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| **Measuring para-athletic performance with a BBC micro:bit** | | |
| Designing and programming a device that a wheelchair athlete can use to measure their performance | | |
| **Subject(s):** Design and Technology, Computing, Engineering  **Approx time:** 80-120 minutes |  | **Key words / Topics:**   * BBC micro:bit * blocks * design brief * distance * inclusive design * para-athletic racing * programming * rotations |
| **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 measure the number of times that a wheelchair wheel turns and how far it moves. * To be able to use the data logging feature of the BBC micro:bit to record the data collected over time. | | |
| **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 and programming a programmable device to help wheelchair athletes monitor and record their sporting performance over time. | | |
| **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 measure and log the number of rotations a wheelchair wheel turns and the distance it has travelled. They will analyse a design brief and design criteria before taking one of two routes through the activity – designing and producing the programming themselves 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 measure and log sporting data 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 help a wheelchair athlete measure and record their sporting performance over time.  **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). If using a V1 micro:bit the data logging feature will not be possible to add.  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 a new project. They should then write their own code to satisfy the needs of the design brief. The teacher could show or provide access to the example program wheel:bit to help them, or take them through how to write the code step by step.  Route 2  Learners to follow the instructions on slide 8 to open the wheel:bit example program on screen and download to their micro:bit. The main focus in this instance will be on the use of the device to measure the number of rotations and distance travelled by the wheelchair, and on any modelling of the wheelchair itself.  **Testing the device (20-30 minutes)**  Learners to test their device by attaching the micro:bit to a wheelchair wheel (or other as described in the teacher notes) and measuring the number of rotations and distances travelled when it moves.  They should also test the data logging feature by recording the different distances travelled to the data log.  **Checking data and plotting graphs (20-30 minutes)**  Learners to plug the micro:bit back into the computer and open the data.htm file in the MICROBIT drive to see the data recorded. They could then interpret and plot graphs from the data shown in the table. |  | 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. If using with V1 then an external speaker would be needed for the sound.  **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:   * Route option 1 – learners themselves 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. * Route 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 its use to record the measurements when attached to the wheelchair.   **Testing the device**  The micro:bit should be attached to the wheel being used for testing. This could be an actual wheelchair wheel, a bike wheel or a trundle wheel. Alternatively, teachers could produce a scale model of a wheelchair in advance of the activity for testing, or challenge learners to make their own out of card, dowels, Lego, kits etc. With the wheel:bit program, every time the micro:bit screen faces up, it adds one to a counter. Learners will need measure the circumference of the wheel being used for testing (or measure the diameter and calculate the circumference) and enter this into the code. The display then shows the number of rotations on press A, and the total distance on press B.  **Example programs**   * Starter example program - This program is for the starter activity (presentation slide 3). * wheel:bit example program – This program is for the main activity. The first part of this program, and the simplest solution to the problem set, is code that counts wheel rotations, based on the starter program. Teachers could explain how to calculate distance from the number of rotations and the wheel circumference. Also, explain that by convention we use upper case variable names to indicate something that is a constant (the CIRCUMFERENCE). Learners could also choose to code in the diameter/radius and put the maths in the code to calculate the circumference. The second part of the program adds code related to data logging. This allows data from a particular sports event or training session to be captured and analysed in the future to gain further insights.   Teachers could get students to try the standard micro:bit data logging video on the microbit.org website to understand how this works, or demonstrate clicking on data.htm on the MICROBIT drive, and looking at the numbers and the graph preview. They should also explain that if the data log fills up it needs to be cleared, and get learners to add an A+B press to delete the log.  Note that if you power cycle or press RESET, the timestamp goes back to zero, and the log graph preview will not show any data after a timestamp goes backwards, so having a 'delete log' feature is very useful.  You will need to use 'EXTENSIONS, add data logging' in order to get the data logging feature, and this won't work on a V1 micro:bit, only V2. |

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| **Differentiation** |  |  |
| **Basic** |  | **Extension** |
| * Provide the wheel: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 program for them to add the missing blocks of code. * Provide a pre-made wheelchair model for testing. |  | * Watch all parts of the microbit.org data logging video. * Download the CSV file of the data recorded and load into Excel. Use the data to plot graphs and estimate other useful information, such as speed. * Make a model of a wheelchair racer for testing the device. |

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| **Resources** |  | | **Required files** icon-docicon-pdficon-ppt |
| * BBC micro:bits (V1 or V2) and associated USB download cables * 3 V power supplies for micro:bits (e.g. 2 x AAA battery packs) * Computers with access to the internet * Excel spreadsheet software |  | | icon-ppt Primary Presentation – BBC Micro:bit Para-athletics  Example HEX programs:   * Starter example program * Wheel:bit example program |
| **Additional websites** |  | |  |
| * **BBC Micro:bit homepage:** <https://makecode.microbit.org> * **BBC Micro:bit data logging information and videos:** <https://microbit.org/get-started/user-guide/data-logging/> * **How to upload HEX files to the program editor:** <https://support.microbit.org/support/solutions/articles/19000065686> | | | |
| **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 program and how it works. * Discuss the needs of wheelchair athletes and what data they could use to help them improve their performance in different sporting events. | | **Plenary**   * Evaluate how well the device worked when tested. What went well and what could be improved? * Self/peer assess the completed device against the requirements of the design criteria. | |

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| **The Engineering Context** |
| * 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. * Engineers must be able to create solutions that are both inclusive to all and that provide benefits to wider society, such as in sports, education and healthcare. For example, supporting people with disabilities to take part in sports events. |

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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   * How forces can affect the movement and distance objects can travel. * 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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