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| **Learning to live on Mars with the BBC micro:bit** | | | |
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| Designing and programming a device that can help an astronaut living on the surface of Mars | | | |
| **Subject(s):** Design and Technology, Computing, Engineering  **Approx time:** 80-120 minutes |  | | **Key words / Topics:**   * astronauts * BBC micro:bit * blocks * data logging * design brief * living on Mars * programming * radio signals * space travel |
| **Stay safe**  Whether you are a scientist researching a new medicine or an engineer solving climate change, safety always comes first. An adult must always be around and supervising when doing this activity. You are responsible for:    • ensuring that any equipment used for this activity is in good working condition  • behaving sensibly and following any safety instructions so as not to hurt or injure yourself or others    Please note that in the absence of any negligence or other breach of duty by us, this activity is carried out at your own risk. It is important to take extra care at the stages marked with this symbol: ⚠ | | | |
| **Suggested Learning Outcomes** |  | |  |
| * To be able to design a programmable device that can take and log temperature and light level readings. * To be able to complete a mission challenge to take readings on Mars and then find their way back to base camp. | | | |
| **Introduction** |  | |  |
| This is one of a series of resources to support the use of the BBC micro:bit in Primary Design & Technology, Computing and Engineering lessons. This resource focusses on learners designing, programming and using a programmable device to complete mission challenge to find out more about the planet of Mars. | | | |
| **Purpose of this activity**  In this activity learners will make use of the BBC micro:bit to design and create a programmable device that can be used to measure and log information during a mission on the planet Mars. They will analyse a design brief and design criteria before taking one of two routes through the activity – designing and producing the programming themselves using a template, or using a pre-written program that they can download straight onto their device and/or edit as they go through.  This activity could be used as a main lesson activity to teach about how programmable devices can be used to help us understand our solar system, within D&T, Computing and/or Engineering. It could also be used as part of wider STEM-based scheme of learning focussed on how programming can be used to embed intelligence into products and systems. | | | |
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| **Activity** |  | | **Teacher notes** |
| **Introduction (5-10 minutes)**  Teacher to introduce the activity and safety notes. Teacher to explain that learners will be producing a programmable system to complete a Mars mission challenge.  **Starter activity (10-20 minutes)**  Teacher to show the starter program to learners. Ask them to look at the code and explain what they think it does. Finally, get them to simulate and then run the code on their micro:bit to see what it actually does.  **Design context, brief and criteria (5-10 minutes)**  Explain to learners that the design context is what sets the scene for the project that they will be working on. Share and discuss the context given on presentation slide 4. Then discuss the design brief shown in slide 5 and the design criteria on slide 6. Teacher to hand out the resources and equipment required.  **Producing the programmable device (30-40 minutes depending on route taken) ⚠**  Learners can be taken through this activity in one of two different ways. Route 1 (presentation slide 7) or route 2 (slide 8).  Ensure and demonstrate safe practices when working with electronic devices e.g. ensure polarity of battery leads are correct, do not touch exposed wires, remove power if components are overheating etc.  Route 1  Learners to follow the instructions on slide 7 to open the suit-template:bit HEX file. They should then complete this template with their own code to satisfy the needs of the design brief. The teacher could show or provide access to the example program suit:bit to help them, or take them through how to complete the template step by step.  Route 2  Learners to follow the instructions on slide 8 to open the suit:bit example program on screen and then download it to their micro:bit. The main focus in this instance will be on using the device to complete the Mars mission challenges.  **Mission challenge (30-40 minutes)**  Learners to use their programmed micro:bits to:   * Leave base camp with a full oxygen tank. * Explore the Martian surface (e.g. the classroom or outdoor space set up for them). * Take light and temperature readings. * Get back to base camp when their oxygen runs low to top up, or when the mission is completed. |  | | This activity could be undertaken as individuals, in pairs or in small groups.  **Micro:bit versions**  This resource fully works with V2 of the BBC micro:bit. It can also be used with V1 if the data logging is feature is not used. With V1 an external speaker will be required if sound is used.  **Initial teacher setup**  The teacher will need to download the basecamp:bit program to the micro:bit that is to act as the base camp beacon. It provides a range measurement feature if the challenge is posed to get back to base camp before the oxygen runs out. Teachers should place this micro:bit at the location of the base camp and ensure it is transmitting the beacon signal before the main challenge begins. This will work well within a typically sized classroom.  **Starter**  Teacher could deliver this starter using the PR of the PRIMM (Predict-Run-Investigate-Modify-Make) process:   * Predict – show the code and ask students what it does. * Run – enter the code and run it in the simulator and then on the micro:bit and observe what it actually does.   **Producing the programmable device**  Learners can be taken through this in one of two ways:   * Option 1 – Learners themselves complete the suit-template file to create the code to meet the design brief, with help as required from the teacher. In this instance the main focus is the programming activity and completing a partially written program. * Option 2 – The example code is treated as pre-written and downloaded onto the micro:bits ‘as is’. In this instance the main focus is on the overall system and the use of the device in context.   **Mission challenge**  The mission challenge is for learners to leave the base camp with a full oxygen tank, explore the terrain, take light and temperature readings, and get back to base camp before the oxygen runs out. This can be set up as role play within the classroom. The teacher could also add extra tasks to complete along the way as desired.  Explain that if it is hotter, oxygen is spent faster. Also if the learner is active, oxygen is spent faster. If learners are a long way from base camp, it will take longer to get back to camp when the oxygen runs low. If learners get the X and the alarm signal, the oxygen has run out and they have failed the challenge. Explain that learners can use the logo-press to measure the distance to base camp, but if they are too far from camp they won't get a signal, and they will need to leave some 'breadcrumbs' along the way to find their way back. The beeping of the beacon will stop if they are out of range of the base camp, so this would alert them to the fact that they are a long way away. Explain that when oxygen is getting low, learners must decide whether to continue with their tasks and collect more readings and samples, or head back to basecamp and recharge their oxygen tanks, then do another run when recharged.  Teachers could leave numbered pieces of paper around the classroom/terrain that learners have to find and take readings at, so they don’t just take readings at random positions. Teachers could also place numbered boxes which have post-it notes or tokens inside that learners collect as 'samples' (evidence) they have visited ad taken readings at those places in the classroom  **Example programs**   * Starter example program - This program is for the starter activity (presentation slide 3). * Basecamp:bit program – this is the initial program to download onto the micro:bit acting as ‘base camp’. * Suit:bit example program - This program is for the micro:bit that is programmed by the learner to use during the mission to gather data and get back to base camp. The micro:bit is to be worn on the suit (or on their arm like a watch). Some aspects of this program are pre-provided as part of the suit-template HEX file, so learners can fill in the gaps. E.g. the oxygen simulator and value display code.   The simplest version of this program will make the micro:bit into a sensing device that can take readings whilst the astronaut is out on a mission. Holding A shows the temperature, holding B shows a light reading. Both use the whaleysans package built in to avoid scrolling the two digits. Teachers should explain that whaleysans only shows 2 digits and a light reading is between 0 and 255; students could either divide by 10 and round it, or use the 'map' block to map it from 0..255 to 0..99 for display as 2 digits.  The activity monitor is easy to add and acts like a step counter – every time a shake is detected, add 1 to the movement variable. This variable is used by the oxygen simulator in the template, to 'spend' oxygen at a higher rate when moving more.  The oxygen level is automatically displayed when nothing else is on the screen. Teachers should get learners to use our showValue function, as that deals with the difficulty of only displaying the oxygen reading if nothing else is on the display. Teachers could explain here that as coders in industry, they could often be expected to modify and improve existing programs, and not always be able to start from an empty page.  For more challenge the program can be modified to include radio messaging. This requires learners to store the radio range in a variable every time a new message is received and convert it using the MAP block into a distance 0..9. Then, when the logo is touched they use our showValue function to show the range to basecamp.  The most level of challenge can be found by building in the data logging feature to log the data recorded. The data must be logged at regular intervals, multiple columns must be logged, and an A+B delete-log feature must be added. |
