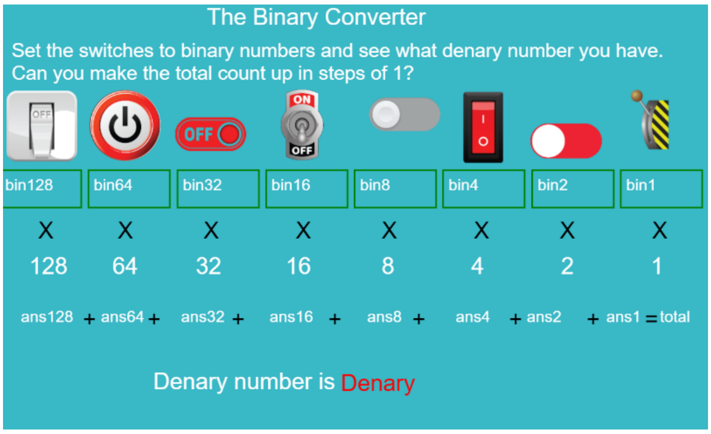
12. What would 10000 be? (16).
13. What is the largest number that you could make with the 5 bits? 11111 = 16 + 8 + 4 + 2 + 1 = 31
14. How could you make 32? Answer: add another bit (32 dots) = 100000.
15. Open the Binary Converter program on the whiteboard. Ask some children to come and work out what it does by switching the switches. Can they make it count up, and down?
16. Ask children to open the Counting in bits file and use the 2Code program to complete it. These are the answers:

Binary	Decimal
1010	10
1001101	77
11001101	205
1110101	117
11111111	255

Number of bits	How many numbers can be made	Highest number possible
1	2	1
2	4	3
3	8	7
4 (called a nibble)	16	15
5 (called a byte)	32	31
6	64	63

17. Did children spot the pattern?
18. If you have time and your class **have experience coding**, you could investigate the code behind the program. Here are some useful tips. For a real challenge some children could try the suggested improvement at the end.

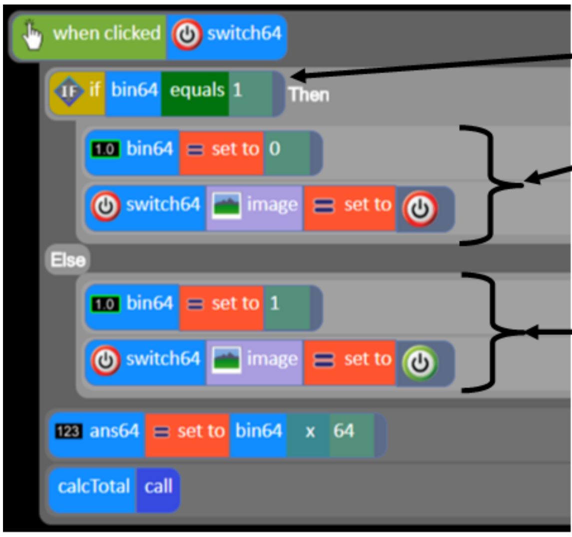
The Design



The bins e.g. bin1 will hold a 0 or 1 depending upon whether their switch is on or off.
This then gets multiplied by the relevant number for the bit position.
All of these are added up to make the denery (decimal, base-10) number.

The code

When each switch is clicked then following code runs (the following is for switch64). Read and interpret the code with the children



If bin64 equals 1 that means that the switch WAS on and the user is switching it off.

So set the displayed number in bin64 to **0** and set the image to the **off** switch.

If bin64 DOESN'T equal 1 that means that the switch WAS off and the user is switching it on. So set the displayed number in bin64 to **1** and the image to the **on** switch.

Set the answer for this bin to whatever value you have just put in bin64 (0 or 1) multiplied by 64. Then call a function called calcTotal.
Note: the sensible name for this function tells you what it does; it's the reason you should always rename your objects and functions to something sensible, it makes the code much easier to read and debug.

Here is the function calcTotal:

Perhaps your class could improve the code; how about adding a reset button that turns all the switches off at once?

