

James Dyson Foundation Undergraduate Bursary 2019/20

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Project Report – Supporting KS2 Teachers to Deliver Integrated STEM in Primary Schools

This project's aim was to help teachers to introduce more STEM (Science, Technology, Engineering and Mathematics) skills into their humanities, arts and science lessons. This was done by creating resources (including lesson plans, PowerPoint presentations and worksheets) that were tested with a year 5 class at St. Mary's Junior School in Cambridge and improving them so that they can be used by every school, no matter what equipment or materials they may have. Teachers are often under pressure to meet targets that the government's national curriculum and the school set out so they may not have much class time to devote to teaching STEM. Resources that 'integrate' STEM into other lessons would really help the teacher be able to meet their targets and do STEM at the same time.

The motivation behind this project is that the UK does not have enough engineers to fill the roles that keep the country growing. It is not clear why the UK's school system does not produce more engineers, but it is expected that it is caused by a range of issues. This includes that many students believe that a career in engineering is nothing more than being a plumber or electrician, but this is far from true. Engineers are not only responsible for building new infrastructure (roads, buildings etc.), but are the brains behind cars, aircraft, electronics, the internet and even medical equipment and devices such as implants and ventilators! Another addition to the equation is the gender divide in the workforce. About a decade ago, only 6% of engineers in the UK identified as women. Since then, this percentage has doubled to 12% and is still growing. By improving the representation of engineering skills and themes in schools, this project hopes to inspire the next generation of engineers!

An investigation into similar online resources that introduces STEM into the curriculum (i.e within geography, history, music etc) was taken in order to find out what teachers like about these resources and what could be improved. It was found that accessibility to equipment was a big issue for many activities; one activity found needed a vacuum chamber – not something you're likely to find in a primary school! Therefore, the project produced a range of activities that would allow more schools to be able to take part. A few of the activities from each session of the pack are described below.

Session 1 of the resource pack included a discussion about the water cycle and the importance of having clean water. Many countries in Africa often have difficulty accessing clean water which affects the whole community. Women and children are often forced to walk miles everyday to collect water for their family, meaning that they cannot work or go to school. The heavy containers of water can injure their backs and affect growth of children. Despite fetching water, it is often not clean and can be dangerous to their health. The practical activity for the first session was to make a water filter from a plastic bottle, sand, gravel and stones, as shown in figure 1. If you try this yourself, you will be amazed at how clean the water can look – just don't forget it isn't clean enough to drink!



Figure 1 – Water filter activity

The second session of the activity pack was based around dissolving and evaporation. We made a saturated solution of salt or sugar in water and left them in various places around the classroom and in different shaped containers, such as in tall thin cups or jam jar lids. The water evaporates out of the solution leaving behind an intricate pattern of crystals – try yourself and see if you can see a difference between salt and sugar crystals!

The final practical activity of the project was to build a water pump. This is a quick building activity that you can do with a few materials you will find online or in your home. Originally the design was quite complicated and needed lots of specialist tools and materials such as hand saws, drills, plastic tubing and wooden discs. With some experimentation, a new design was devised, which you can try yourself from the instructions below:

Instructions to make your water pump!

You will need:

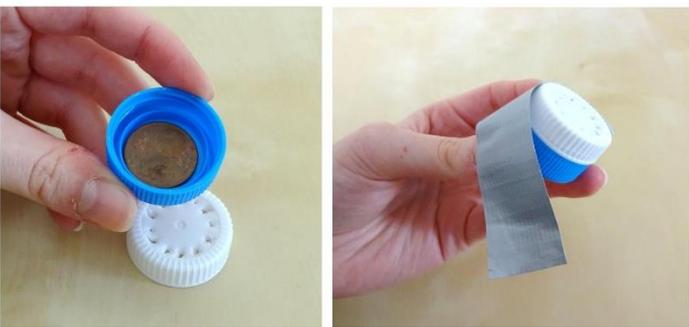
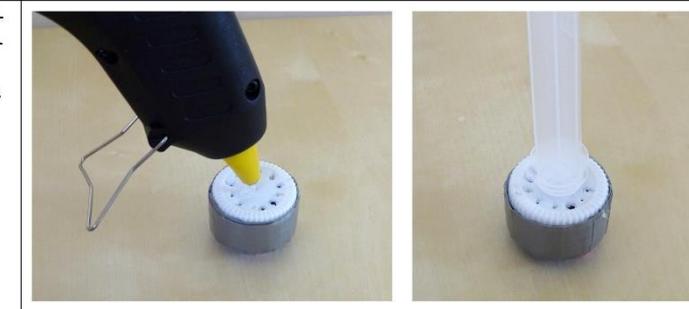
- 100ml Syringe (outer casing)
- 20ml Syringe (inner piston)
- 2x Water bottle tops
- 1p and 2p Coins
- Duct tape
- Glue gun
- Something sharp (like a compass or bradawl)

This is what it will look like! ->



1 Make a hole in one milk bottle top
You may want to make the hole bigger using a stick or pencil!



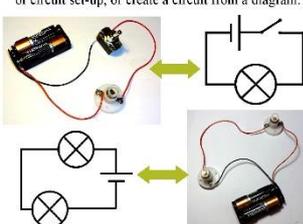
<p>2 In the other bottle top, make lots of smaller holes around the outside using something sharp</p>	
<p>3 In the bottle top with one hole, place the 1p coin. 4 Duct tape the two bottle tops together with the holes on the outside.</p>	
<p>5 Using a hot glue gun, attach the 20ml syringe inner piston to the middle of the bottle top with lots of holes.</p>	
<p>6 Place the 2p coin inside the larger syringe 7 Place the piston in the syringe.</p>	
<p>To work the pump, place it in a bowl of water with the water level reaching the top of the bottle tops (at the 25ml line here)</p> <p>Hold the pump with one hand and move the top of the piston up and down continuously.</p>	

After completion of the resources, some other areas that would integrate STEM into the curriculum were ‘mapped out’ (i.e. planned) and can be seen in the mind-maps below.