| **Differentiation** |  | |  |
| **Basic** |  | | **Extension** |
| * Provide the suit:bit program as a set program that can be downloaded ‘as is’, or edited as required. * Produce the program in sections, with the teacher demonstrating how to do these one or two blocks of code at a time. * Give learners a partially completed template program for them to add the missing blocks of code. |  | | * Download the CSV file of your data and load into Excel - use the data to plot graphs for scientists back on Earth. * Think about how the mission challenges could be completed faster and with less trips back to base camp to top up oxygen. |
| **Resources** |  | | **Required files** icon-docicon-pdficon-ppt |
| * BBC micro:bits (V1 or V2) for learners and to act as the base camp beacon, and associated USB download cables * 3 V power supplies for micro:bits (e.g. 2 x AAA battery packs) * External speakers for sound (if using V1 micro:bits) * Computers with access to the internet |  | | icon-ppt Primary Presentation – BBC Micro:bit Living on Mars  Example HEX programs:   * Starter example program * Basecamp:bit program * Suit:bit example program * Suit-template program |
| **Additional websites** |  | |  |
| * **BBC Micro:bit homepage:** <https://makecode.microbit.org> * **How to upload HEX files to the program editor:** <https://support.microbit.org/support/solutions/articles/19000065686> * **NASA – Overview of Mars:** <https://solarsystem.nasa.gov/planets/mars/overview/> * **Space.com – Everything you need to know about Mars:** <https://www.space.com/47-mars-the-red-planet-fourth-planet-from-the-sun.html> * **National Geographic - Mars explained:** <https://www.nationalgeographic.com/science/article/mars-1> | | | |
| **Related activities (to build a full lesson)** |  | |  |
| **Starters** (Options)   * Use a mind map or spider chart to analyse the design brief and criteria. * Use the information on presentation slide 3 to analyse the starter radio program and how it works. | | **Plenary**   * Evaluate how well the device performed during the mission challenge. What went well and what could be improved? * Produce a class table of results from the mission challenge – who was the fastest to complete it and why? * Self/peer assess the completed device against the requirements of the design criteria. | |

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| **The Engineering Context** film |
| * Programmable systems are an integral part of the world we live in today. Almost all electronic devices, from smartphones to washing machines to complex aircraft control systems, rely on programmable devices for them to function. It is therefore vital for systems engineers to develop skills in using programming to embed intelligence into electronic systems. * Space exploration provides many engineering challenges that will need to be solved in order for us to travel to and live on other worlds. How will we breathe on different planets? How will we cope with different levels of oxygen and gravity? How will we grow and store food? * Radio signals are commonly used to communicate information wirelessly. Engineers working in the communications industry need to know how radio signals are transmitted and received in order to do their jobs effectively. |

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| **Curriculum links** | |
| **England: National Curriculum**  Design & Technology KS2   * apply their understanding of computing to program, monitor and control their products.   Computing KS2   * 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. | **Northern Ireland Curriculum**  The World Around us KS2   * Technology challenges of living in Space, for example, how to survive in Space. * How knowledge in science supports technological * inventions, for example, robots in Space. * Design and make models. * The effects of adding components to simple circuits. |
| **Scotland: Curriculum for Excellence**  Technologies   * TCH 2-09a, TCH 2-12a * TCH 2-13a, TCH 2-14a, TCH 2-15a | **Wales: National Curriculum**  Primary – Science and Technology   * Design thinking and engineering offer technical and creative ways to meet society’s needs and wants. * Computation is the foundation for our digital world. |

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| **Assessment opportunities** | | |
| * Formal teacher assessment of completed programs and systems. * Self/peer assessment of completed devices against the design criteria. * Informal assessment of practical skills used. | | |
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