Lesson 3 Converting from decimal to binary

Aims

Examine how whole numbers are used as the basis for representing all types of data in digital systems through:

- Representing whole numbers in binary, for example counting in binary from zero to 15, or writing a friend's age in binary.
- Exploring how division by two can be used as a technique to determine the binary representation of any whole number by collecting remainder terms

Success criteria

- Children can convert numbers to binary using the division by two method.
- Children can check their own answers using the converter tool.

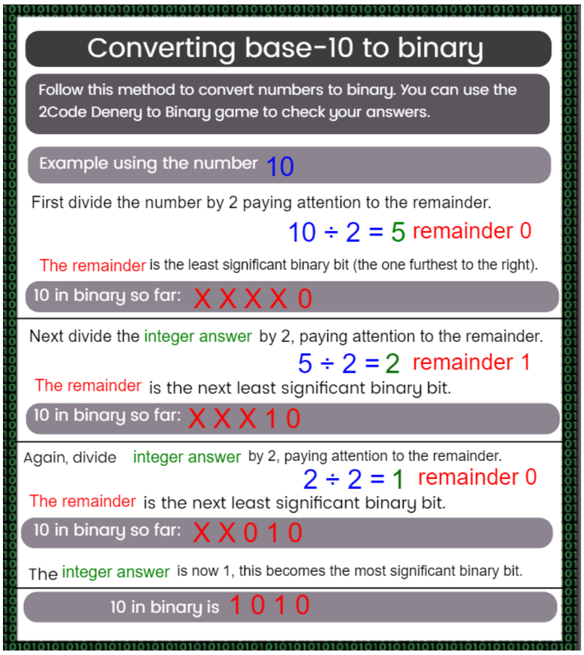
Resources

Unless otherwise stated, all resources can be found on the main unit 6.8 page. From here, click on the icon to set a resource as a 2do for your class. Use the links below to preview the resources; right-click on the link and 'open in new tab' so you don't lose this page.

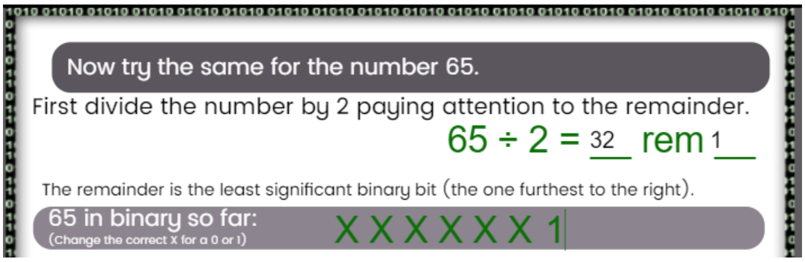
- Converting to binary guide - to be used on the whiteboard or can be used individually (online or printed)
- Convert to binary quiz - set this as a 2do for the class
- 2Code Convert your age to binary program. In the resource (and in the computing section binary folder) folder there are 2 copies of this program, one that opens in play mode to use and one that opens in code mode to see the code.
  Link to play mode version
  https://www.purplemash.com/app/code/examples/2Code_denary_to_binary
  Link to code version
  https://www.purplemash.com/app/code/examples/2Code_denary_to_binary_code

