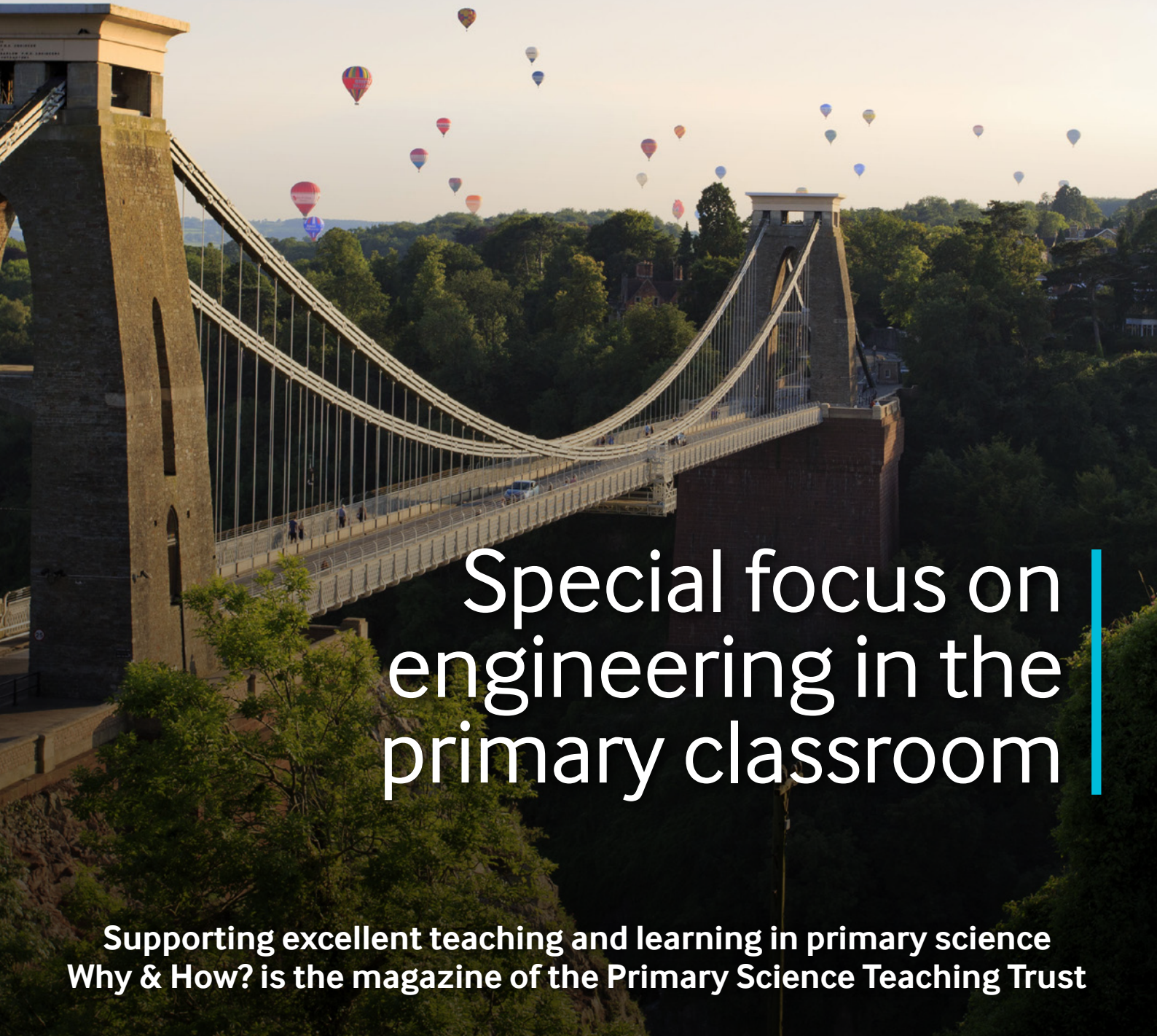
Why&How?

Magazine

Spring 2023: **Issue 17**



Special focus on engineering in the primary classroom

Supporting excellent teaching and learning in primary science
Why & How? is the magazine of the Primary Science Teaching Trust

In this issue...

Why & How? is the brand name of the Primary Science Teaching Trust

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Welcome

Welcome to the Primary Science Teaching Trust's termly magazine, Why and How? This issue has a special focus on engineering in the primary classroom.

Active engagement with engineering in the primary classroom enables children to apply their learning in maths and science to solve problems in creative and exciting ways. Opportunities to explore how things work and find ways of making improvements fosters curiosity, builds resilience and gets the children thinking like engineers, and relating this learning to real-world contexts helps them recognise and appreciate the importance of engineering to all our lives.

This issue of Why and How? contains a wide variety of resources to support teachers with bringing exciting engineering activities into the primary classroom. We are delighted to be able to include a wealth of engineering support for primary schools from many other organisations in the sector, and we thank them for their enriching contributions.

Our **picture for talk** gets the children thinking about the mechanics of how we open a door, and we highlight a whole range of other PSTT engineering-related **free resources**. In the **Explorify** section, we have picked out exciting activities that link to engineering, and in **Climate Science**, PSTT Trustee and civil engineer, Jyoti Sehdev, explains how looking closely at nature can provide us with very rewarding engineering solutions.

Two of our Fellows outline engineering related projects they have carried out in school with Royal Society Partnership Grants. David Rigmand describes how the children in his school became involved with designing and testing the UK's first artificial luge track, and Katharine Pemberton shares the story of how her school developed ways of using renewable energy sources to reduce their use of fossil fuels.

Making visible a diverse range of engineers will help all children develop an identity with engineering, and this issue contains multiple ideas and suggestions for raising awareness of the diversity of people that do engineering. We also highlight the resource '**1001 Inventions**' which brings alive and celebrates the historical contributions of less well-known engineers and scientists from other Eastern cultures.

In the **collaborator update** section, SSERC describes many aspects of its valuable work for primary STEM, including the development of a young STEM leaders programme.

The authors of our '**I bet you didn't know?**' articles have responded to teachers' feedback, and future articles will now be written specifically for children. In this issue, Julia Nash shares how scientists and engineers have developed planetary rovers that can cope with varying terrain more effectively. 'I bet you didn't know .... Weird, wiggly, crawling wheels roam Mars' has a reading age of 10-11 years.

This is the 17th issue of our magazine. We hope that it continues to be a source of practical classroom support, along with **news** from PSTT as well as from other organisations across the primary science education sector. We value feedback from our readers so please do keep us posted about what you find most useful and interesting in our magazine, and keep sharing it with anyone else who would like to receive free resources, classroom guidance, and updates from PSTT and other organisations who s upport primary science.

Primary Science Teaching Trust

Special welcome from Jyoti Sehdev, Civil Engineer and PSTT Trustee

Engineering is the foundation of our communities. Whether it's building houses to live in, designing cars to travel in, or providing us with the internet to communicate with each other, engineering is at the heart of our lives. However, many children are unaware of what being an engineer really means, often comparing it with the mechanic fixing their boiler, as opposed to the person designing nationwide heating schemes to keep us warm this winter.

I am delighted to have joined the Primary Science Teaching Trust as a Trustee, bringing with me my experience of working as a civil engineer in construction with Costain Group, as well as a focus on equity, diversity and inclusion, in my current role as the EDI Lead for the Group.

I know from my own experience in engineering that is essential to bring diverse teams together to solve complex challenges. When we are creating solutions for the public to use, I believe that a team which is representative of the end-users is fundamental to creating an accessible and meaningful project which is treasured by the community.

As a STEM Ambassador, I am committed to attracting a variety of young minds to the engineering profession. As an ethnically diverse, LGBTQ+ woman, I know that construction and engineering may not appear to be an inclusive and accepting space. That said, I am seeing a positive change in the industry, and a true desire to bring in a diversity of perspectives and experiences in project teams, and a space where people can truly bring their whole selves to work.

Engineering is fast-paced, extremely rewarding and enables you to make a real impact on people's lives as well as the world around us. As we face the challenges of climate

change, we need engineers who are environmentally focused, putting the equality of all life at the heart of our solutions. I am personally evangelical about the practice of biomimicry within engineering to achieve this, which you can read more about on page 9.

Martin Pollard
Chief Executive Officer

Sue Martin
Chief Operating Officer

Ali Eley
Outreach Director

Dr. Sophie Franklin
Research Director

Peter Sainsbury
Cluster Director

News

Glass design competition

In 2022, PSTT launched a 'Bringing Back Glass' design competition for primary children to design an object that would be beautiful and could be useful in a primary science classroom. We were delighted to be able to draw upon the expertise of an internationally renowned glass designer, Allister Malcolm, who led the recent judging panel to decide on the winning entries. Supported by the Worshipful Company of Glass Sellers of London, Allister will be creating the winning design in glass as part of the prize for both the winning designer and their school. This and other prizes for the top entries will be presented later this term.

You may have seen Allister in the recent BBC series 'Make It At Market', where he is the glass expert and mentor guiding others to success in the industry.

In choosing the winners, Allister had to consider the practicality of creating the design from glass, as well as its aesthetic qualities and the child's ideas for the object's use. Allister and the other glass experts on the panel were incredibly impressed with all the submitted ideas!

Our amazing prizes are:

1st prize

- £1000 for school to spend on science
- Design made in glass by Allister Malcolm
- A trip for the winner (and accompanying adult) to visit the factory where the design is created

2nd prize

- £500 for school to spend on science
- a microscope and science books for the child

3rd prize

- £350 for school to spend on science
- a microscope and science books for each child

The winners are:

1st Place: Heidi, aged 5, from St Bede's (RC) Infant School in Widnes

2nd Place: Max, aged 6 from St Thomas' (RC) Primary School in Sevenoaks

3rd Place (shared): Jhanvi and Diya, year 6 pupils from Sandfield Close Primary School, Leicester

Following judging, an additional prize has been offered by the Worshipful Company of Glass Sellers to recognise a thought-provoking design involving lenses that the creator hoped would keep a homeless person warm in winter.

The awardee for this prize is Arthur, aged 9, from St Mary's (CE) Primary School, Woodbridge.

The school will receive £350 to spend on science; the child will receive a microscope and science books.

We will be displaying the shortlisted finalists' designs, along with a selection from other entrants, in the summer term magazine.

Focus4TAPS CPD programme is shown to have positive impact on children's attainment in science

The Education Endowment Foundation (EEF) trial of Focus4TAPS has demonstrated that the programme had a positive impact on year 5 pupils' science attainment, with children who received the intervention making – on average – an additional two months' progress. Encouragingly, this was also true for children from socio-disadvantaged backgrounds.

Focus4TAPS is part of the wider Teacher Assessment in Primary Science (TAPS) project developed by Bath Spa University, with a long-term funding commitment by the Primary Science Teaching Trust. Focus4TAPS aims to boost primary school children's science outcomes by supporting teachers with key areas of their science teaching, such as deepening their understanding of how children progress through the science curriculum, applying formative assessment strategies, and providing appropriate levels of support or challenge for their children.

The full report is available **here**.

Professor Becky Francis - Chief Executive of the EEF - said, "This new research is an exciting contribution to the evidence base: one that increases the options available to primary schools looking to improve science attainment in their setting."

To find out more about Teacher Assessment in Primary Science (TAPS) and the associated resources, please see **here**.

PSTT offers warmest congratulations and thanks to Dr. Sarah Earle at Bath Spa University for this excellent achievement. We also extend thanks to the many teachers who have worked with Sarah over the years to support the development of TAPS and its associated resources and CPD programmes.

Primary Science Quality Mark – EEF and Wellcome funded evaluation

Findings from this evaluation of PSQM suggest that the programme can benefit schools in multiple ways. Headteachers and science subject leads taking part in the trial attributed several changes to science in their school to the programme. For example, headteachers and science subject leads reported that taking part in PSQM had raised the profile of science in their schools, with more time being dedicated to science.

The programme was well received by science subject leads. School staff said that factors which enabled them to implement PSQM effectively included support from the Senior Leadership Team in the school, support from the PSQM hub leader, and the positive attitude of staff involved in the programme. Staff time and the workload of the programme were considered the biggest barriers to implementation.

The full report is available **here**.

N.B. Due to school closures caused by the Covid-19 pandemic, the planned collection of pupil outcome data was not possible in this trial.

Through a strategic partnership with the University of Hertfordshire, PSTT has been a core funder of PSQM for ten years. PSTT congratulates Jane Turner (PSQM Director) and Helen Sizer (PSQM Co-director) and their excellent team of hub leaders and core staff at the University of Hertfordshire for the positive findings in this trial, and for the significant contribution that PSQM makes to the wider primary science education community.

Meet our Trustees

PSTT's Trustees are responsible for governance of the charity, and they provide essential support for the work we do. All volunteers, they bring a wide range of experience and enthusiasm to the board.


Fred Young (chair)


Samira Anderson


Saurabh Das


Helen Ferris


Patrick Hand


Asima Lone


Rima Nasser-Ferris


Michael Reiss


Julia Ryle-Hodges


Jyoti Sehdev


Paul Shuter

Teachmeet at the Association for Science Education conference 2023

This well-attended 'speed dating' style event enabled colleagues from across the primary science education sector to share latest thinking, resources, classroom ideas, events and more. Brilliantly organised by PSTT Fellow and Regional Mentor Sarah Eames, each contributor was given one slide and two minutes to speak. For anyone wanting a recap, or for those unable to attend, Sarah has collated all the ideas shared in this **free to access padlet**.

Fellows' Successes

PSTT was delighted to hear that one of our newest Fellows, Melanie Boyeson, was one of four key workers recognised in BBC Humberside's 'Make a Difference' Awards 2022 last term for her work with children and support for families during the pandemic. She was nominated by a pupil and parent at Newport Primary School, East Yorkshire, who appreciated the opportunities Melanie provided for enjoyable home-learning, improved wellbeing and interactions with friends during difficult times. Congratulations, Melanie!

Further congratulations go to PSTT Fellow and Regional Mentor Kulvinder Johal, who was commended in the **Science Council's** CPD Awards in November 2022. The annual CPD Awards celebrate the continuing professional development (CPD) carried out by registrants from across the Science Council registers, which include Chartered Science Teacher (CSciTeach), the category in which Kulvinder was recognised with her commendation.

In January 2023, Kulvinder was also presented with honorary membership of the Association for Science Education (ASE) 'in recognition of her outstanding contribution to the Association and to science education'. A presentation was made to Kulvinder at the ASE's recent Annual Conference in Sheffield.

Royal Society of Chemistry Awards

We are delighted to congratulate all winners of the RSC 2022 Education Awards, especially those that are specifically given for primary school science.

Each year, the Royal Society of Chemistry recognises individuals, teams and schools across primary, secondary, further education and higher education, for their exceptional contributions to chemistry education.

In their most recent awards, PSTT Fellow Caroline Skerry was awarded the '**2022 Excellence in Primary Education Prize**' for her outstanding contributions to delivering primary science teaching and supporting others to provide excellent teaching through establishing and leading the Cornwall Primary Science Share.

PSTT's Leicester Primary Science Cluster, led by PSTT Fellow Sarah Eames, was awarded the '**2022 Team Prize for Excellence in Primary Education**' for a collaborative an supportive approach to improve teaching and learning of science across nine primary schools, including practical science, raising science capital and championing diverse scientific role models.

We also send warm congratulations to Serena Parker-Sharp from Spring Grove Junior, Infant and Nursery School, who won the '**2022 Early Career Prize for Excellence in Primary Education**' for championing inclusion and diversity within the primary school classroom to allow children of all backgrounds to see themselves as scientists.

ROYAL SOCIETY OF CHEMISTRY

You can read more about all the RSC Excellence in Education Prizes awards and the winners **here**.