KS2 integrated STEM and Geography resource: Electricity



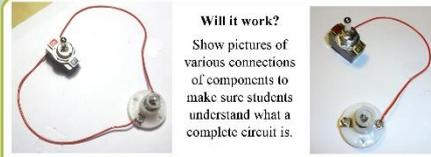
Draw the diagram!
Task the class to draw a circuit diagram from a picture or circuit set-up, or create a circuit from a diagram.



Circuit Diagrams
Y6 Science

Electricity: use recognised symbols when representing a simple circuit in a diagram.

Will it work?
Show pictures of various connections of components to make sure students understand what a complete circuit is.



Series Circuits
Y4 Science

Electricity: identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery.

Solar panels convert the sun's heat energy into electric energy. This is useful in sunny climates.



Hydroelectric power plants use falling water to generate electricity. This is useful where you have a dam or running water.



Renewables!
KS2 Geography

Human geography: including the distribution of natural resources including energy

How does an electrical circuit work?

Design
KS2 D&T

Design: use, research and develop design criteria to inform the design of innovative, functional, appealing products that are fit for purpose, aimed at particular individuals or groups

Y6 Science

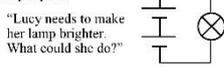
Electricity: compare and give reasons for variations in how components function, including the brightness of bulbs, the loudness of buzzers and the on/off position of switches

Design a circuit for a specific purpose:

"Sarah only has one battery pack but needs to power two lamps. Design a circuit to help her."



"Lucy needs to make her lamp brighter. What could she do?"



"Adam needs to be able to control his lamp with a switch. Design a circuit to help him."



How do we build electric circuits?

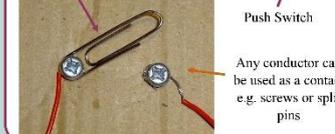
Switches!
KS2 D&T

Make: select from and use a wider range of materials and components... according to their functional properties and aesthetic qualities

Make your own switch and test in a complete circuit.



Toggle Switch



Push Switch

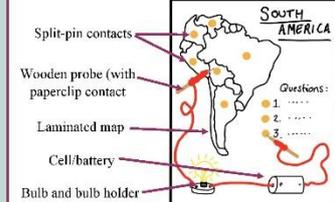
Any conductor can be used as a contact e.g. screws or split pins

Where does electricity come from?

Wiring!
KS2 D&T

Technical knowledge: understand and use electrical systems in their products.

Build an electrical map!
Reinforce geographical knowledge by integrating a circuit into a question and answer map.



Split-pin contacts
Wooden probe (with paperclip contact)
Laminated map
Cell/battery
Bulb and bulb holder

The bulb holder and battery holder can be glue-gunned to the laminated map.
Extension: build a wooden frame to support the map.

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KS2 integrated STEM and History resource: Stonehenge



Building Stonehenge required moving huge blocks of stone over long distances. Friction and air resistance makes this very difficult.

Weighty object we used sand inside a Tupperware box.

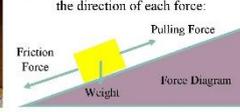


Spring Balance

Drag a heavy object up a slope with different surfaces and measure forces with a spring balance. See if you can find relationship between the force needed to move the object and the roughness of the surface.

Rough surfaces e.g. carpet, sand paper, plastic

Try and draw a force diagram to illustrate the direction of each force:



Friction Force
Weight
Pulling Force
Force Diagram

Friction and Forces
Y5: Science

Forces: identify the effects of air resistance, water resistance and friction, that act between moving surfaces

Using pictures as a reference, build a model of Stonehenge out of Jenga blocks and draw a plan view (from above) of the arrangement and label:



- 'sarsens' (the outer circle of arches)
- 'sarsen trilithons' (larger stone arches in a horseshoe shape)
- 'bluestones' (inner and outer circle of small stones)
- 'station stones' (outside the central monument)

Discuss and decide which theories about what Stonehenge was used for you think are true. Was it a burial ground or a calendar?

KS2 History Changes in Britain from the Stone Age to the Iron Age

What is Stonehenge?

Structural Materials
KS2 D&T

Technical Knowledge: apply understanding of how to strengthen, stiffen and reinforce complex structures. **Evaluate:** evaluate their ideas and products against their own design criteria.

Would you build a bridge out of ... Wood?

Why?  why not? Discuss what materials we use to build bridges and why?

Mathematical Bridge

Would you build a bridge out of ... Glass?

Introduce composite materials: they can improve their properties e.g. glass reinforced plastic or steel reinforced concrete

Riverside Bridge

Look at the design of local bridges, how do they stand up? What do you like about the design? What could be made better?

How do we move large objects?

Mechanisms
Y5: Science

Forces: recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect

Building Stonehenge involved lifting heavy stones upwards like this. You can lift heavy objects easily with levers. Try this at home by putting something heavy into a sand pit.



Lever up one side of the object using the pivot and pack sand under it.

Spatula as a lever Cork as a pivot

Repeat with the other side of the object and watch it gain height!

How do we build structures?

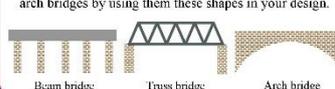
Arches
KS2 D&T

Technical Knowledge: apply understanding of how to strengthen, stiffen and reinforce complex structures

Build a bridge from Jenga blocks (or lollipop sticks and hot glue) to show how bridges support weight.



Introduce the idea of beam bridges, truss bridges and arch bridges by using them these shapes in your design.



Beam bridge Truss bridge Arch bridge

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