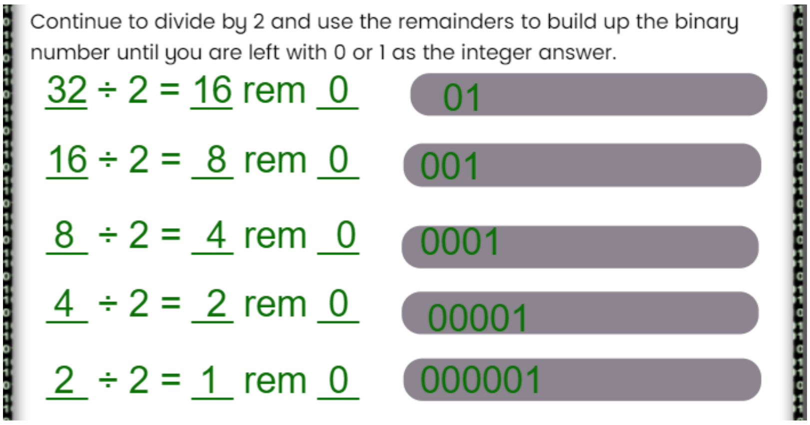
Activities

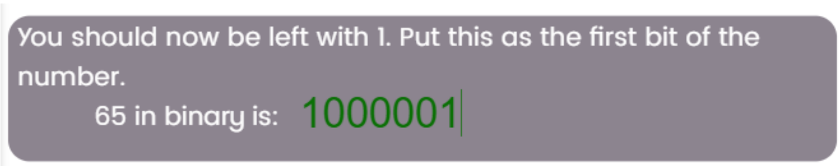
1. Review what the children did last week; converting numbers between binary and decimal using the switches program.
2. Explain that this week they will learn a method for converting any number from decimal (denery, base-10) to binary.
3. Open the Converting to binary guide on the board and use this to explain the method:



4. Work through the example on the next page together

a. 

b. 

c. 

5. Children can now try the quiz. They could also jot down their answers as we will be checking them using a 2Code program after.
6. Open the 2Code Convert your age to binary program. It is designed to convert any age to binary but can be used for any number up to the maximum. Ask the children whether they can work out the maximum age it can be used for using their knowledge from last week. Refer them to the table they filled in the Counting in bits file if they need a pointer.
7. Answer: there are eight possible bits in the answer (a byte). The biggest is equal to 128 but 128 is not the largest number that can be made from 8 bits. 128 is equal to 10000000. What would 11111111 be?
8. Use the 2Code program to go through and check the answers for the quiz.

Lesson 4 Game states

Aim

Examine how whole numbers are used as the basis for representing all types of data in digital systems through:

- Representing the state of an object in a game as active or inactive using the respective binary values of 1 or 0

Success criteria

- Children can make use of a variable set to 0 or 1 to control game states.

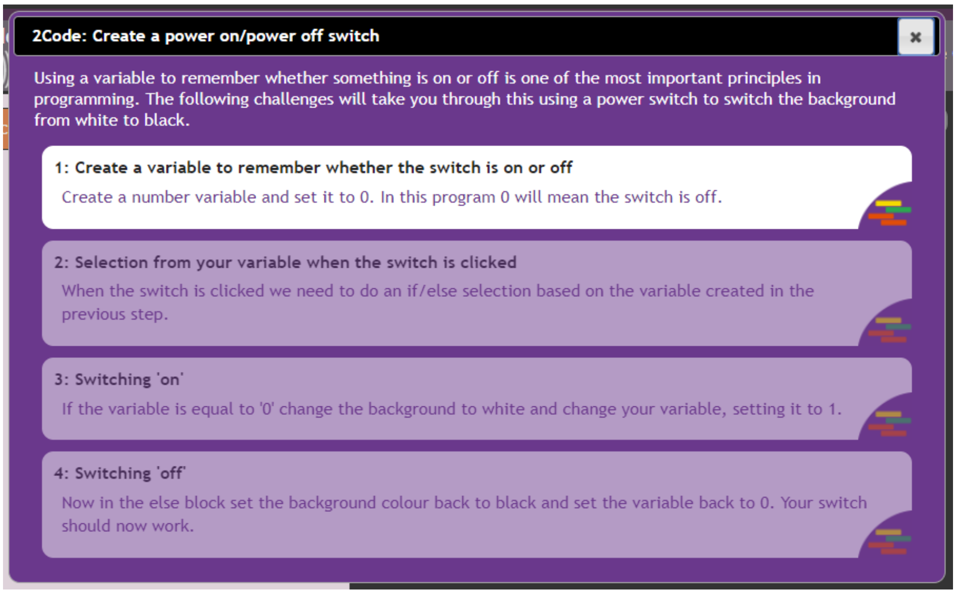
Resources

Unless otherwise stated, all resources can be found on the main unit 6.8 page. From here, click on the icon to set a resource as a 2do for your class. Use the links below to preview the resources; right-click on the link and 'open in new tab' so you don't lose this page.

- Binary Quiz – set this as a 2do2.
- Set the following Gibbon 2Code guided lessons as 2dos. They can be found by going to Tools>Computing>2Code and scrolling to the Gibbon section.
    - Switching background
    - Night and Day (Gibbon)
- Print some storyboard frames if needed for designing in step 6. These can be found in the Program design section of the Computing page.