Climate science

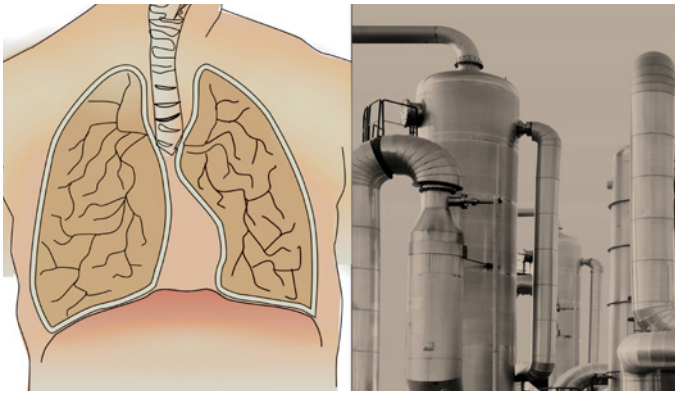
Turning to nature as our teacher

PSTT Trustee and civil engineer, Jyoti Sehdev, describes how biomimicry – using ideas from nature as models for the design of new structures and systems – can be part of the solution to some of the global challenges we are facing.

Engineers are problem solvers. We evolve our designs over and over to meet the changing needs of society. The last issue of the Why & How magazine focused on society's greatest challenge of the moment: human-induced climate change which is leading to a mass extinction of species.

Consequently, engineers are looking for ways to reduce our use of fossil fuels whilst evolving infrastructure to be resilient to the impacts of changing weather events. Perhaps we need to turn to the very species we are trying to protect, the beings that have been evolving for 3.8 billion years, to develop truly sustainable answers to these challenges.

Biomimicry is the conscious emulation of life's genius to create sustainable designs. Biomimetic design in engineering has led to the development of more efficient and lower carbon solutions. The following examples illustrate some of the recent biomimetic approaches that have been used by engineers.



Biological processes in chemical engineering

Recent climate change regulations require industrial factories to capture CO_2 as a resource instead of allowing it to enter the atmosphere. The company Saipem has taken learning from an enzyme found in red blood cells, carbonic anhydrase, which converts carbon dioxide to carbonic acid to be transported in and out of the lungs. They have developed an 'Industrial Lung', which is a carbon capture solution that uses a synthetic carbonic anhydrase enzyme to dramatically accelerate CO_2 capture.

Find out more **here**.

Structural and materials engineering

Honeybees build hexagonal honeycombs as the tessellating shape provides the most area with the least perimeter for honey storage. The honeycomb pattern also provides a high strength-to-weight ratio, enabling scientists and engineers to incorporate hexagonal designs into building applications, such as flexible panels for bridge construction, sound absorption and even building better surfboards.

Find out more **here**.

Mathematical form in automotive engineering

Japanese engineers turned to the kingfisher when tasked to reduce the noise from drag on the Shinkansen (Japanese bullet train). The new trains are designed on the beak of the kingfishers, which has evolved to aerodynamic perfection to avoid disturbing the water's surface, increasing the bird's chances of catching fish.

Find out more **here**.

Physics in mechanical engineering

Buildings in hot countries need to keep their inhabitants cool all day long. So do termite mounds, often found in desert conditions. Engineers have built the Eastgate Centre in Zimbabwe to cool itself like a termite mound, with porous walls with opening and closing vents, without needing to use expensive and energy-intensive air conditioning.

Find out more **here**.

Inspiring children to look to nature for solutions

Biomimicry and nature-based learning is a great way to engage children with different engineering challenges whilst encouraging interest in the natural world around them. "Why?" and "How?" are exactly the questions we should be encouraging children to ask about their local ecosystems. Why does that look like that? How does it grow like that? By incorporating bio-inspired learning into the classroom, we have an opportunity to inspire children to have a reverence for the life around them and a personal sense of environmental stewardship as part of their education, preparing our next generation of engineers to find truly sustainable solutions.

Free resources

Picture for talk

Click to download image

A picture can be a very good stimulus for children to engage in effective talk in science.

Using pictures is an inclusive approach which facilitates high levels of participation. Pictures can also be used as a starting point for enquiry. The discussions the children have will generate questions that they want to investigate.

Asking the children carefully chosen questions about the picture will support them with learning to:

- Construct explanations and link their ideas with evidence
- Make confident challenges to the ideas of others
- Explore scientific terminology and use it with genuine understanding

Pictures for talk in science activities are designed to be very open ended and usable with children of any age. The activities can be done as a quick ten-minute starter, or extended into a longer and more in-depth lesson.

What to do

Download the image on page 11 by following the link and either display it on a whiteboard or give out printed copies. Ask the children to discuss, in groups of three, the following questions:

What similarities and differences do you notice between the pictures numbered 1 to 4?

What would you need to do with your hand to open each of these doors?

Which door would be the easiest to open and which would be the hardest?

Why do you think this?

The children might identify that they would need to do the following to open each door:

1. Pull the metal knob upwards to release the catch.

Ask them to think about the positioning of the metal knob on the horizontal latch and what would happen if it had been put further to the left.

2. Rotate the metal ring anticlockwise.

Ask them to think about the diameter of the metal ring and what difference it would make if it was bigger or smaller.

3. Twist the doorknob anticlockwise.

Ask them to think about the difference it would make if the doorknob was bigger or smaller and to explain why they think this.

4. Push down on the handle.

Ask them to think about what it would feel like if they held the part of the handle closest to the middle where it attaches to the door compared with holding it right at the end of the handle.

After the children have shared their ideas, explain that the type of engineer that designs door mechanisms is called a **mechanical engineer**. Ask them to think about and discuss why we need door handles, and why engineers and product designers might want to keep thinking about new designs.

Other questions to generate and promote thinking and explaining

- What materials are each of the doors and handles made from? Why do you think these were chosen?
- Which type of handle do you think was most likely to have been used in the past? Which type do you think is the most recent invention? Why do you think this?
- How do door handles actually work? What do you think must be inside the structure of the door?
- If you could design a new type of door handle what would it look like? How would it work?

Note that the door mechanisms shown in the pictures are numbered 1-4 to give a very rough idea of how designs have changed over time, and this isn't to say that handles like the one shown in picture 4 were not used in earlier times, or that latches like the one shown in picture 1 are not made any more.

Follow-on ideas

The learning from this picture for talk can support learning about forces (pushes, pulls, twists) and also about levers.

Children could observe all the different kinds of door opening mechanisms they can find in the school, at home, and around and about. In particular they could identify whereabouts in the mechanism a lever is being used, and what type of force they need to use in order to open the door. They could also find out more about door mechanisms by taking apart a door handle (ask local hardware shops if they would donate some spares or old ones).

Meet Rafsan Chowdhury, a mechanical engineer, by watching this video and looking at this slideshow from PSTT's A Scientist Just Like Me resources.

The following resources support learning about levers:

Explorify activity: Have you ever moved position to get a see-saw to work better?

A guide to common misconceptions about Levers, Gears and Pulleys, with ideas for classroom activities, by PSTT Fellows Jenni Monach and Bryony Turford

Free resources

From PSTT to support engineering

The following PSTT resources to support engineering in the primary classroom are all available free on our website.

Science and STEM clubs – Engineering Our World

Created by PSTT College Fellow and Regional Mentor Kate Redhead, the Engineering Our World club introduces eight famous scientists, engineers and artists as a springboard for group-based engineering challenges. These club activities are validated by the Children's University and as such count towards accredited learning for any children taking part in the scheme.

Each club pack consists of activity ideas and a supporting fact sheet.

Engineering Our World resources could be an early step towards addressing the inequalities that currently exist between those who participate in science post-16 and those who do not. You can read more about the benefits of introducing scientists' work (historical and contemporary) in the primary curriculum with regard to **science capital** and social justice in an article **Introducing scientists to primary children: Does this always enhance children's science capital?**, published in the Association for Science Education publication, Science Teacher Education.

Chain Reaction

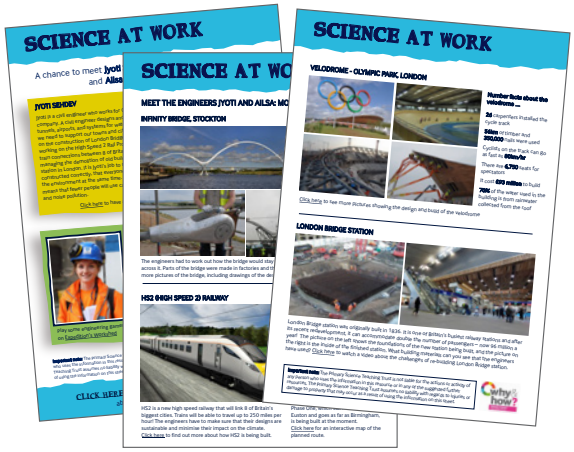
The Chain Reaction project provides children with the opportunity to design, test and refine their own chain reaction ideas, by applying simple engineering skills and an understanding of forces. The notion of cause and effect is familiar to most children and their own life experiences will have provided many examples ever since they dropped things on the floor as babies. Chain reaction harnesses children's natural curiosity and encourages them to explore the consequences of different actions. They start by rolling cars down a ramp to knock over dominoes that have been set up on their ends in a line, so that they then fall over one by one. The children can then add further components to develop a mechanical chain reaction where the movement of one object leads to that of another and then another. The chain is limited by the number of components that are available, and by the skill of the creator to arrange them in such a way that sufficient energy from one component is passed to the next to enable it to move.

Click **here** for more information about running a Chain Reaction activity in your school and to download the free booklet, written by Sue Martin (PSTT COO), Peter Sainsbury (PSTT Cluster Director) and Caroline Galpin (PSTT Fellow).

Meet a structural and a civil engineer in Science at Work

Find out more about **what structural and civil engineers do** in this video with Ailsa Roberts and Jyoti Sehdev. Click **here** for the activity sheet for children to learn about the two engineers; there are links to related topics and activities, and a further information sheet about actual engineering projects they have been working on is available **here**.

Children might like to find out more about Isambard Kingdom Brunel, the civil engineer responsible for the design of numerous ships, railways and bridges, including the Clifton suspension bridge (as seen on the cover of this magazine). The Brunel activity sheet and video can be accessed **here**.



Science at Work activity sheets and videos were created by Ali Eley (PSTT Outreach Director) through a collaboration between the Primary Science Teaching Trust, **Spectrum Drama** and **St. Mary's University** to provide opportunities for children to 'meet' past and present scientists and to learn more about people who do jobs that use science.

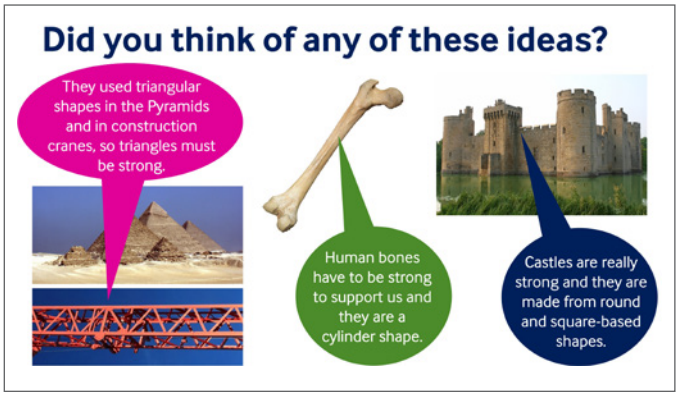
Click **here** to find out more about Science at Work.

The resources consist of a set of six activity sheets to accompany videos in which past scientists (played by an actor) and present scientists talk about their work and answer questions submitted by children. Although there is no longer an opportunity for children to submit their questions, it is worth encouraging them to think of what they would like to ask, as they are quite likely to hear a similar question answered when they watch the videos.

Paper Towers investigation from Starters for Science

Find out how the shape of a building affects its strength with this **Paper Towers investigation**, introduced in a video with PSTT Fellow Alex Farrer.

The video encourages children to think about what they already know about the shapes and strengths of different structures.

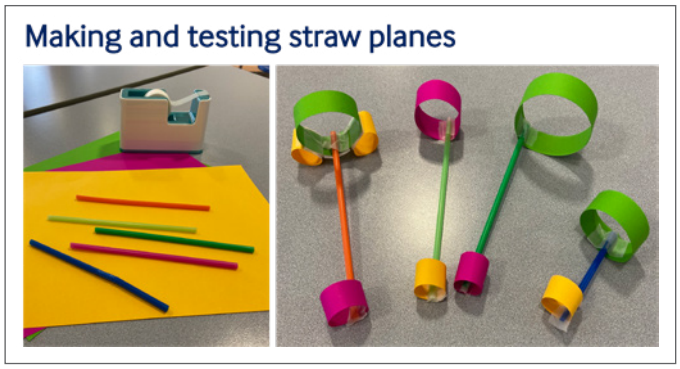


Starters for Science is a series of five-minute videos created to support teachers to get started with practical science enquiry. They require minimal resources and can be used in school or at home. This means that teachers can do science enquiry with a class and any children who are at home can do the same lesson.

Each video includes:

- A question or scenario related to the real world
- Time for children to think about what they already know
- A demonstration of a starter practical activity
- Time for children to think of their own questions
- Ideas about what they could find out for themselves
- Encouragement to share what they found with others

Please note that the videos are designed to get children doing some simple practical science enquiry and as such are not age specific, nor directly aligned to any particular curriculum unit. They are intended to give children valuable practical experiences that they will then be able to draw on once they meet the relevant concepts in a more formal learning situation.



Other Starters for Science videos that are linked to engineering include:

- Straw planes
- Falling paper
- Levers and catapults
- Spinning paper
- Floating boats

The **Starters for Science** videos were created by PSTT Fellows Ali Eley, Kate Redhead and Alex Farrer, with contributions from other Fellows in the PSTT College.

Find out more about different engineers with slideshows from A Scientist Just Like Me

Click here and search for 'Engineering' to find slideshows about the lives, work and interests of lots of engineers, including the people pictured here:

Gunay - corrosion engineer

Edward - software engineer

Erusa - innovations engineer

Raquel - renewable materials engineer

Kath - civil engineer

Danial - mechanical engineer

A Scientist Just Like Me is designed to raise awareness of diversity in science-related jobs and to provide illustrated examples of a wide range of science-based careers. It consists of a series of short slideshows, each one 'telling the story' of a particular scientist or person working in a science-related job. The resources focus on the skills, attitudes and habits that are needed to carry out the work, rather than on any expert knowledge, which may be daunting or seem out of reach to children.

At the end of each slideshow, the children are encouraged to imagine and discuss what it might be like to do that job.

The slideshows are intended to be used as discussion prompts, guided by a teacher. They can be used in different ways and for different purposes, for example,

- to show children an example of someone from a particular ethnic background working in a science job
- to challenge gender stereotypes about science jobs
- as part of a science topic that relates to the work of the scientist
- as stand-alone fifteen minute discussion activities
- with a small group or the whole class, or in a whole school assembly

Where appropriate, the final slide includes suggestions about possible linked resources that teachers may find useful.

The **A Scientist Just Like Me** resource was created by PSTT Fellows, Kulvinder Johal, Alison Trew and Ali Eley.

Whole school engineering-related challenges from PSTT, CLEAPPS and SSERC

Design a marble run

Visit **CLEAPSS for all the resources**. NB you will need to log in to access them but this shouldn't be a problem for most schools in England, Wales and Northern Ireland as they will have membership via their local authority. To find out if your school is a member and to receive your CLEAPSS ID and password, please email **membership@cleapss.org.uk** with your school name and postcode.

Build a rubber band car

Encourage the children to work scientifically to design and make a car and then experiment to find out how they can get it to go further, e.g. by changing the size or position of the wheels. This activity works well as a class, year group or whole school challenge. Download the activity sheet **here**.

