THE ROYAL SOCIETY

# How can better coding improve the efficiency of motorised buggies against friction and gravity?

## 1. Project overview

| Duration of project |
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| 1 term minimum to cover testing (ideally repeated with different groups over the year).<br>Easily repeatable year-on-year |

Through this project students will be able to investigate how coding can be used to help a buggy to move a fixed mass in various conditions. They will discover and gain a greater understanding of simple coding techniques, learning about the effect of gravity and friction on the movement of masses. Working with their STEM partner, the students will be able to explore, implement and evaluate options for the buggies, finding the limits of what the system can manage and communicating their findings with the wider school community. Linking strongly to the curriculum, this project will enable teachers to inspire the next generation of computer scientists and engineers. Details of the investigative work required to support this project can be found in section 4.

## 2. Student involvement

This project is aimed at primary school students aged between 7 – 11, however, it could be adapted to suit other age groups and abilities. This project can be adapted to suit large groups, from clubs to whole year groups or larger, and we encourage projects to be as inclusive as possible. The project can be used to engage a wide variety of students in the school. For example:

1) older students mentoring younger years to engage with the coding and testing sections of the investigation
2) students with an interest in art and design helping to communicate the findings of the project to the wider school community via media such as video, posters etc.
3) students with an interest in design and technology helping to build the buggies and slope terrains.

## 3. STEM Partner involvement

Funding will only be offered to schools that can demonstrate a strong partnership. The partnership can either be with one individual STEM partner or a team of STEM partners. If there is a team of STEM partners, one must be identified as the lead STEM partner for the application process and must have sustained and meaningful engagement (in-person or online) with the students and teacher throughout the duration of the project. Other STEM partners in the team can support the project, if needed, to provide specialist knowledge or to help spread the time commitment and ensure the students have regular STEM partner engagement. For a term-long project such as described here, we would expect a ***minimum of 4 in-person visits over the course of the project***, undertaken by any of the STEM partners involved. The STEM partner(s) will provide the students with relevant guidance and knowledge to help them with their investigations, as well as an insight into potential careers.

The main role of the STEM partner(s) is to support the planning, design and implementation of the investigation that the students will carry out. Examples of how the STEM partner(s) could support the implementation of the investigations include (but are not limited to):

- supporting students to form their own hypotheses
- supporting students to set up their investigations following the scientific method
- helping provide secondary research sources and support the understanding of technical information

- helping with data collection and identification
- helping the development and implementation of student plans to increase the efficiency of the buggies' performance
- helping with any building or design elements

Other activities that the STEM partner(s) could get involved with are:

- arranging a visit to their place of work
- providing an introductory talk to the project group, or whole school, regarding their career and the relevance of this to the project being undertaken; and
- supporting the students end of project presentations.

Examples of STEM partners that could support this project are university or industry-based researchers, with a degree or equivalent background in a subject such as computing, engineering, and physics. Professionals who are working in engineering, programming or transport and logistics.

For more information about the STEM partner eligibility requirements and guidance on how to find a STEM partner, please read the What is the partnership page on our website.

## 4. Investigation options

The following investigations described in the plan below will underpin this project and help the students answer the project title question. Please note some of the investigations may need to take place in parallel rather than sequentially throughout the year. The individual investigations suggested may need to be adapted or altered, dependant on the school facilities and space available. Teachers can also add in additional investigations and other project elements as required.

| Project plan | Equipment suggestions |
|---|---|
| **Initial set up:**<br>Research basic principles of coding and understand how simple instructions can help control a device such as a programmable buggy (a non-computer-based activity can help the students understand how simple instructions (coding) can work and the importance of being clear and accurate).<br><br>Set up and become familiar with the coding and buggy system to be used for the main investigation. | Simple motorised and programmable buggies (crumble kits / MOVE mini buggy kit and Micro:bits)<br>Rechargeable batteries<br>Laptops if needed for coding (optional) |
| **Baseline data collection:**<br>Set up a simple slope for the buggy and explore the code needed to move the buggy from the bottom to the top of the slope. Record some baseline data on performance to use in comparison with data collected throughout the rest of the investigation.<br><br>Variables could include: distance travelled, speed of travel, direction of travel, power given to motor etc. | Ramp sets |