Activities

1. Introduce the guided activities if children haven't encountered them before. Open the Switching background activity from the 2Code page, though explain that you have set it as a 2do for the class.
2. These are the steps:

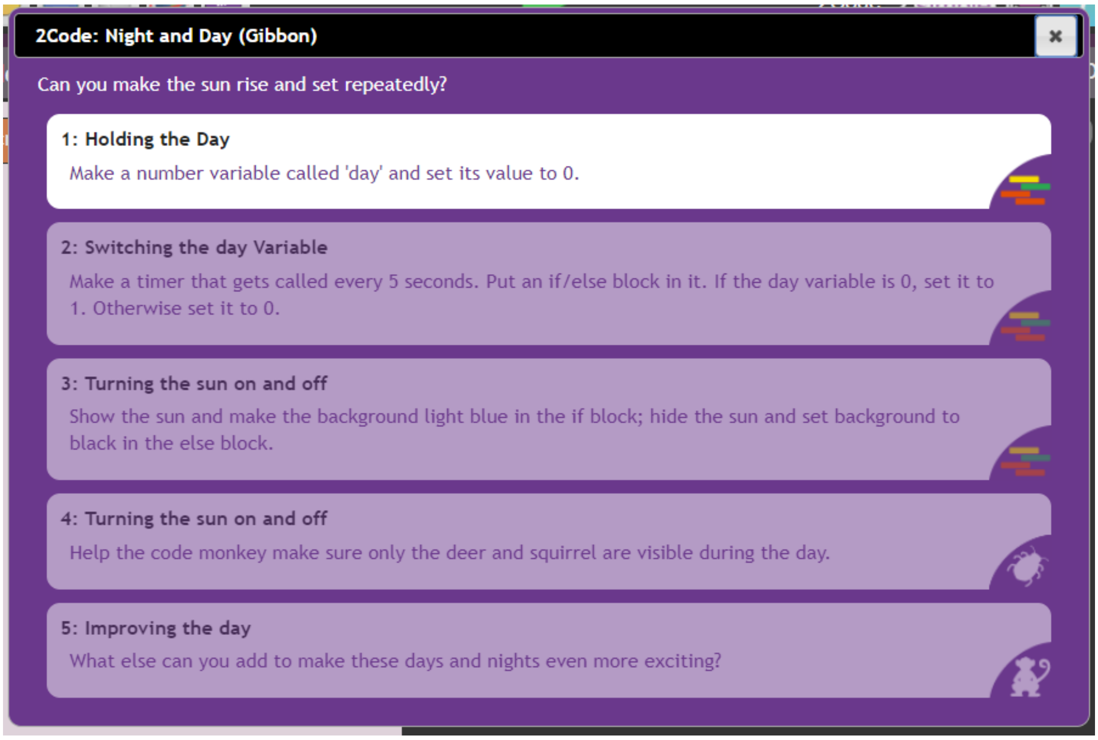


3. Explain that in this lesson, children will be investigating how states within computer programs and games are often represented in code using binary values of 1 (for on) and 0 (for off). This is usually done using something called a variable:

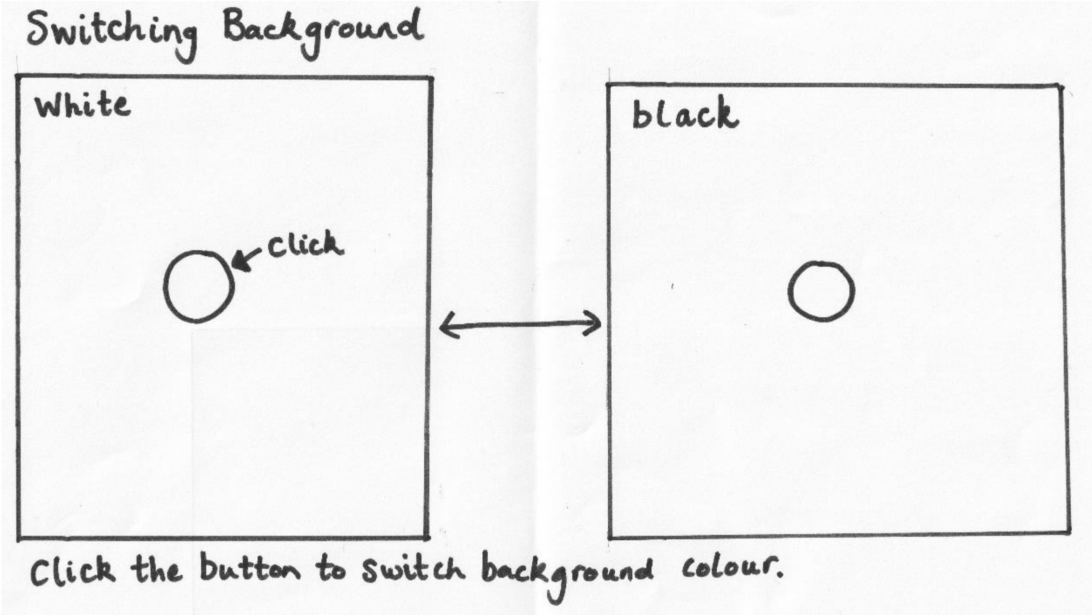
> A ***variable*** is used in programming to keep track of things that can change while a program is running.
>
> In 2Code variables can be numbers or strings. A variable must have a name and the value of the variable is the information to store.