Design and launch a paddle boat and a distress rocket

Use this **series of short videos**, created by the primary team at **SSERC**, to get started with some practical science and engineering activities based on the story of the Titanic.

1001 Inventions

1001 Inventions brings alive the historical contributions of less well-known engineers and scientists from Eastern cultures. Their fascinating and varied stories help all children to build an identity with STEM subjects. PSTT Fellow and Area Mentor, Michele Grimshaw, shares one of these stories here.

The next time you travel by car or public transport spare a thought for the engineer who made this possible. The names usually associated with mechanical engineering are those of George Stephenson, James Watt, and Nikola Tesla to name a few. However, the foundation for some of their discoveries lies with a Turkish engineer born in 1136CE.

Ismail Al-Jaziri was interested in making and designing machines from a young age. He had a creative imagination which led to him designing some amazing, automated creations. He recorded all these in 'The Book of Knowledge of Ingenious Mechanical Devices' which was published in 1206 and is still available today.

An artistic depiction of Al-Jazari by Ali Amro (@1001inventions

One of Al-Jazari's greatest contributions to the modern world was the invention of the crankshaft, which allowed continuous rotary motion to be converted into linear motion, and is central to modern machinery such as the steam engine and the internal combustion engine.

Al-Jazari is also credited with the development of the oldest known mechanical water supply system using the first known crank-slider mechanism. This was established in Damascus in the 13th century, providing water to hospitals and mosques in the city.

Linking science with history and culture, 1001 Inventions challenges the notion that STEM disciplines are exclusive to the Western world, and support children to develop an appreciation of a shared human heritage.

Find out more about 1001 Inventions **here**.

Explorify

Explorify and engineering

Lots of Explorify activities support children to think like engineers and to learn more about the role of engineering in the world around them.

Burly bridges **Age 5-7**

See what the children notice about the shape and construction of these three railway bridges, each made of a different material.

VIEW HERE

Unusual house **Age 5-7**

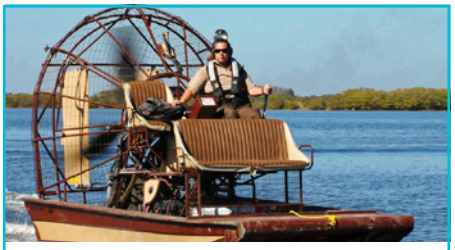
Get the children discussing how homes are designed and built and the different materials building methods that might be used.

VIEW HERE

Mighty magnets **Age 7-9**

Find out how engineers have used knowledge about super-powerful magnets to sort and recycle metals.

VIEW HERE



Moving propellers **Age 7-9**

Challenge the children to find similarities and differences between these three propeller-driven machines.

VIEW HERE

How can the wind help us? **Age 7-11**

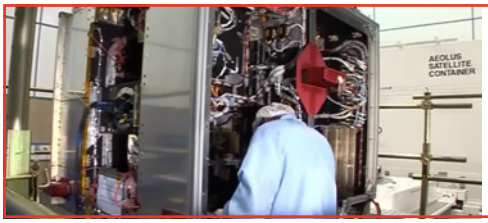
Get your class thinking about wind turbines with this fun investigation.

VIEW HERE

Moving bridges **Age 9-11**

Bridges are incredible feats of engineering, and where they span busy waterways, moving parts are sometimes used. Get your children talking about how the bridges in these images make use of levers, pulleys and gears to enable them to move.

VIEW HERE



Space engineer **Age 9-11**

Find out more about the life and work of a space engineer.

VIEW HERE

New activity type – Who is ...?

We continue to add activities that celebrate the lives and work of a diverse range of scientists and engineers. Our new activity type, Who is ...? encourages children to look closely at an image comprising a scientist and a picture that depicts the nature of their work. They are prompted to suggest what kind of science they are involved in and when they lived. The activities are linked to curriculum learning, and are designed to inspire children to consider STEM subjects (science, technology, engineering and maths) as potential career choices.

Chi Onwurah?

Age 7- 9

Before becoming an MP, Chi Onwurah spent over twenty years working as an electrical engineer. Her goal in life is to 'make life work better for people' and she believes that engineering is the most caring profession.

VIEW HERE

Charles Macintosh?

Age 5-7

Charles Macintosh was a Scottish chemist who used his science skills to solve a very common problem – how to stay dry in wet weather. Children could take inspiration from him and try to find ways of making and testing their own waterproof fabric.

VIEW HERE

Kiara Nirghin?

Age 9-11

When Kiara Nirghin was only 16 years old, she wanted to help farmers in South Africa because the droughts were causing their crops to fail. She used her STEM skills to create a biodegradable super absorbent polymer (SAP) which helped soils retain water.

VIEW HERE

Find out more about how to use Explorify activities to celebrate the life and work of different scientists with this helpful read.

The power of Explorify – free CPD sessions!

Join our half hour online sessions, or watch the recordings, to find out how Explorify can:

- Help develop long term memory
- Enhance whole school events
- Build science capital
- Develop thinking, speaking and listening skills

You can book to join a live session, where you will have the opportunity to ask questions and find out more from the Explorify Engagement Leader running the session. If you cannot attend live, don't worry as all the sessions are recorded and you can access them at any time. Upcoming sessions include:

Building Science Capital

Tuesday 7th March 2023, 16:00-16:30

This session will look at the Primary Science Capital Teaching Approach (PSCTA) and how you can use Explorify activities to support this. The PSCTA aims to broaden the ways in which science is represented, by valuing what all children bring with them and by connecting science with children's identities, experiences and what matters to them and their communities.

Register HERE

Developing Thinking, Speaking and Listening Skills

Wednesday 19th April 2023, 16:00-16:30

In this session, we delve into how and why regular use of Explorify activities can develop children's 'higher order' thinking skills and improve their confidence, relationships and vocabulary.

Register HERE

Click here to download recordings of past Explorify planning support sessions.

Keep in Touch!

Let us know what you think about what's new at Explorify as it will help us as we create more great activities and supporting materials for CPD. Contact us using Twitter, Instagram or our Facebook staffroom.

Royal Society Partnership Grants

A teacher's experience

Katharine Pemberton
PSTT Fellow and Area Mentor

The Royal Society's commitment to science goes back several centuries.

Since its conception, following a lecture by Sir Christopher Wren in 1660, the Royal Society has counted some of the most famous scientists among its Fellows: Isaac Newton, Charles Darwin, Michael Faraday, Rosalind Franklin, Dorothy Hodgkin and, more recently, Elon Musk. Its Partnership Grant scheme offers the chance for you and your pupils to carry out your own scientific research and, in doing so, become a small part of the work of the world's oldest scientific academy.

If you have never heard of the Royal Society's Partnership Grants, its website provides comprehensive information on the projects and how to apply for them. In this article, I'm going to share my own experience of the scheme and hopefully encourage you to take part in it. My pupils and I recently submitted our final report and the experience gained from the project was unexpectedly varied and rewarding.

The children's experiences were just like those of real scientists, all the way from collecting and interpreting data to sharing their findings with others at a conference.

Background to Partnership Grants

The Partnership Grants scheme, which is open to primary and secondary schools in the UK, provides funding to run scientific research projects with the support of professional scientists. A more recent extension to the scheme, 'Tomorrow's climate scientists', focuses more specifically on research relating to climate change and biodiversity. As it says on the Royal Society website, "The programme aims to give students not just a voice but an opportunity to take action themselves to address climate and biodiversity issues." This sounded great to me, but I didn't know where to start.

Turning your idea into a project

What's stopping you?

I knew what skills I wanted my pupils to take away from a project, but I had no idea how to go about planning one. I wasn't sure what counted as a Partnership Grant project - how long it should last, how challenging it should be, and more importantly, I had no idea how to get a STEM partner involved.

I had decided to apply for a grant when I noticed how responsive my pupils were to news stories about climate activism. They engaged with Greta Thunberg and were inspired by seeing other young people speaking to government and sharing their views. However, it was also clear that my pupils were not very sure about what the climate protests were demanding. Whilst they knew they were about campaigning to those in power about climate change, they didn't know what they would

want governments to do if they themselves had a voice. The message they were taking away was how to flag up discontent rather than how to try to be part of a solution and I hoped to change that. I wanted them to learn a bit about taking an overwhelming problem and breaking it into manageable steps. We teach this all the time in maths lessons but rarely in real world situations.

At this stage, my first step was to come up with a question. My initial idea was, "Could we use renewable energy to provide the electricity for our school?" I knew that the children had heard of wind turbines and solar panels, so renewable energy seemed a good place to start. My advice to anyone at this stage, where you have the seed of an idea but not much more, is to contact the education team at the Royal Society. They can help you by advising on whether your idea is likely to be supported by their funding panel and can guide you on how to improve it based on their past experience. They helped me improve my initial idea and I was then able to come up with the smaller questions that would form the steps of our investigation. My title became, "How can we reduce our school's use of fossil fuels by generating renewable energy on site?" This big question acted as an umbrella over a series of smaller questions that formed the manageable steps we needed:

- How much fossil fuel does our school use?
- How much electricity could we generate from wind energy?
- How much electricity could we generate from solar energy?
- How much renewable energy could be stored and used on site?

The questions other primary schools have used can be found on the Royal Society website and their range is diverse, for example: Why are the earthworms such an important part of our world? What would be the impacts of growing green walls on our learning and well-being in our school? and How can science help us investigate the impact of humans on our shoreline?

Approaching a STEM partner

You need to have a STEM partner before you submit the first part of the application and, for me, the thought of finding one was the most daunting part of planning a project. I had decided upon the topic but didn't know anything about current research in that area. I began by searching key words on the internet to find out the technical name of the area of research. My next step was to look at the websites of STEM organisations to see whether they had a group working in that field. I started with universities in our county and was lucky enough to find a relevant department at the University of Exeter. I wrote to them, and whilst the first person that I contacted was unable to help, he put me in touch with the scientist who was to become our STEM partner.

If the idea of writing a 'cold calling' letter to an unknown scientist and asking for their help worries you, then you need to remember that the Royal Society is famous and well respected. This means that if you approach a STEM professional, they will already know the organisation and are likely to be keen to be associated with it. Some scientists are inherently interested in sharing their ideas with the public through outreach activities. However, in recent years, the pressure for all scientists to do so has increased. Organisations that provide the funding for scientific research often have a formal requirement for outreach work, including engagement with schools. This provides a great incentive for a STEM professional to get involved in your project.

What is the STEM partner supposed to do?

Figure 1

Figure 2

Our industry partner was Andrew Mitchell. He works at the Centre of Energy and the Environment at the University of Exeter and is an expert in the field of energy use and renewable energy. As well as showing children potential career opportunities, working with a STEM partner provides them with the experience of working like a scientist, with a scientist. For this to really work, it is important that you plan for the STEM partner to be actively involved with the children and their work, not just acting as a teacher's advisor. However, the exact role of the partner may vary, depending on the stage of the project. At the start of our research, Andrew advised me on the equipment I would need (Figs. 1&2), where to buy it and how to install it, allowing me to come up with a budget for the grant. Once the project had begun, he gave workshops to the children explaining

Figure 3

the importance of renewable energy and answering their questions. Later, he taught us how to process and interpret our data, whilst in the final stages, the roles were reversed: the pupils presented their own findings to Andrew, and he asked the questions. At the end of the project, Andrew said, "On a personal level, I found the project hugely rewarding: being able to pass on some of my experience of setting up equipment to others; talking through the concepts and findings with the children and seeing how engaged they were in the whole project."

Should you bother?

It is undeniable that for you, the teacher, the project is likely to take up quite some time. However, the rewards are huge and the experience for your pupils is hard to beat. Our project encouraged pupils to act as real scientists in ways not covered in normal school science: they collected and analysed longer-term data sets (Fig.3) and learnt about the strengths and weaknesses of renewable energy. From the STEM professional, they learnt how to explain climate change and interpret data sets (Fig. 4) and, most importantly, they presented their research in termly updates to the rest of the school, to our local MP and to other schools. In doing so, they become scientific ambassadors who had to share their research and use it to deliver a message.

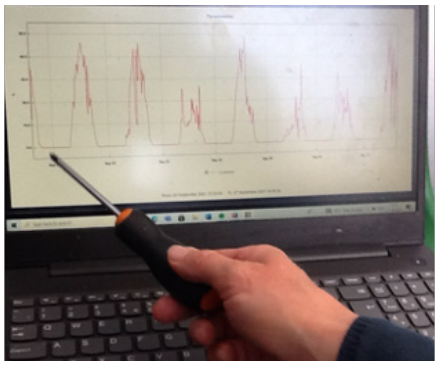


Figure 4

The experience was valued in different ways by different children: some felt the highlight had been learning more about climate change; some valued the applied maths skills they had developed and others said that they had learned how to present both sides of an argument. All the children commented that one of their favourite parts had been presenting their work to others and being listened to.

As a teacher, watching the children represent themselves and their science, at first nervously and later with growing confidence, was incredibly rewarding. They began to see lists of numbers and graphs as tools to support their own understanding and arguments. Through the project, they started to become critical scientists who now have the belief that there are solutions to tricky problems and that they can be part of them.

The Royal Society's motto is 'Nullius in verba' which means 'take nobody's word for it' (I am told!). I urge you to apply for a Partnership Grant as a way to teach your pupils to think critically and to give them the belief that they do not have to take other people's word for it. Their 'agency' and voice may work towards solving some of the world's problems in the future.

You can watch Katharine's project video on the Royal Society website here.

Designing the UK's first artificial luge track.

College Update

David Rigmaund
PSTT Fellow

PSTT Fellow David Rigmaund describes how his school was involved in the design of the UK's first ever artificial luge track.

The children completed multiple thought-provoking investigations linked to properties of materials, aerodynamics and fitness. Replicating the processes of combining materials to manufacture the luge ramp by carrying out virtual welding and chocolate welding were particular highlights. This exciting and innovative collaboration between Todholm Primary and five other Renfrewshire primary schools, Glasgow Caledonian University (GCU) and the Royal Navy was supported by a Royal Society Partnership Grant.

The opportunity to collaborate with Glasgow Caledonian University and the Royal Navy to design the United Kingdom's first artificial luge track gave children in six primary schools an exciting real-world problem to solve. This cutting-edge creation will allow luge athletes to train for the sport in the UK, enabling UK athletes to enhance their competitive edge.

The children learned more about luge as a sport, and the unique design features required for a luge track. They carried out material testing in the classroom as well as visiting the university to observe the design processes used. A distinctive part of this approach was that children experienced elements of further education at primary level, which supported the development of their science capital, and helped them explore some of the skills required for future career pathways.

The children were guided throughout the process by a combination of digital and in-person workshops with the Royal Navy and students from Glasgow Caledonian University. In these sessions, they were challenged with experiments that would develop their understanding of the science behind sport and engineering. Specifically, they had to find out more about the factors luge engineers need to consider when they are designing a track: welding, construction, coding and electronics. The children's motivation in these workshops was high as they knew that the skills that they acquired would be immediately useful in the project.

Investigation highlights

1. Properties of materials

Exploring properties of materials in settings that are familiar to children allowed them to make connections with the actual welding metals being used. By welding chocolate, they gained an understanding of the importance of changes of state to the manufacturing process, and subsequently learned more about the metals that are used to form the luge ramp.

Chocolate welding with Dr Munoz

2. Angle of luge ramp descent

The children investigated different angles of descent to find the optimal angle for the fastest speed and the longest distance over a set course. They discovered that the slope on a natural luge track is no greater than 1.5 percent (about 1°), meaning that for every 30 meters of track, the maximum elevation change is 45 centimetres. Speeds can reach up to 80 kilometres per hour.

