Applicable standards

The national curriculum in England

KS3 Computing

Element of the curriculum	Lessons 1	2	3	4	5	6	7	8	9
• Understand the hardware and software components that make up computer systems, and how they communicate with one another and with other systems	✓	✓	✓	✓	✓	✓			
• Use a programming language to solve a variety of computational problems		✓	✓	✓	✓	✓		✓	
• Use computational abstractions that model the behaviour of real-world problems and physical systems		✓	✓	✓	✓	✓			
• Understand simple Boolean logic [for example, AND, OR and NOT] and some of its uses in circuits and programming			✓	✓	✓	✓			
• Understand how data of various types can be represented and manipulated digitally			✓	✓	✓	✓			
• Undertake creative projects that involve selecting, using, and combining multiple applications to achieve challenging goals, including meeting the needs of known users								✓	✓
• Create, re-use, revise and re-purpose digital artefacts for a given audience, with attention to trustworthiness and design									✓

KS3 Design & Technology

Element of the curriculum	Lessons 1	2	3	4	5	6	7	8	9
• Use research and exploration to identify and understand user needs							✓	✓	✓
• Develop specifications to inform the design of innovative, functional, appealing products that respond to needs in a variety of situations							✓		
• Use a variety of approaches to generate creative ideas and avoid stereotypical responses							✓		
• Develop and communicate design ideas using annotated sketches, oral and digital presentations and computer-based tools								✓	✓
• Select from and use a wider range of materials and components according to their functional properties and aesthetic qualities								✓	
• Test, evaluate and refine ideas and products against a specification, taking into account the views of intended users and other interested groups								✓	✓
• Apply computing and use electronics to embed intelligence in products that respond to inputs, and control outputs, using programmable components								✓	✓

SCHEME OF WORK

All resources can be downloaded from:
encounteredu.com/teachers/units/code-smart-11-14

Lesson 1: Robot cars and smart cities

Overview

In the first lesson of this unit of work, we will introduce your class to the concept of robotics and autonomous cars. Your students will discuss what cities in the future will look like, and think about the role that robots and autonomous vehicles will play. Next, your class will work in groups to complete the main challenge of the first lesson: building the mBot, then getting it moving around the classroom with the remote control.

Learning outcomes

- Name a benefit of smart cities
- Describe characteristics of an autonomous vehicle
- Compare characteristics of robots and humans
- Construct a robot
- Name the basic parts of the robot
- Control a robot using a simple remote
- Identify and share problems encountered with solutions

Resources

Slideshow 1:
Robot cars and smart cities

Student Sheet 1a:
What are the differences between robots and humans?

Video:
Building your robot

360 Video:
Look! Driving with no hands!

Image:
Comparing my mBot to a driverless car interactive

Lesson 2: Controlling cars with code

Overview

In the second lesson of this unit of work, we will introduce your class to the concept of using code to control cars. Your students will discuss how programming a car compares to programming a standard computer. Next, your class will work in groups to complete the main challenge of the second lesson: programming the robot to drive in different shapes around the classroom.

Learning outcomes

- Understand the difference between hardware and software and how they relate to each other
- Describe functions carried out by software and hardware
- Get the robot moving with code
- Learn about loops (repetition)
- Debug programs
- Identify and share problems encountered with solutions

Resources

Slideshow 2:
Controlling cars with code

Student Sheet 2a:
Electric motors explainer

Student Sheet 2b:
Controlling cars with code

Answer Sheet 2b:
Controlling cars with code

Video:
What is code?

Video:
Uploading code to your robot

Lesson 3: Where am I?

Overview

In the third lesson of this unit of work, your class will learn about the role of mapping in autonomous vehicles. They will then be challenged to make their robot vehicle follow a path using new hardware and software. Students will learn about how the line follower sensor on the mBot works, then use the sensor data and logic-based code to autonomously control their robots. Finally, they will relate this activity to real world driverless vehicles and discuss the other sensors needed to make driving efficient and safe.

Learning outcomes

- Understand why mapping is important for programming autonomous cars
- Describe functions carried out by software and hardware
- Describe how a line follower functions
- Apply logic to get a robot to follow a defined path
- Debug programs
- Identify and discuss ways of solving the same problem under different conditions

Resources

Slideshow 3:
Where am I?

Student Sheet 3a:
Explaining the line follower

Student Sheet 3b:
Coding the line follower

Answer Sheet 3b:
Coding the line follower

Video:
Where am I?

SCHEME OF WORK

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Lesson 4: What's around me?

Overview

In the fourth lesson of this unit of work, your class will learn about obstacles and sensors. They will discuss the risks that a smart city presents, focusing on the challenges that an autonomous vehicle faces while navigating in the real world. They will then learn about the ultrasonic sensor on-board the mBot and how to use it to avoid obstacles. Finally, they will think about how driving speed can influence a vehicle's ability to react to obstacles.