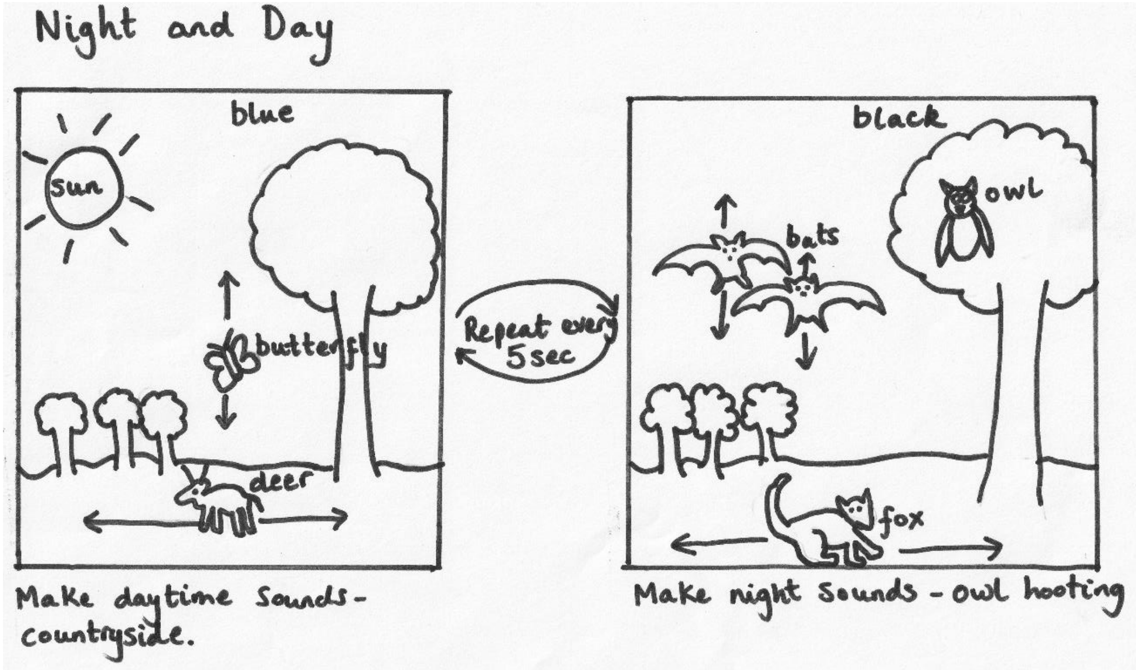
4. Click on step 1 and watch the first video as a class. If children have not had much experience with 2Code you might want to do this as a class coding activity. Otherwise children could try completing the activity on their own devices.

5. The next activity is Night and Day in which a variable stores the state of day or night-time as 0 or 1. It includes a debugging step (step 4) and a challenge step (step 5). Children should complete this including the challenge.



6. Children could then design their own program that uses a variable set to 0 or 1 to control the on or off state of an aspect. They should draw an annotated design first to help them structure their code. Here are examples of annotated designs for the two activities above:





7. This is the last binary lesson so see how much children have remembered by completing the quiz set as a 2do.