Luge ramp design and descent

The project culminated in schools visiting Glasgow Caledonian University for the big reveal of the new luge ramp to the Royal Navy and the luge athletes. The children collaborated with other schools on the day and the recognition by everyone of their part in the process, including in press coverage from ITV news, gave them a huge sense of pride and agency.

Luge ramp launch tests

Launch event at GCU – Todholm pupils

Key pointers for doing this type of project

- Being involved in a real-world problem solving where the children's ideas were making a genuine contribution is highly motivating for the children and builds their science capital.
- Working with a nearby university was invaluable as it showed children first-hand some of the careers people have in STEM.
- It would be beneficial to organise more events throughout the year in which the schools involved come together to work together on the experiments, rather than just meeting at the end.
- An online platform for the schools to collaborate about their investigations would also be helpful.
- For more information about Royal Society partnership grants click **here**.

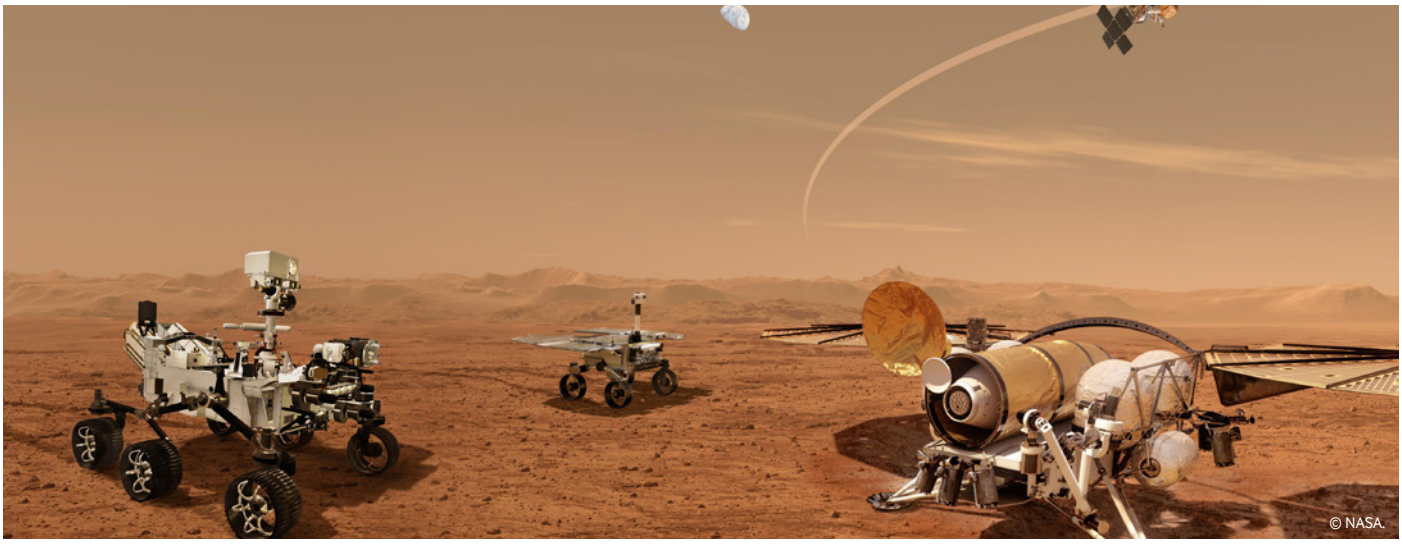
Find out more on Glasgow Caledonian University's website

Read about the project in the local newspaper

Check out the project on Twitter

I bet you didn't know

Weird, wiggly crawling wheels roam Mars



Concept image of future Mars exploration.

Dr. Julia Nash
PSTT Fellow
julia.nash@pstt.org.uk

GLOSSARY

NASA - the 'National Aeronautics and Space Administration', a government organisation in the United States that is responsible for science and technology related to air and space

rover - a vehicle designed for exploring on a moon or a planet

What is the surface of Mars like? How would you drive across it?

The surface of the Moon and Mars are like a sandy bank. Scientists have been designing motor vehicles (**rovers**) that can drive on these surfaces. The best rovers have wheels that wiggle.

What happens if you ride your bike or your scooter up a sand bank?

It is tricky! You and your bike or scooter might get stuck. This happened to a **NASA** Mars rover called Spirit. In 2010, it became stuck in a sand trap and the mission was ended (Figure 1).

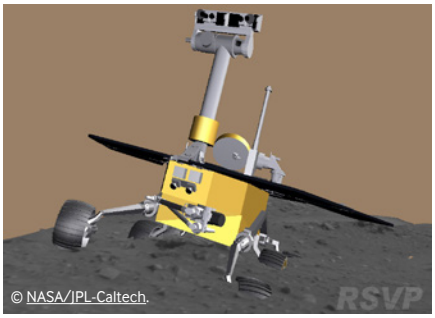


Figure 1. A computer-drawn picture showing how Spirit's wheels became stuck in soft material on Mars.

Have you seen a car trying to move in wet mud or loose sand? What happens?

Have you tried walking, driving, or riding a bicycle in sand? Why do you think it is difficult?

Have you found ways to make moving this way easier?

For many vehicles driving on sand or mud, the wheels spin, slip and sink. Mud or sand builds up all around the wheels. The same could happen with a rover.

How do planetary rovers move?

Rovers have six wheels attached to large **limbs** that rock up and down (Figure 2). These are called the rockers. The force pushing down into the ground is the same through each wheel. This means that the rover can move over large, solid objects of up to 40 cm without getting stuck. This is great for firm ground, but not on loose, sandy ground when the wheels spin, slip and sink.

Why is it important to redesign planetary rovers?

Rovers must travel over uneven, dusty ground, known as **regolith**. The risk of the wheels getting stuck is great. If this happens, the rover will not be able to travel far from where it has landed. Scientists will only be able to collect information from a small area.

Scientists need reliable rovers that can travel long distances. Then we will learn more about moons and planets in space.

How did engineers solve this problem?

To solve the problem of getting stuck on different surfaces, NASA engineers suggested that the way the rover moved over these surfaces could be changed by a computer. There could be different ways of moving on different surfaces.

GLOSSARY

limb - a structure like a leg or an arm

regolith - a layer of loose solid material covering the surface of a planet

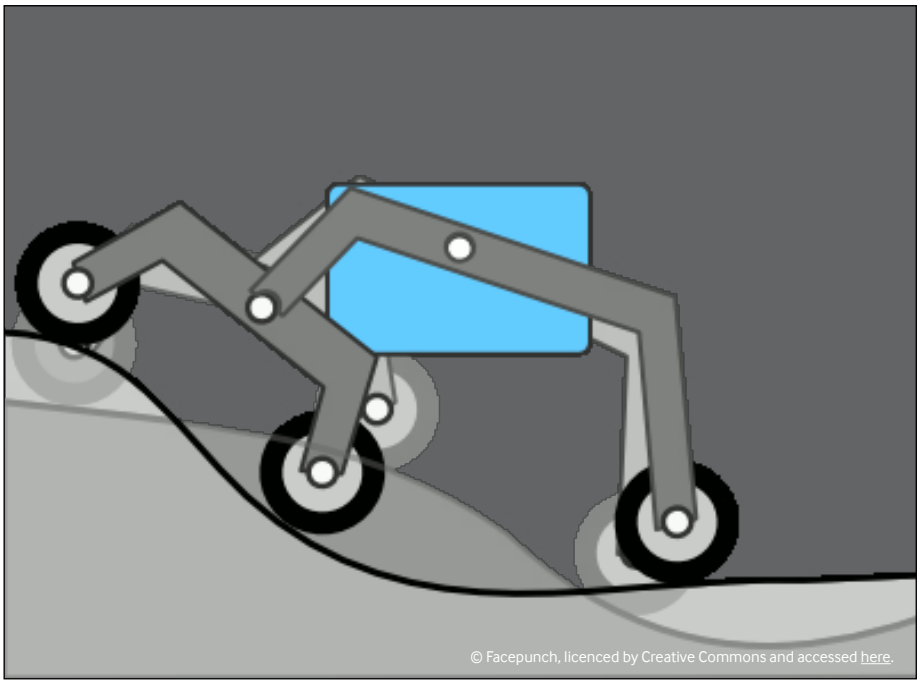


Figure 2. The Rocker-bogie system for a rover.

Scientists in Daniel Goldman's laboratory worked with NASA engineers to create small model rovers (Figure 3). The 'Mini Rover' has limbs that can lift the wheels up and down, and wheels that can wiggle as you can see in this **film**. This allows the rover to crawl and swim through loose sandy material. Think about the moves you make when you swim through water to move faster or change direction. This is what the Mini Rover can do in the sand.

The Mini Rover was tested on dry poppy seeds because they are non-sticky and they do not cause damage to the rover. It was also tested on wet sand. Each wheel of the Mini Rover was computer-controlled to create different paddling movements. The Mini Rover can 'swim' uphill on slopes of up to 15°.

Why do you think scientists and engineers make models?

What are the advantages of making models? What might be the disadvantages?

How did the engineers test their ideas using model rovers?

More tests are needed to make sure that a full-size rover can travel across a wide variety of surfaces. The weight and size of the rovers will affect how these vehicles move on Earth and on Mars.

Why is this research important?

Scientists use rovers to take photographs on the Moon and Mars, to collect information relating to the weather and the types of rocks there, and to take samples of the surface. Since 1970, four rovers have landed on the Moon and six on Mars. If rovers can move reliably across tricky surfaces, scientists will be able to get more information about the unexplored areas of these places.

You can find out more about the Mars exploration here and practical activities are described in the accompanying **Teacher Guide**.

What next?

As rovers explore new areas, scientists may identify signs of life on Mars. When scientists know more about what it's like on Mars, they could prepare for humans to explore there (Figure 4). Rovers could also be used on Earth to explore places that are hard for humans to visit.

What can a rover do to find out more about a planet?

Where do you think that rovers could be useful on Earth?

Figure 3. The Mini Rover.

Figure 4. An artist's impression of what it might look like if humans live on Mars.

The paper that inspired this work was:

Material remodelling and unconventional gaits facilitate locomotion of a robophysical rover over granular terrain.

By Siddharth Shrivastava[1], Andras Karsai[2], Yasemin Ozkan Aydin[2], Ross Pettinger[3], William Bluethmann[4], Robert O, Ambrose[4], Daniel I, Goldman[2]

Published in Science Robotics Vol. 5, Issue 42 (2020) **DOI: 10.1126/scirobotics.aba3499**
Last accessed 27.10.22

1. *School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, USA*
2. *School of Physics, Georgia Institute of Technology, Atlanta, USA*
3. *Jacobs Engineering Group, Houston, USA*
4. *NASA Johnson Space Center, Software Robotics and Simulation Division, Houston, USA*

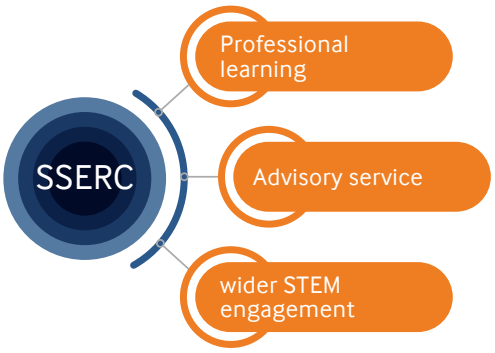
Collaborator update

What can SSERC do for you?

PSTT supports primary science in Scotland through a strategic partnership with SSERC. While SSERC's core purpose is to support teachers and schools across Scotland, they also engage in wider programmes and have much to offer across the UK.

This article describes SSERC's key programmes and activities, and it also highlights how anyone, wherever they are, can access its resources and support.

SSERC is a membership-based organisation, a company limited by guarantee and a registered Scottish Charity, based in Dunfermline, and set up for the benefit of Scottish education with all 32 Scottish local authorities as members. SSERC offers a broad range of services, supporting all areas of the STEM curriculum, which can be broken down into three strands of activity: professional learning, advisory service, and wider STEM engagement.



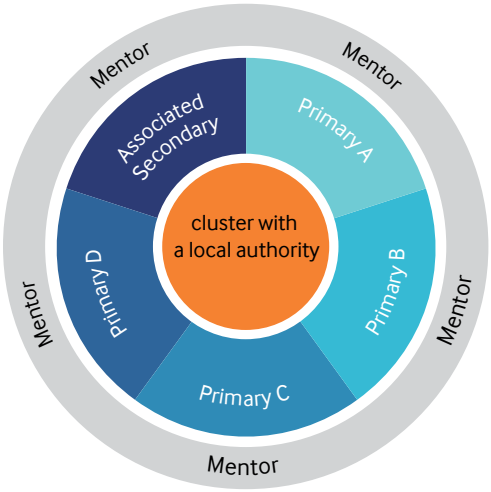
Through these strands, SSERC aims to inspire, enthuse and support STEM educators for the benefit of all learners. This article will focus on how SSERC supports Early Years and Primary practitioners.

Professional Learning

SSERC's Early Years and Primary Professional Learning (PL) offers hands-on, experiential activities to enhance the learning and teaching of all STEM curricular areas, demonstrating progression from Early Years to 2nd level Curriculum for Excellence (CfE). A full overview of our offers can be found on our professional learning calendar (see QR codes on page 30). These activities include:

- Live open SSERC Meets
- Online self-study courses
- Day courses
- Residential courses
- ENTHUSE-funded courses

The Primary Cluster Programme (PCP) represents the team's key offer. Through PCP, SSERC works with selected local authorities to offer teachers within a cluster (including their associated secondary school) opportunities to build their knowledge, skills, confidence, and expertise in STEM. Each cluster school nominates a teacher to take on the role of a SSERC STEM mentor. This group of mentor teachers then work together to design and implement a bespoke programme of PL for all teachers in their cluster, supported by SSERC.



The programme is supported by funding from Scottish Government, PSTT and the Edina Trust. Clusters from all 32 local authorities have taken part in the programme and the funders are committed to supporting the programme through 2022-23.

Live Open SSERC Meets are open for application to any educational setting across Scotland. These are fully funded PL opportunities, with resources sent to delegates to allow active participation by up to 10 staff members during the event. Through the 2021-22 session, the team delivered 210 training days to 37800 delegates, offering nine courses:

- Pneumatics and hydraulics
- Marvellous magnets
- Sensory Science
- Zoom in, Zoom out
- Sowing the seeds of STEM
- Mystery messages
- Teddy in the Park
- Maths Week Scotland
- Science enquiry – finding an association and fair testing

Throughout the coming session, the team will expand their delivery with five new offers, including two ENTHUSE-funded courses called 'Investigating the Human Body' and 'Sustainable STEM'.

The Early Years and Primary Digital and Computing Skills portfolio include 'Let's Play (a Computing Science', 'Meet micro:bit V2' and 'VEX GO'. These have been delivered both remotely and face-to-face, reaching 265 practitioners across Early Years, Primary and ASN between April 2021 and May 2022. The team continue to build strategic partnerships with Sphero, VEX Robotics and Robotical.

To maximise reach to practitioners across Scotland, the team have developed comprehensive online learning resources, including home-learning activities, 'STEM by the book' and their quarterly bulletin.

Find out more using these QR codes

PL Calendar

Home learning resources

STEM by the book

Advisory Service

SSERC's Advisory Service supports the delivery of safe STEM learning activities across Scotland, offering enhanced support through unlimited access to special advisors as well as to professional learning courses and activities. SSERC can offer advice on health and safety and model risk assessments, information on troubleshooting practical activities, and updates on legislation and guidance. Access to the health and safety area of the SSERC website is restricted to SSERC member organisations and schools. SSERC's sister organisation, CLEAPSS, supports similar activities in England, Wales, and Northern Ireland.