Learning outcomes

- Describe what smart cities are and give examples of smart city initiatives
- Describe risks for autonomous vehicles in smart cities
- Describe how an ultrasonic sensor functions
- Apply code and sensor output to navigate around an obstacle
- Debug programs
- Identify and share ways of solving problems

Resources

Slideshow 4:
What's around me?

Student Sheet 4a:
Explaining the ultrasonic sensor

Student Sheet 4b:
Coding the ultrasonic sensor

Answer Sheet 4b:
Coding the ultrasonic sensor

Video:
What's around me?

Lesson 5: Safety and signalling

Overview

In the fifth lesson of this unit of work, your class will learn about how technology and people interact. They will learn about signalling movement and giving warnings with light and sound. Students will use code to control their robot car's LEDs and buzzer to produce lights and sounds for a variety of different scenarios. They will then combine an input – the ultrasonic sensor – and an output – the LEDs and buzzer – to create a proximity sensor. Finally, they will discuss the other sensors and signals they think would be useful.

Learning outcomes

- Understand what we mean by signalling and why it is needed to keep people safe
- Discuss the best ways for robots to signal to humans
- Understand, describe and control LEDs and buzzers
- Integrate inputs (ultrasonic sensor) to outputs (LEDs or buzzer)
- Debug programs
- Identify and share problems encountered with solutions

Resources

Slideshow 5:
Safety and signalling

Student Sheet 5a:
Safety and signalling

Answer Sheet 5a:
Safety and signalling

Video:
Safety and autonomous vehicles

Image:
Comparing my mBot to a driverless car interactive

Lesson 6: What do I do next?

Overview

In the sixth lesson of this unit of work, your class will learn about some of the ways in which technology has failed in the past, and how engineers have worked to overcome those problems. They will then will look back over the hardware and software they have been using in the past five lessons and combine these skills to complete challenges. This lesson should be used as an opportunity to consolidate learning, revisit any shaky territory and experiment with combinations of inputs, outputs and different ways of coding the mBot.

Learning outcomes

- Understand that failure is an important part of technology development
- Describe how failure and persistence can help them learn
- Link a variety of inputs to a variety of outputs using code
- Debug programs
- Share learning
- Identify and share problems encountered with solutions

Resources

Slideshow 6:
What do I do next?

Student Sheet 6a:
Hardware and function cards

Student Sheet 6b:
Smart city challenges

Answer Sheet 6b:
Smart city challenges

Video:
What do I do next?

Video:
Failing is good

All resources can be downloaded from:
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Lesson 7: Designing our smart city pt. 1

Overview

In the last section of this unit of work, your class will take part in a Design Thinking Workshop that can be delivered as three one hour sessions or combined as a half day activity.

In part one of the workshop, your class will use personas to empathise with different types of people. They will then use these insights to brainstorm ways that robots and autonomous vehicles can improve lives or solve problems.

Learning outcomes

- Understand that design is a process
- Name at least one job associated with design
- Describe basic design thinking techniques
- Understand that issues affect people in different ways
- Empathise with different people and describe how they might see the world
- Think creatively to generate solutions to problems
- Share and evaluate their own ideas

Resources

Slideshow 7:
Designing our smart city pt. 1

Student Sheet 7a:
User profiles

Student Sheet 7b:
Empathy map

Video:
Design thinking

Lesson 8: Designing our smart city pt. 2

Overview

Part two of the workshop sees your class use an ideas funnel to select and refine ideas from the brainstorming activity in part one. Each group will then prototype one of the ideas using the hardware and software skills they have learned with the mBot in lessons 1-6.

Learning outcomes

- Understand what prototyping is and why it is used
- Describe a number of prototyping methods
- Evaluate and refine own ideas and the ideas of others
- Combine hardware, software and crafting skills to make a prototype
- Share learning with the class

Resources

Slideshow 8:
Designing our smart city pt. 2

Student Sheet 8a:
Ideas funnel

Video:
Prototyping

Lesson 9: Designing our smart city pt. 3

Overview

In part three of the workshop each group will discuss different ways of sharing ideas then create articles, posters, videos, photo galleries or reports to persuade their audience that their prototypes are worth taking forward. Then each group will present their prototypes and demonstrate their ideas in action using the mBot as part of a working display.

Outcomes

- Understand why sharing ideas is important
- Name at least one job associated with communication
- Identify a variety of different media and describe when each might be used
- Plan and prepare a group presentation
- Select and create an appropriate way of sharing a project
- Present and explain a group project
- Share learning

Resources

Slideshow 9:
Designing our smart city pt. 3

Student Sheet 9a:
Communicating your ideas

Video:
Communications and marketing