| | |
|---|---|
| **Secondary research:**<br>Carry out secondary research to learn about the difference between pushing and pulling masses, what effect gravity has on objects, and the effects of friction on movement and how it slows or stops moving objects. | |
| **Main Investigation:**<br>1. Investigate how coding can be used to help a buggy 'push' a set mass up a set, smooth incline. Consider variables such as speed, accuracy and power used. Before coding solutions are tested, make predictions on what is expected to be observed. As results are collected, the coding process might need to be adapted and improved to get the best results. Identify the most effective solution and see if this confirms or disproves the original predictions. Repeat for the buggy 'pulling' the mass.<br><br>2. Using the results from the previous investigations, investigate if there is a more effective solution to move the mass using a combination of pushing and pulling techniques. As before, make predictions, adapt and improve the coding and see if the results confirm or disprove the original predictions.<br><br>3. Change the roughness of the surface to investigate what affect friction has on your previous solutions, and if alternate coding can help move the mass more efficiently under these new conditions. What is the maximum load that can be moved up the slope with the additional friction? As before, make predictions, adapt and improve the coding and see if the results confirm or disprove the original predictions.<br><br>4. Investigate the change of your results if the mass is mounted on a wheeled trailer or similar. As before, make predictions, adapt and improve the coding and see if the results confirm or disprove the original predictions.<br><br>5. Investigate the relationship between battery charge and the power the buggy can exert under different condition (friction, distance, slope angle). As before, make predictions and see if the results confirm or disprove the original predictions | Set of masses (if not already available in school)<br><br>Different surfaces for ramps (if not already provided) such as plastic, and various grades of sandpaper.<br><br>Small, wheeled trailer and mountings to fix to the buggy. |
| **Wider communication:**<br>Communicate the results to the wider school community; methods could include information leaflets/posters, school assemblies, getting other years practically involved in the project, or a short film. | Please note: additional film grants towards a camera / software / microphones etc. are available to Partnership Grant holders. |

A suggestion of essential equipment and supplies needed to undertake each of the parts of the project has been listed to assist you when putting together your budget. Please also consider any relevant additional costs permitted within the scheme, such as teacher cover, essential teacher CPD and/or travel costs for project related visits. For more guidance, please read the eligibility and judging criteria page on our website.

## 5. Benefits and skills

Involvement in a long-term investigative project should enable students to have an in-depth experience of working scientifically as well as developing their general team working and communication skills.

Through this project the students will specifically learn about the principles of coding to control the movement and efficiency of motorised and programmable buggies, gaining detailed knowledge about the most effective way to manoeuvre a mass up a slope in differing conditions as well as a broader understanding of effects of friction and forces. They will learn skills in research, coding, data capture, data analysis, working scientifically and problem solving. Dependant on the exact investigations and activities you propose to undertake, there may be additional benefits and skills you can identify in your application.

## 6. Legacy activities

It is important that Partnership Grant projects are sustainable, providing long-term benefits to your students and wider school community in terms of the teaching and learning of STEM subjects.
Your legacy activities could include (but are not limited to):

- repeating the project with successive year groups
- re-using the equipment to test other slope conditions or challenges
- testing out new coding solutions
- expanding the project to include other schools in the area, loaning out the buggies and ramps to collate more evidence to compare with your own.

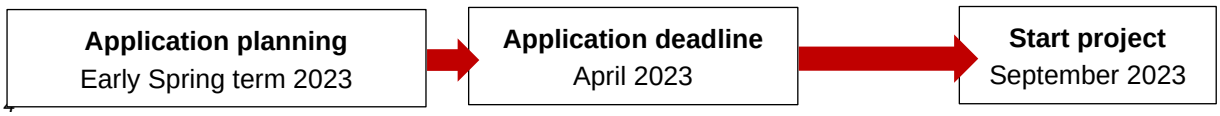
## 7. Next steps

### 1 - Securing your STEM partner

Using the information about STEM partners above, search for universities and businesses within reasonable travelling distance to you that might have suitable contacts to approach. A good route to finding these contacts is often your own school's Governors and student's parents, another is the national STEM Ambassador scheme. Once you have a few contacts in mind, write an email/letter inviting them to be involved in the project, providing clear and concise information about areas you need support with, the time commitment you are expecting, and the duration of the project. If you need further advice as to how to find a STEM partner, please contact the Schools Engagement team directly via education@royalsociety.org .

### 2 - How to start an application

This project can be started in any term, however the project should run for at least 1 term (two would be preferable or repeated each term with different groups). To get the funding secured and paid in time for the start of the next academic year, you will need to submit the full grant application for the April deadline in the academic year before. An example timeline is given below, and more information about The application process and timelines can be found on our website.



You can access the application form via the Royal Society's grant management system called Flexi Grant: https://grants.royalsociety.org/. When you first create your log-in and access Flexi Grant several grants will be visible on the screen. Please make sure you choose the ***Partnership Grants stage 1*** form to start.

### 3 - Where to get more information

You can find full information about the Partnership Grants scheme, including eligibility and judging criteria, application guidance and exemplar forms via our website: www.royalsociety.org/partnership

If you have specific questions about your project idea, STEM partner or application, please either attend one of our online training sessions or please contact the Schools Engagement team directly via education@royalsociety.org .