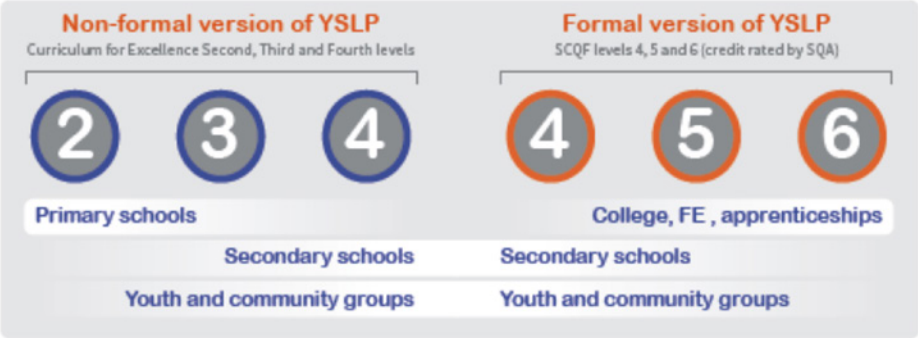
SSERC offers a wide range of STEM engagement and enrichment programmes to further increase access to, and participation in, STEM beyond the classroom setting.

Young STEM Leader Programme

The Young STEM Leader Programme (YSLP) is an award open to all young people in Scotland to inspire, lead and mentor their peers through the creation and delivery of STEM activities, events and interactions within their schools, communities or youth groups.

The YSLP project team at SSERC has been working with key partner organisations and groups to develop robust programme content at all levels, and to train and support Tutor Assessors and Young STEM Leaders across Scotland.

The programme is available across six levels, split into two versions: non-formal and formal.



Over 7000 Young STEM Leaders have engaged with the programme, with representation across every local authority in Scotland. Jayne Mays, a primary school teacher from Fintry Primary School, delivered the YSLP in her classroom using the BBC Micro:bits. Her Young STEM leaders created an activity for peers to explore algorithms using BeeBots, reinforcing many aspects of learning, including position and movement.

SSERC entered into a joint venture with Sports Leadership Qualifications (SLQ) to offer a similar programme for STEM Leaders across Scotland. In November 2022, SLQ launched the STEM Leaders programme into the English secondary education market via a joint venture with SSERC. This encourages learners to inspire, lead and mentor their peers through the creation and delivery of STEM activities events and interactions within their schools, communities or youth groups.

YOUNGSTEM leader led by sserc

SLQ

STEM Leaders

338 Learners

16 Centres

Two levels of a new qualification in STEM Leadership have been developed:

Level 1 Qualification in STEM Leadership (Key Stage 3/Years 7 and 8), broadly equivalent to SSERC's YSL4 award.

Level 2 Qualification in STEM Leadership (Key Stage 4/Years 9 and 10, broadly equivalent to SSERC's YSL5 award.

STEM Ambassadors in Scotland

STEM Ambassadors in Scotland is based at SSERC and coordinates the STEM Ambassador Programme across Scotland on behalf of STEM Learning. STEM ambassadors are employees or students working in STEM focused roles who volunteer their time to engage and inspire learners.

The STEM Ambassadors in Scotland team has over 30 years of experience working with STEM Ambassadors, STEM employers, schools, community groups and partners. We support over 5,000 Ambassadors in Scotland to deliver engaging STEM experiences for schools, community and youth groups.

Education-Industry partnerships

At SSERC, we work in partnership with individuals and organisations who are committed to support STEM learning experiences in Scottish education. Our Education Industry Partnerships (EIPs) are a growing list of people who represent an increasingly diverse range of settings and specialisms, all with the shared value of developing and delivering inspirational and engaging STEM opportunities for educators and their learners.

Taking part in an Education Industry Partnership with SSERC offers organisations the opportunity to innovate, creating fresh and impactful engagements in STEM. It is gives everyone involved the collaborative and creative space and time to ensure corporate social responsibilities are delivered with the greatest possible effects and outcomes.

We have a range of existing programmes for partners to choose from, meaning support can be promptly launched into learning communities in Scotland and beyond. Alternatively, the team at SSERC will work with EIPs to create new and bespoke programmes, using everyone's expertise and experience to create something truly unique.

Enthuse Partnerships

Enthuse Partnerships empower schools, colleges and employers to share practice and to work collaboratively with the aim of achieving:

- Increased attainment in STEM subjects, narrowing the gap for disadvantaged students
- Increased interest in STEM careers: more students interested in working in STEM industries
- Increased understanding of STEM careers: more students aware of the qualifications and routes to progress in STEM

Each Partnership will develop a tailored two-year action plan, including, for example:

- Teacher CPD combining residential, local and online courses
- Free, curated and quality assured resources
- Teacher placements in a STEM-related industry or university department
- Engaging with STEM Ambassadors to inspire young people
- STEM Clubs to engage young people and develop practical skills

Wider STEM engagement

SSERC's wider STEM engagement programme offers activities to link educators with industry partners, integrating its programmes and services. As an example: the Early Years and Primary Team support two EIPs, working with education and industry partners across Northern Scotland. Michael Wall, an Education Officer for ALI energy, designed a bespoke 'Climate Quest' workshop to deliver in local schools, coinciding with COP26, to raise awareness of climate change.

For more information about SSERC's wider STEM engagement programme, including:

- ESERO Champion
- Nuffield Placement Programme
- Scottish STEM Placement Programme
- STEM Club Quality Mark

Visit: STEM Engagement - SSERC

Wider support for engineering in primary schools

There is a wealth of support available for engaging with engineering in primary schools. Many organisations have ready-to-go classroom resources, suggestions for exciting experiences for children, inspiring profiles of engineers, professional development offers for teachers, or a mixture of all of these and more. We are delighted that so many of these organisations have shared details of their primary engineering support in this issue of Why and How?

Cardiff University School of Engineering / Prifysgol Caerdydd Ysgol Peirianneg

CIEC Centre for Industry Education Collaboration

IET The Institution of Engineering and Technology

I'm an Engineer Get me out of here

neon Brilliant Inspiration

nustem

Primary Engineer Programmes ...the first step

Royal Academy of Engineering

Rochester Bridge Trust

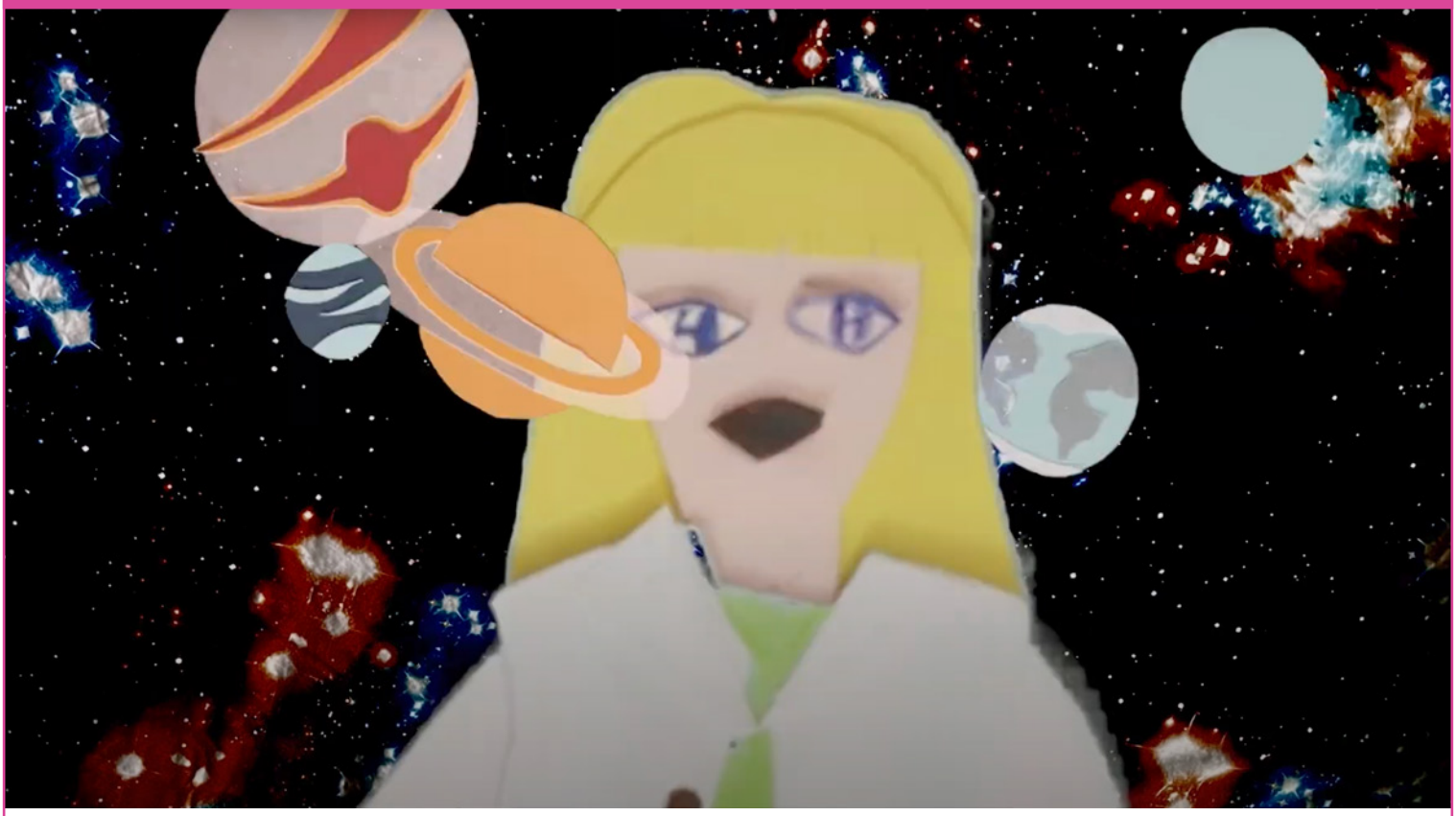
science made simple

Manchester 1824 The University of Manchester

Sentinus Science Technology Engineering Mathematics

STEM Learning

Please note that while we are keen to promote the work of the organisations featured, this does not constitute an endorsement from PSTT. Please click here to read PSTT's safety notice and disclaimer.



CARDIFF UNIVERSITY SCHOOL OF ENGINEERING

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD
School of Engineering
Ysgol Peirianneg

Engineering as community rather than competition

Diversity is a cross-cutting theme in the new curriculum in Wales. Deborah Syrop, Public Engagement Officer for Cardiff University School of Engineering, explains how they are working to embed this throughout their support for schools.

Engineering is a great way to provide context for science and maths learning. It underlines how these subjects can help people and improve lives. Whilst this wider context is useful when thinking about increased representation in STEM, embedding diversity into our approach has surfaced much deeper issues around inclusion.

Historically, science and maths have been the preserve of those with sufficient resources. This has led to a limited world view defining what is important and what is valued. It has also meant that many people have

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been excluded because of a lack of resources, access to social contacts, non-inclusive working practices and discrimination.

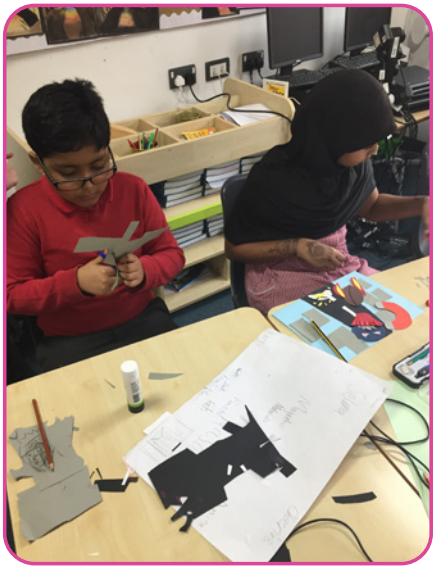
Growing up with these narrow perspectives as the norm makes it difficult to imagine what a more inclusive, anti-racist, representative STEM curriculum looks like. Acknowledging our own bias and blind spots has been a crucial first step, closely followed by filling gaps in our own knowledge.

It's easy to think that diversity is just about having a wide range of people in our pictures. Whilst needed, this is only the tip of the iceberg. We have looked at all aspects of our work: our language, the examples we use, the way we interact or organise our activities. Each of these elements can inadvertently make people feel like they don't belong.

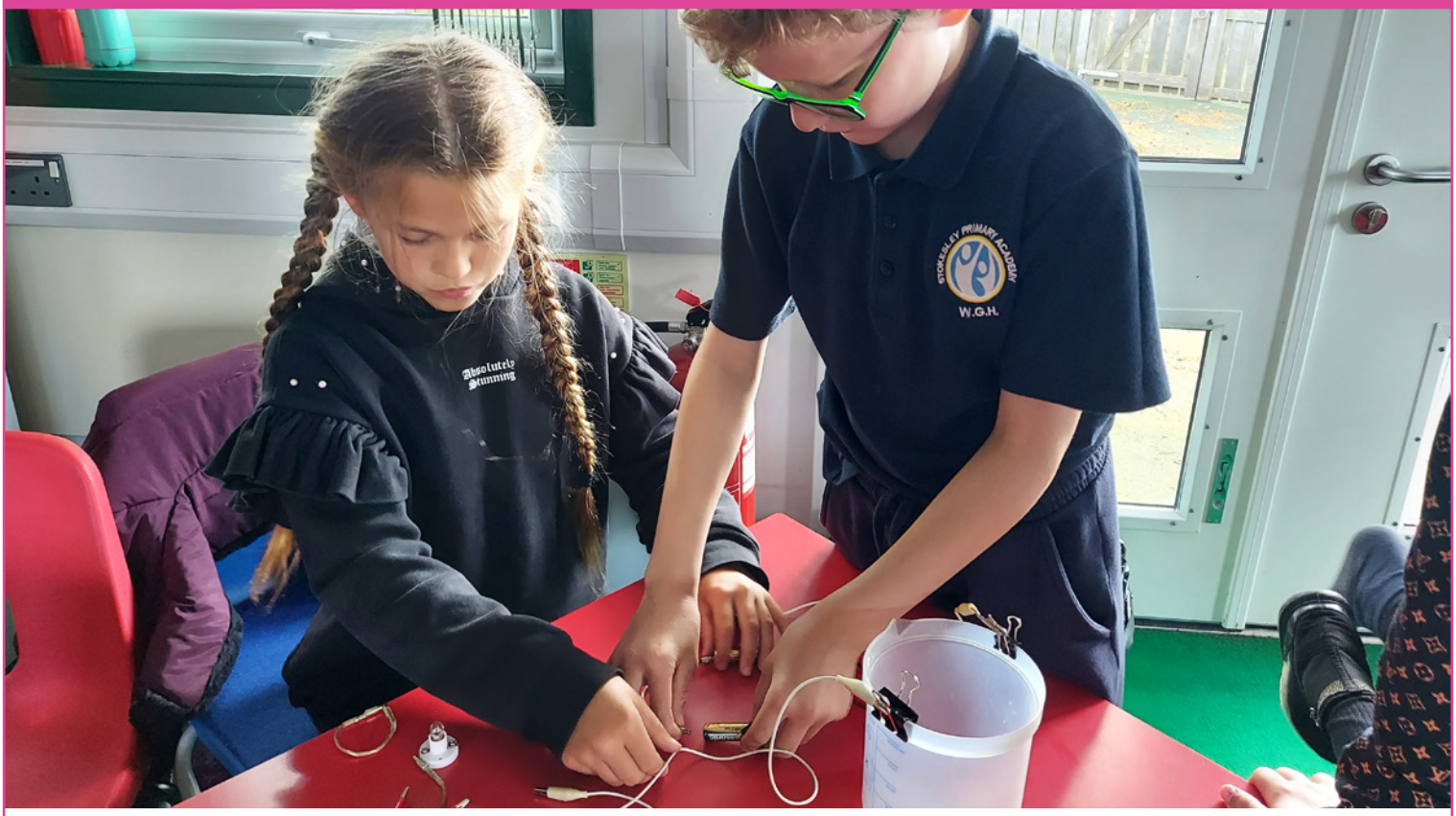
It has been an opportunity for creative approaches. Working with Winding Snake Productions, we asked a group of Year 6 students to create animations based on the work of one of our research groups. The resulting **short films** are one more way for us bring a wider range of voices to our public and schools' activities.

Even with better representation and increased perspectives, it's still possible to make learners feel 'othered'. We inadvertently lump people into 'us' and 'them' categories, make generalisations and use stereotypes - positive and negative. All these things can make people feel judged by their perceived identity rather than actual abilities and interests. The last thing we want is to spotlight students who already feel they are having to work harder to 'fit in'.

There is a tendency to talk about individuals - the high achieving scientist, the solo inventor. But this doesn't reflect reality. STEM professionals work together in teams. People contribute different skills and experiences. It's a community effort. Yet, we often make it a contest. Competition is overused in engineering activities, and it gives an impression of an ambitious,



unfriendly, aggressive career. Isn't it more important for young people to see collaboration? It's easy to replace 'Who is the best at this?' with 'How many different ways can we find to solve this?' or 'How can we share our skills to succeed?' Rather than competing against each other we can work together to solve the big issues facing society. Our key message is that we all have a part to play.



Children use their developing understanding of electricity to solve a real-world problem.

THE CENTRE FOR INDUSTRY EDUCATION COLLABORATION

CENTRE *for* INDUSTRY EDUCATION COLLABORATION

Supporting primary engineering through science

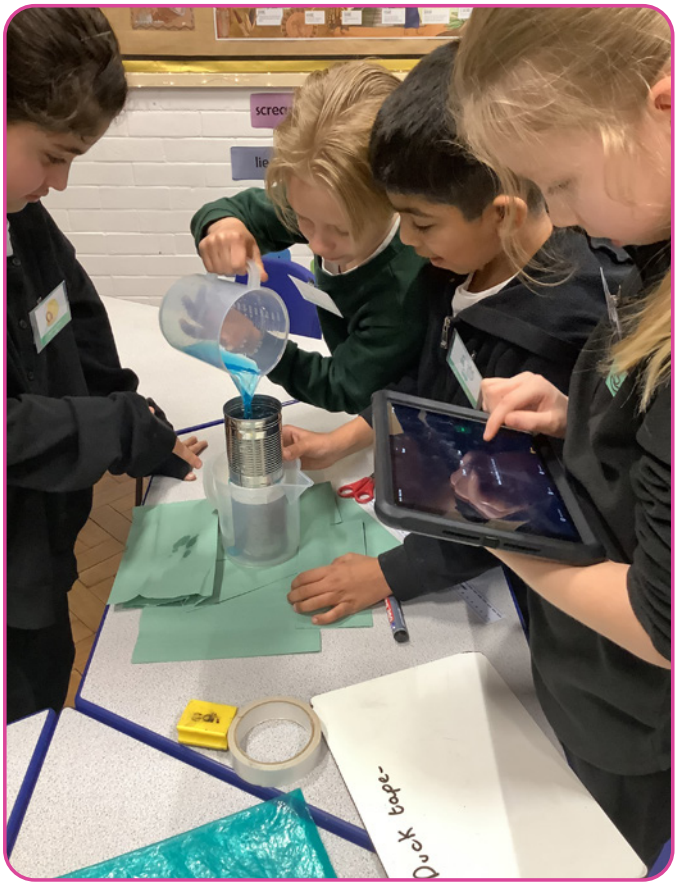
Our work with primary teachers and pupils has shown us that many have a narrow view of what comprises engineering and do not realise what a vital role it plays in our lives. Even children with otherwise high science capital do not always understand that a career in engineering would be an opportunity to apply science to solve real world problems. Moreover, some of the problems addressed by engineers include the ones that exercise children most, such as climate breakdown, pollution, and sustainability.

The Centre for Industry Education Collaboration (CIEC) has a long history of supporting primary teachers to deliver engaging and relevant lessons which make credible links between real world applications and the national curriculum. In recent years they have extended their library of lesson plans with an extensive range of activities which showcase the work done by industry to ameliorate their impact upon the environment and make their products more sustainable. The teacher notes include guidance to support the involvement of local 'industry ambassadors' to support learning and provide role models.

Renewables Don't Run Out: A class of children watches intently as small quantities of different materials are burnt

CENTRE *for* INDUSTRY
EDUCATION COLLABORATION

For example, one of the latest additions to the publication, **Sustainable Stories**, invites children to consider the properties of different packaging materials. They are asked to consider what factors influence the design decisions that are made by engineers as they apply their science knowledge to produce packaging which does the job that it needs to, while having as little environmental impact as possible.



Children investigate ways of joining pipes by using empty cans which have had the lids and bases removed.

Another publication, **Water for Industry**, includes an activity with a strong engineering focus where children are challenged to design a method for cooling water. Other activities include an investigation of the best way of sealing pipes to prevent leaks, and the most effective material for filtering dirty water.

Children investigate using wind as a source of power as they attempt to lift a small load using a windmill.

The production of clean energy is addressed in the publication **Generating Electricity**, which explores the use of wind power. The children work together to find a solution for a village from a developing country which needs to find an economic way to produce power that will enable them to meet their daily needs.

These activities give children a sense of agency and hope and can help them to make positive decisions for their own future careers as well as for the health of the planet. Moreover, teachers tell us that they appreciate how easy they are to resource and teach, and how much children benefit from them.

If you would like to know more about the broader work of CIEC in supporting primary science and engineering, please contact us at ciec@york.ac.uk.

THE INSTITUTION OF ENGINEERING AND TECHNOLOGY

The Institution of Engineering and Technology

Inspiring young people with exciting STEM activities

As engineering and technology advance at a rapid rate and changes the world around us, it has never been more important to inspire young people into science, technology, engineering and maths (STEM). The Institution of Engineering and Technology (IET) provides support to both teachers and students, helping to develop skills which are valuable not just in the engineering sector, but across the global economy. The IET offers a wide range of curriculum-linked resources, initiatives and programmes for schools and teachers at a primary level and beyond to introduce young people to the sheer excitement of STEM.

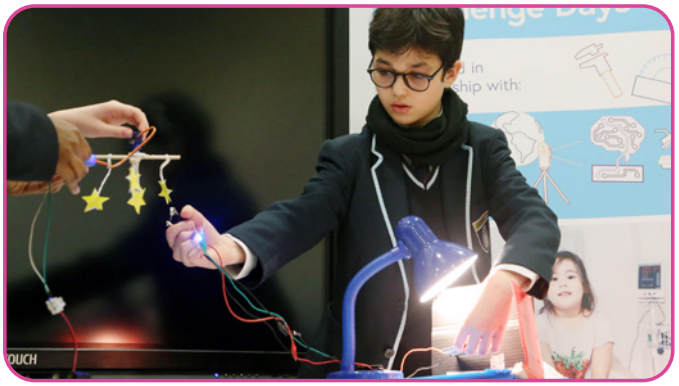
Teaching resources

Our free teaching resources will enhance your teaching and bring students' learning to life. The resources are designed to support the delivery of key topics within design and technology, maths and science. They provide practical activity ideas in themed collections that could be used as one-off activities or linked with other areas of the curriculum, and they are all fully editable so you can tailor them to your students' or your school's needs.

Join in and work through the activities on offer to spark your pupils' curiosity: browse the free resources **here**.

The Institution of Engineering and Technology

IET Faraday® DIY Challenge Days



Download our free guidelines and electronic resources that will take you through a classroom-based engineering challenge day, with an introductory presentation, handouts, video clips, printable IET Faraday® currency and student certificates.

Why not invite our Education Officers and Ambassadors to give you a hand on the day and bring real-life engineering experience into the classroom?

Find out more about **IET Faraday® Challenge Days**

FIRST® LEGO® League

The IET is the operational partner for *FIRST*® LEGO® League in the UK and Ireland. There are two programmes relevant to primary schools: Discover and Explore!

***FIRST*® LEGO® League Discover** is a playful introductory STEM programme for 4 to 6 year olds which happens in the classroom. Children work in teams of four to explore a real-world theme using an exclusive LEGO® Education Discover model. Using this as inspiration, they then design their own models using LEGO® DUPLO® elements to solve meaningful problems.

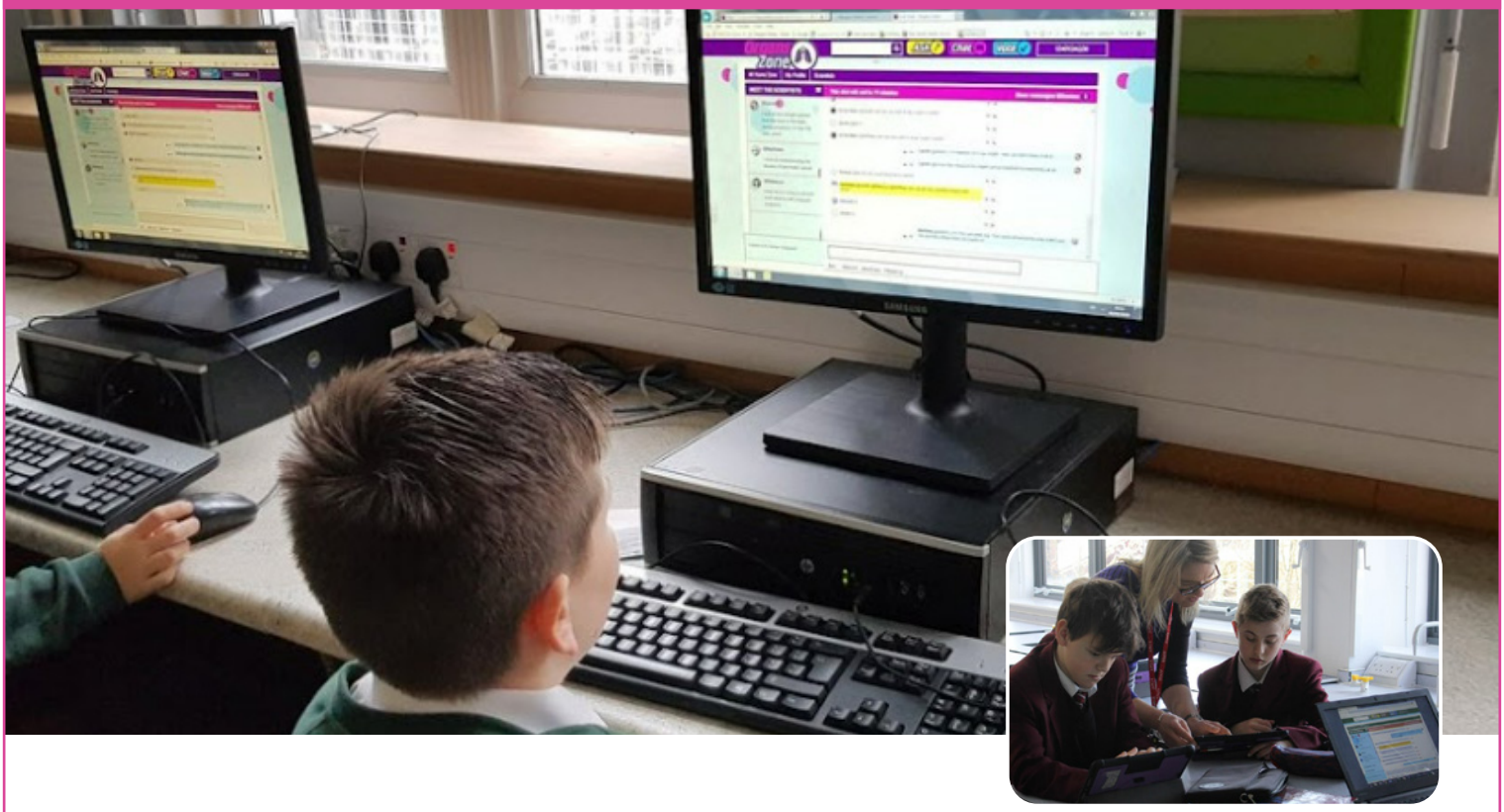
***FIRST*® LEGO® League Explore** sees the children working in teams to research a specified theme relevant to the world around them, displaying their ideas on a team poster. They also build a LEGO® model and program it to move using LEGO® SPIKE™ Essential. Teams then attend a regional festival or an in-school Class Pack event.

Find out more and get your school involved:

***FIRST*® LEGO® League Discover**

***FIRST*® LEGO® League Explore**

IET Education:
Inspiring the next generation of engineers and technologists.



I'M AN ENGINEER, GET ME OUT OF HERE

Get your students buzzing about STEM in Chats with engineers

***I'm an Engineer, Get me out of here* is a free, online, student-led activity connecting school students with people in engineering-related roles.**

Students aged 10 and over connect with engineers in live, text-based chats, explore their profiles, and ask follow-up questions.

After taking part, students will be able to achieve learning outcomes like: showing higher order thinking skills; engaging in conversations; recalling new scientific content; and naming STEM-related careers.

Students can choose to ask the questions that they're interested in. Miss Cody, a teacher, explained: "As teachers we constantly hear, *'Why is this important for me? Why do we have to learn this?' I'm an Engineer* gave them an opportunity to go to a real-life person using science out there, and actually ask them."

Teacher Heather agrees: "Students at my school don't often get these 'real world' opportunities." With *I'm an Engineer*, students learn more about engineers and their lives; see engineering as personally relevant to them; and see how their learning transfers outside of the classroom. Heather says, "Taking part has ... made them think differently about how relevant STEM really is."

With an average of 5 engineers per Chat, students can connect with people who look like them; talk like them; and have the same interests as them. All of this can help them break down 'clever scientist' stereotypes. Ultimately, this supports their science capital and helps them to see STEM as something 'for them'.

Take part in I'm an Engineer with your students: imanengineer.org.uk/teachers

I'm an Engineer is free for UK state-maintained schools thanks to support from funding partners.

All interactions are facilitated by DBS-checked moderators.

NEON

Inspire engineering in primary with Neon

Are your students engineers in the making? Bring the STEM curriculum to life for your students with real-world engineering experiences they won't forget.

Neon helps primary school teachers introduce their students to future STEM careers and explore the excitement of engineering through **brilliant activities**, **inspiring case studies** and **supportive resources**.

Help your class spark a love for experimenting, learning and exploring the world around them. Careers in science, engineering and technology are growing faster than any other and it's never too early to engage and excite children of all ages in engineering concepts and jobs with STEM activities. It will help them ask questions, think through problems, collaborate with others and ignite a passion for a career in engineering!

When you register on Neon, you can discover amazing primary activities to involve your class in all things engineering – from programming robots to designing eco-friendly solutions to everyday challenges.

Choose from over **40 amazing activities** specifically for primary to excite your class with the incredible world of STEM. There's something for everyone on Neon, regardless of how much (or little) time you have available, lasting from an hour up to a full day of excitement.

Plus, find exactly what you're looking for with our search and filters. Find activities that develop a particular key skill or focus on a specific topic - Neon allows you to tailor your search to exactly what your class needs.

Why register with Neon?

- Save time – get a personalised experience and suggestions, allowing you to focus on creating the moments that inspire and excite in your classroom and beyond!
- Browse and save your favourite activities to come back to
- Discover things that are local to you, for exactly the age ranges and topics you need
- Get fortnightly newsletters with the latest activities and advice, straight into your inbox

Join over 1000 schools across the UK registered on Neon and help inspire the next generation of engineers.

Sign up for free at www.neonfutures.org.uk

Families building towers in an Engineering for Families workshop

NUSTEM

Northumbria University NEWCASTLE

nustem

Engineering resources from the NUSTEM group

NUSTEM is a STEM outreach and research group at Northumbria University. We want to help children (and their influencers – teachers, parents and carers) to feel confident that a career in STEM could be for 'people like them'. One way of achieving this is to identify personal characteristics of people already working in STEM, and to support children and carers in reflecting on how those characteristics align with how they see themselves. Our work shows the breadth and application of STEM in the world around us. Below are a range of activities that directly focus on bringing engineering into the classroom in primary schools from Early Years to Key Stage 2.

Engineering for Families

This **free resource** helps schools run a five-week after-school activity club, for Key Stage 2 children and their families. The course is thoroughly tested, uses cheap and familiar materials, and is straightforward to facilitate. Each week of the course focuses on a career within a different engineering discipline.

STEM in Early Years

We think that the earlier intervention starts, the better. The aim of our units is to develop, deliver and enable high-quality STEM learning in Early Years. The units are STEM themed, with 3 linked to engineering: Marine, Robotics and Magnet Engineers. **These resources** provide everything you need to support engineering exploration through adult and pupil-initiated activities and have been tailored for early years practitioners.

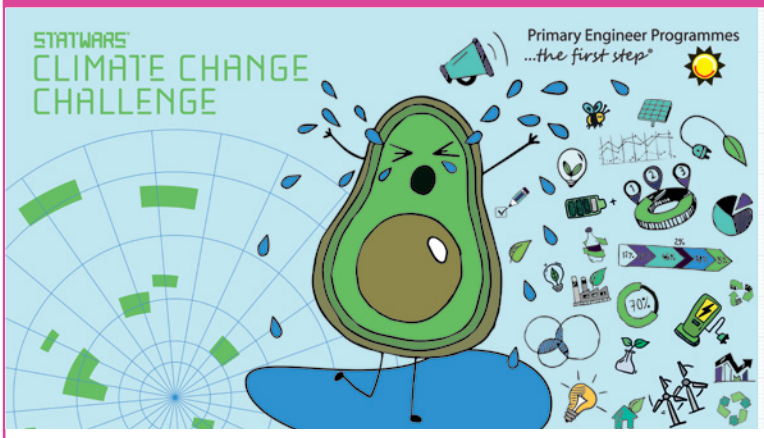
Levers, Gears and Pulleys

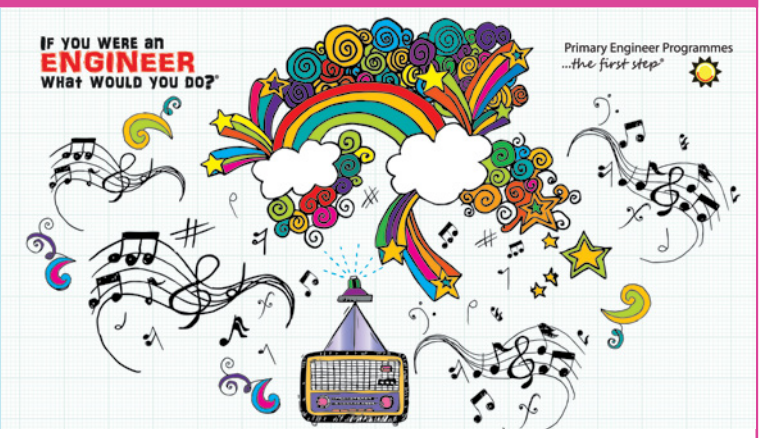
Levers, pulleys and gears appear in primary national curricula for science.. We've pulled together a series of activities and explanations to help teachers understand the concepts behind these simple mechanisms and included some examples of how they link to engineering careers. Look out for our **Mini Mangonels resource,** which is a great way to explore engineering principles in a making and tinkering activity.

Primary Careers Tool

Our **Primary Careers Tool** helps teachers to link the science curriculum with careers, which helps broaden the career aspirations of young children. Across primary science and maths, there are over 100 linked careers in the resource. About a third of the database covers engineering jobs, linked to relevant curriculum areas and easy to slot into your existing lessons.

If you're interested in finding out more about our work, please get in touch through our **website** or by emailing **nustem@northumbria.ac.uk**





Primary Engineer Programmes
...the first step®

PRIMARY ENGINEER

Primary Engineer share details of two of their annual UK-wide competitions.

How to stop your family from eating avocados with the power of Maths and Science!!

STATWARS: Climate Change Challenge from Primary Engineer has all the power you will need! Make STATWARRIORS of your pupils by adding the STATWARS: Climate Change Challenge to your science and maths programme of study.

Primary Engineer have created a full set of beautifully designed teaching resources, with video content for upper primary and lower secondary with links to data professionals, to bring the world of data to life through the context of sustainability and climate change.

This STATWARS challenge will see pupils exploring the world of data to identify things which they and their family could personally change to have a positive impact on Climate Change. The aim is to empower them with how data can help them make informed decisions.

Clearly, as the person at the front of the class you would be the STATWARRIOR-in-Chief – with a certificate to prove it!

If you are up for the challenge visit:
www.statwarscompetition.com

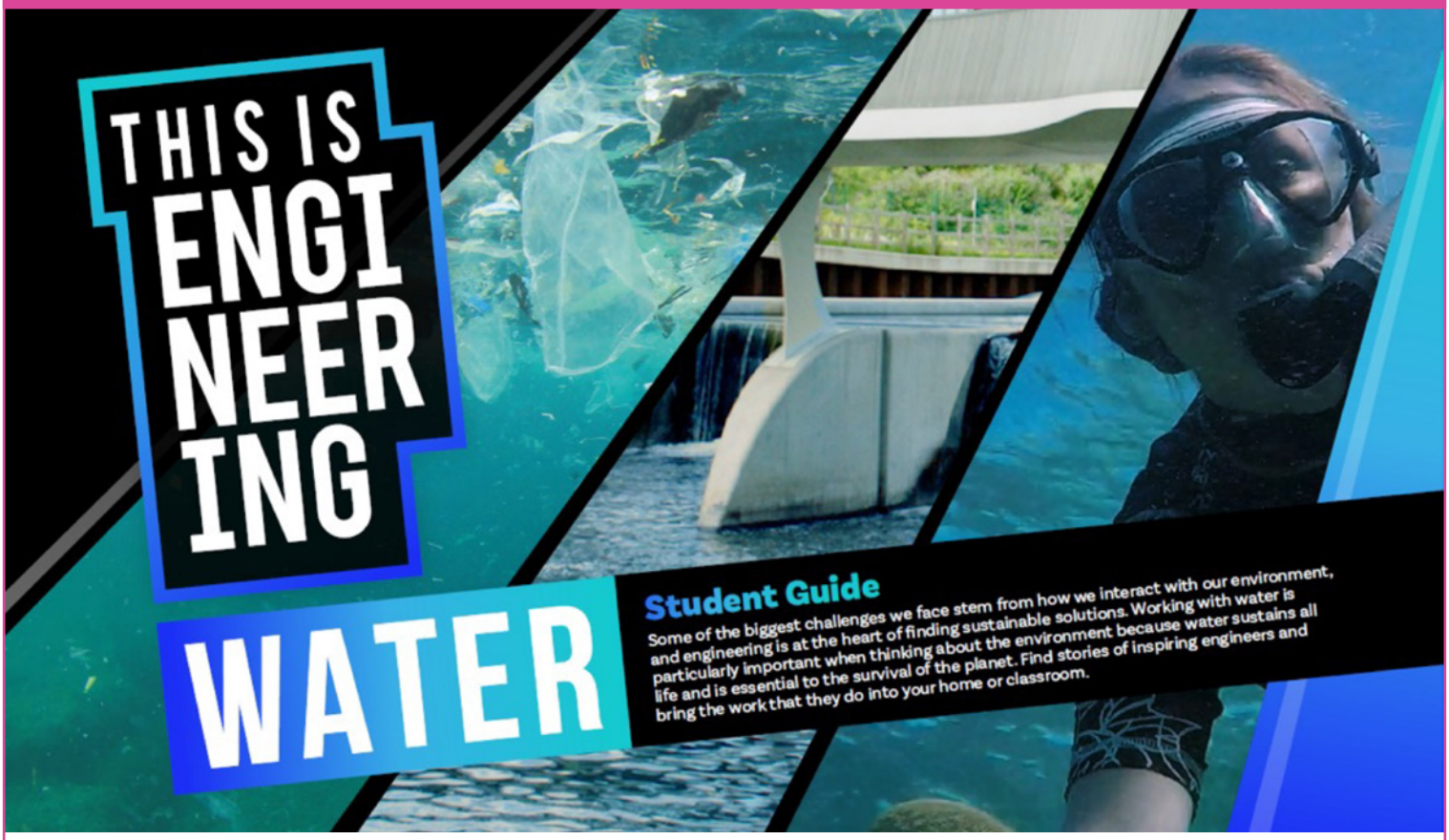
Oh to dance under rainbows!

When the question is as open-ended as 'If you were an engineer what would you do?' you have to be prepared for the range of solutions to problems that you never knew even needed one! Like a radio with a prism on the top that water sprays through so you can dance under rainbows at birthday parties!

Pupils between the ages of 3 and 19 answer the question after interviewing engineers and finding a problem. They then draw and annotate their ideas, adding a letter to an engineer saying why their idea should be built – every entry is read by engineers and graded pass, merit, distinction or shortlisted and each child receives a named certificate. Award winners are chosen from each year group regionally across the UK.

Register and take part this year. Download all the free teaching resources. Join live the broadcast interviews with engineers or catch up on our YouTube channel and hear from Carl Starr from NASA, Andrew Smyth from Rolls-Royce and former finalist of The Great British Bake Off, Mo Taher from Heathrow Airport and many others too. Or listen to pupils, teachers and engineers talking about their ideas on the 'If you were an engineer' Podcast which is available on all your favourite podcast platforms.

Let's bring engineering into the classroom and inspire engineers in the making!



ROYAL ACADEMY OF ENGINEERING

Royal Academy of Engineering

STEM Teaching Resources

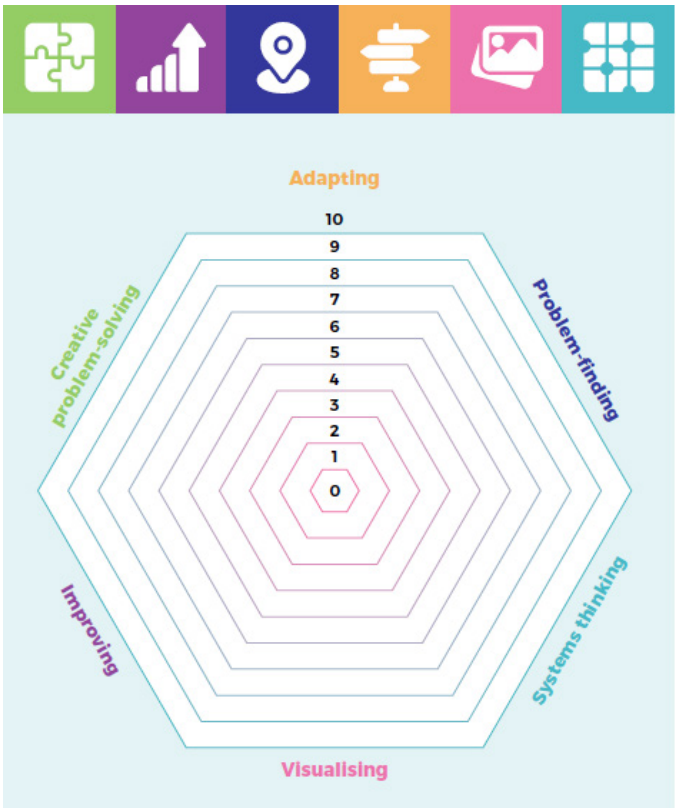
The Royal Academy of Engineering develops engineering-themed teaching and learning resources in partnership with teachers and engineers to engage and inspire students about a career in engineering.

For schools, the resources are linked to the upper primary and lower secondary STEM curricula and can easily be adapted for older or younger learners. The resources provide engineering-themed learning activities for use in a STEM club, for a STEM challenge day or to enhance and add context to the STEM curriculum. An important aim of each resource is to enable teachers or club leaders to engage their students with STEM through hands-on activity and stimulating engineering contexts, such as renewable energy, sustainable development, aerospace engineering, and even the entertainment industry.

The most recent resource developed by the Academy is titled This is Engineering: Water. It includes a range of activities and challenges – from creating bioplastics and designing flood defence mechanisms, to investigating what microbes are getting into our water systems. It also explores how we might generate electrical energy from water. The activities are presented alongside three case studies of engineers working in related water industries, to give valuable real-life context, and also to get students thinking about the skills and qualities needed in engineering, known as engineering habits of mind.

Check out this resource on the Academy's STEM resource hub **here**.

Royal Academy of Engineering



The STEM resources promote 'Engineering habits of mind'.

Engineers make 'things' that work or make 'things' work better. But they do this in particular ways. The 'engineering habits' describe the way engineers think and act.

Take the **quiz** to discover your engineering habits now.

Find out more about Engineering Habits of Mind in the Academy's recent report, **'Progressing to be an engineer'**.

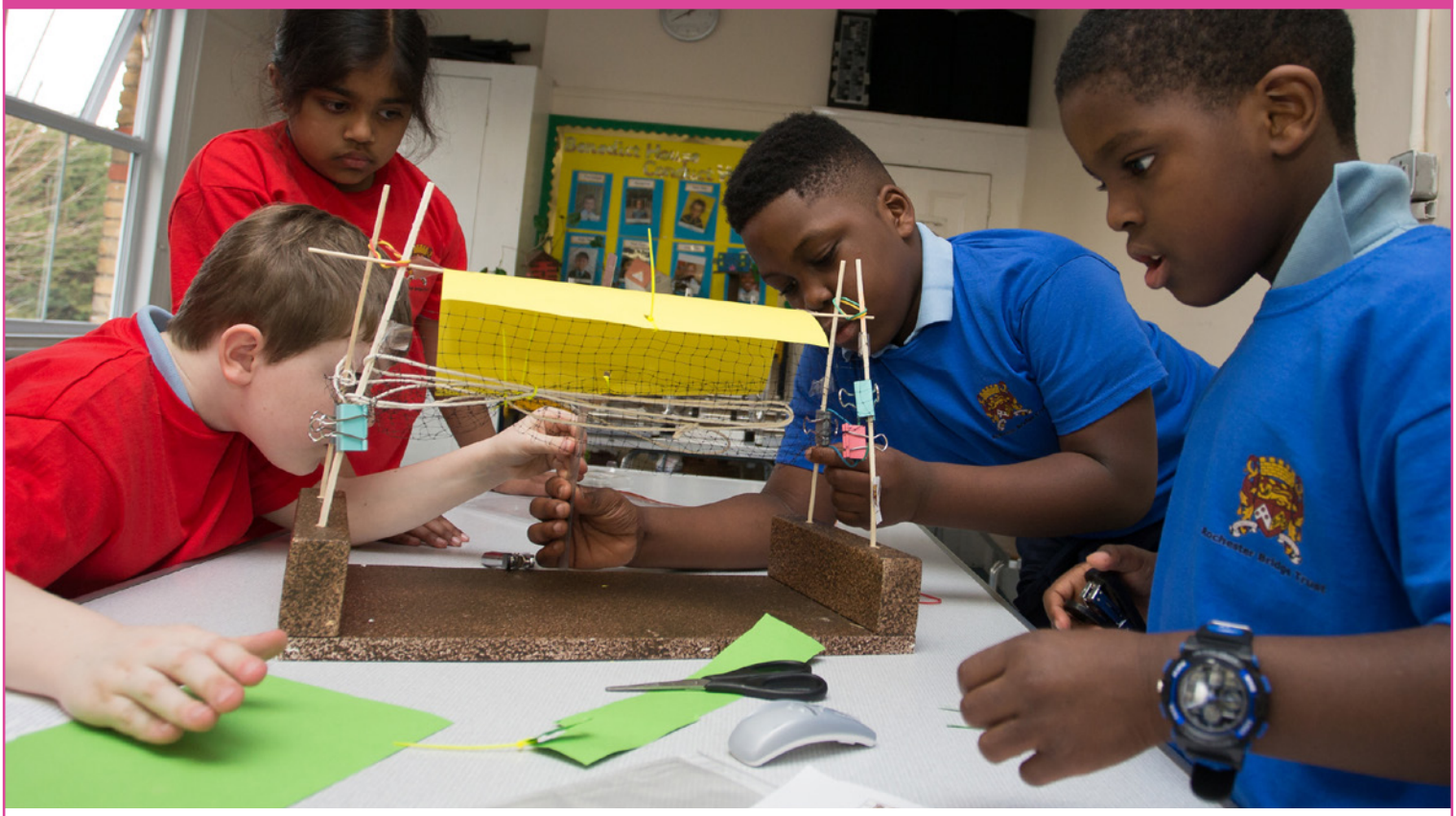
Alongside the resource, the Sustainable Futures Innovation Challenge competition has been relaunched for a second year. This competition is open to 9-11 year olds, and 11-15 year olds who can work in teams to submit an idea for an innovation around one of the following themes:

- Travel and transport
- Food systems
- Our homes and habitats
- Our lifestyles and what we consume

The deadline for entries is 1st May 2023, and the winning teams will have an opportunity to meet with real engineers and share their projects, take part in a STEM experience and join in a Q&A session with a panel of engineers.

Details of the resource and competition can be accessed **here**.

Past resources can be accessed through the Academy **website**, where you can search for key words, and filter resources according to audience and topic.



ROCHESTER BRIDGE TRUST

Building bridges with young children

More than six centuries of experience underlie a suite of free educational materials to encourage children to take an interest in civil engineering.

The activities are provided by the Rochester Bridge Trust, a medieval charity responsible for three bridges across the River Medway in the south east of England. Caroline Chisholm, Education Manager at the Trust, explains more about the resources.

There has been a bridge at Rochester for almost 2,000 years, and the Trust has looked after the crossings since 1399. To ensure the bridges continue to be there for centuries to come, we need to inspire the bridge builders of tomorrow. At the Rochester Bridge Trust, we do this by providing fun, educational activities for children early in their lives to try and counter the influence of stereotypes, because children can grow up to do anything if they are given the right encouragement and opportunities.

All the Trust's activities are provided **free of charge**. They come in a range of styles to be used in bite-size chunks or as longer sessions for science classes or after school clubs. The aim is to encourage youngsters to get involved in civil engineering, trying out different techniques, and thinking about the challenges involved in bridge building as they learn through play. The activities use easily available materials that are often already found in the classroom or home, such as string, cardboard and sticky tape, and where items may need to be purchased these are always things that can be easily found in shops, at minimal expense.

ROCHESTER BRIDGE TRUST

Learning about Bridges is a set of 12 lesson plans featuring Langdon the Lion, aimed at Key Stage 2 and focused on bridges. Each chapter covers a different bridge type or engineering principle and can be used as a standalone activity or as part of the series. Activities within this book can also be easily adapted for ages 2-18, with the paper bridge challenge proving popular for all ages.

Building on the lessons of Learning about Bridges, Exploring Engineering Challenges are a set of three more detailed activities which lead children on a journey from identifying a problem, through the design phase, and into the construction and testing of their solution. These can be run as a whole day, two half days or four 90-minute sessions. They ask children to design an animal crossing and a filter to clean water, and to create a roller coaster buggy. In addition to these books, a range of short and simple, paper-based activities is available for quick educational wins.

All activities can be found at www.rochesterbridgetrust.org.uk under the Learning Activities tab.

Action against stunting hub – STEM day with students in Coventry

SCIENCE MADE SIMPLE

Career context, contemporary STEM and the Sustainable Development Goals

Science Made Simple is a STEM outreach service that provides no-cost or low-cost enrichment for schools through funded projects encompassing all areas of science, technology, engineering and maths. Rachel Mason, Associate Director for Development, shares details of some of this support.

It's a tall ask of teachers to teach STEM topics, while incorporating contemporary content, with global societal impact, AND with the voices of researchers to bring that all-important career context. That's a heck of a lot of research. At Science Made Simple, it is our bread and butter to support teachers in this work.

Through our researcher training programmes we work directly with jobbing scientists and engineers to help them connect their work to school audiences; this helps us in-turn to create enrichment materials – shows and workshops – which help students explore the relevance of the STEM they learn in the classroom. In short, we do that 'heck of a lot of research' for you and bring it in to school. Here's just one example:

Since 2019 we've been working with scientists in India, Senegal, Indonesia and the UK on the **Action Against Stunting Hub** – an international project addressing many of the United Nations' **Sustainable Development Goals**.

Through our relationships with the scientists, we are developing live school events and downloadable classroom materials for students aged 10-14.

science made simple

SUSTAINABLE DEVELOPMENT GOALS

2 ZERO HUNGER

The Road to Zero Hunger

The Road to Zero Hunger allows students to take part in a research project that is helping to address a problem affecting 162 million children in the world today; students reflect on problems in society beyond their doorstep and recognise the wide range of skills they develop in school that contribute to solving such problems, like language learning, making, adaptability, compassion and communication.

The close relationship we develop with scientists allows us to bring colourful imagery and stories from around the world, showing how science operates in the field as well as in the lab, and how it can look in different national settings. The Action Against Stunting project is truly multicultural, multidisciplinary and collaborative. The schools' enrichment resources provide a rare opportunity for teachers and students to investigate a global problem which connects across so many areas of the curriculum. In Spring 2023 we'll be heading off to India to gather new materials and stories – science is always updating, and we aim to reflect that for schools.

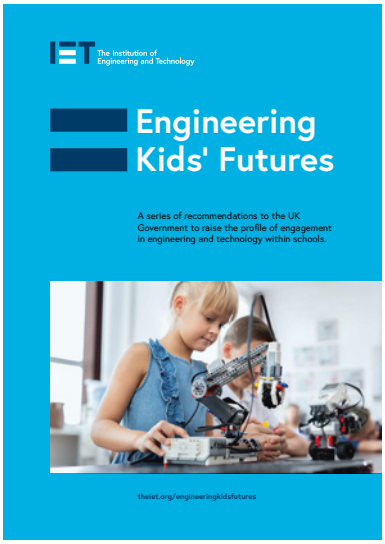
The Road to Zero Hunger STEM days, delivered in association with the Royal Academy of Engineering, are available for Summer 2023 – we are open for expressions of interest. This is just one of our many, many projects.

You can get in touch to find out more through our website www.sciencemadesimple.co.uk

SCIENCE AND ENGINEERING EDUCATION RESEARCH AND INNOVATION HUB

The Science & Engineering Education Research and Innovation Hub (SEERIH) at the University of Manchester has long been associated with PSTT, and their work has championed engineering in primary schools, particularly over the past decade. With the support of the Royal Academy of Engineering and industry partners, and working in partnership with teachers, they have created and curated a range of resources to inspire you and your colleagues to plan for further emphasis on the E for engineering within our science and wider curriculum. Dr. Lynne Bianchi, Director of SEERIH, spotlights these resources here.

Emphasising the E for engineering within the primary curriculum



It's a frosty morning as I make my way back from the Parliamentary reception to launch the Institution for Engineering & Technology's '**Engineering Kids Futures**' **report** to government. If you've not yet seen it, it's well worth a read, as the recommendations encourage us all to think more about the teaching and learning policies and practice that can offer young children high quality experience with engineering in mainstream curriculum teaching.

Tinkering for Learning: learning to teach engineering in the primary and KS3 classroom (2018)

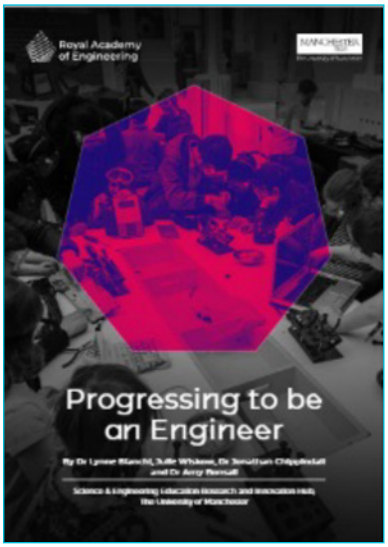
This report explores the ways primary school teachers can develop teaching approaches that lead to better and more engaging learning opportunities for would-be engineers. It builds upon the 'Engineering Habits of Mind' (EHoM): making things that work, problem-finding, creative problem-solving, visualising, adapting, improving, and systems-thinking.

Seven Principles for Engineering in Primary Schools distil evidence from teachers to outline key features that underpin teaching and learning approaches for engineering in primary and secondary education. Read more about each of these principles and the impact on classroom learning in the full report.

1. Pupils are engaged in purposeful practical problem solving
2. Pupils take ownership of the design and make process
3. Pupils embrace and learn from failure
4. Pupils' curiosity and creativity is responded to
5. Pupils demonstrate mastery from other curriculum areas
6. Pupils draw on a range of thinking skills and personal capabilities
7. Pupils' learning experiences are guided by a whole-school approach

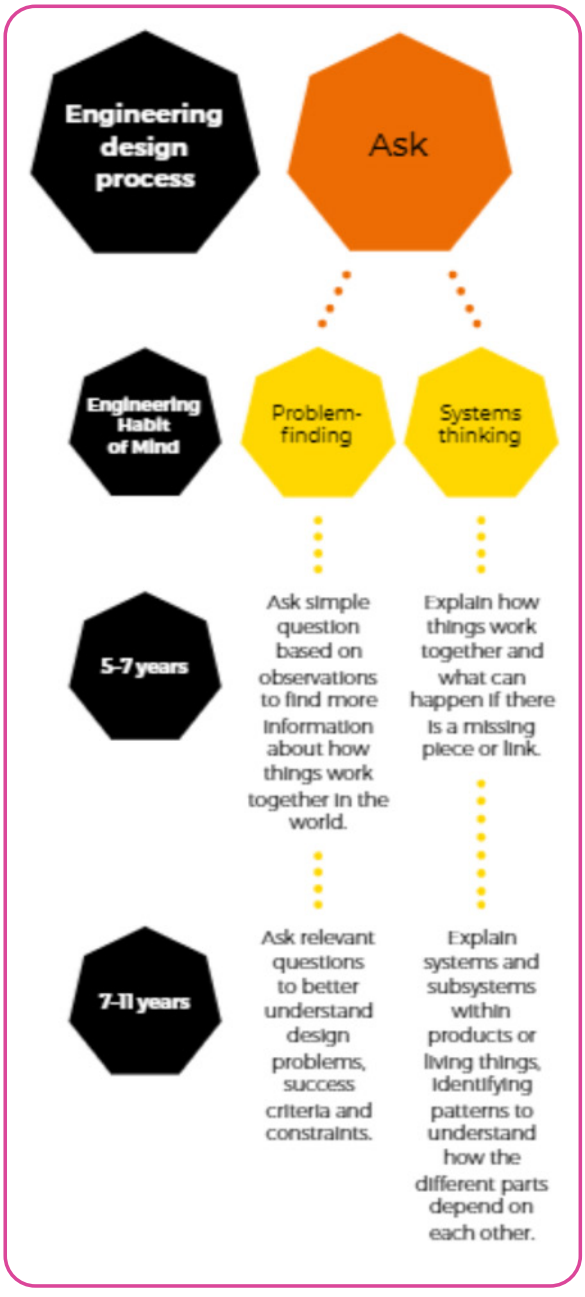
The University of Manchester

[Progressing to be an Engineer](#) (2021)



In this report, specific focus is paid to **progression** and how children's learning of Engineering Habits of Mind and skills can be developed with 5-7 year-olds and 7-11 year-olds. A draft **Engineering Learning Progression Framework** for primary schools was developed, integrating three key elements: the **Engineering Habits of Mind**; the Engineering **Design Process and aspects of Primary Design and Technology National Curriculum** (DfE 2014).

The framework outlines progression steps for teachers to use, and although these steps are not intended to be used as age-related judgements, they describe learning expectations that develop across the primary and secondary age phases. This is an important part in taking our mission to emphasise the E in engineering in primary schools forward, as it supports the drive to make explicit how engineering skills and knowledge can be developed in the primary years and how this can be made progressive.



An extract from the framework

COMING SPRING 2023: Progressing to be an Engineer – the Approach (2023)

Over the past 2 years teachers have worked further with the SEERIH team to refine and exemplify the **Progressing to be an Engineering Framework.** Soon for release will be the **Progressing to be an Engineer (PEng) Approach**, supporting teachers to embed knowledge, skills and understanding of engineering into the primary and lower secondary science, mathematics and design technology curriculum. The approach includes descriptions of intended learning outcomes from 5-14 years, and exemplars of these applied in classroom settings with diverse groups of pupils.

WIDER SUPPORT FOR ENGINEERING IN PRIMARY SCHOOLS

The University of Manchester

Engineering Educates: a national campaign for engineering in primary schools

This newly branded campaign builds on the award-winning Greater Manchester Engineering Challenge. Now a UK-wide campaign, Engineering Educates works on a two-three year cycle, working with industry and engineering sector partners to inspire 7-14 year olds to think and work as engineers in real-world contexts. Find out more at www.engineeringeducates.org

Engineering Eduacates Farmvention Challenge 2022-25

NOW LIVE - involving three age-related pathways tailored to inspire 7-9, 9-11 and 11-14 year olds to think as engineers in the context of British Farming. Each includes sequences of five curriculum-linked sessions. Learners apply maths, science, design technology and computing skills and knowledge through the context of farming and agricultural engineering. The pathways lead learners through the engineering design process and embed key issues of environment and sustainability. By thinking as engineers, learners solve problems that make a difference in real-world settings, using creativity, imagination and collaboration.

All resources are freely available and include:

- Teacher Guidance and Professional Development Webinars
- Downloadable pupil resources
- Direct-to-the-classroom videos
- Live Webinars with engineers and farmers

SEERIH runs this campaign with the support of the **National Farmers' Union** and key stakeholders across the UK, including **SSERC**.

Connect with the campaign at: **@EngEduChallenge #EngEduFarmvention**

SEERIH is based at the University of Manchester and is a nationally recognised centre of science and engineering education. We develop and engage teachers in innovative, research-informed continuous professional development programmes to ensure high-quality learning outcomes for young people. Contact us at fascinate@manchester.ac.uk

NFU EDUCATION

SENTINUS

Programmes for Primary Schools

For more than 40 years Sentinus has been supporting primary teachers in Northern Ireland to deliver practical science and technology in the classroom. Through a wide range of programmes and activities, Sentinus aims to help young people of all ages understand the importance of science and engineering, make the subjects fun and develop practical skills, while at the same time, support teachers in the delivery of science and technology within the World Around Us area of learning of the Northern Ireland curriculum.

With shortages of engineers in all disciplines and, in particular, with low numbers of women entering the profession, Sentinus recognises the need to expose children to activities which highlight the excitement of engineering. Hence several of its programmes focus on the subject, including electronic, structural, mechanical and software engineering, and help introduce it to the primary classroom, all within a context to which pupils can relate.

While pupils at Key Stage 2 have always been a key target audience for Sentinus, in recent years it has developed programmes to bring engineering activities to Foundation (P1 & P2) and Key Stage 1 (P3 & P4) pupils. Recognising how gender stereotypes can be formed at a very early age, these programmes aim to break down preconceived ideas about who is good at STEM subjects, make problem-solving fun, and help children realise that everyone can aspire to become an engineer. These activities are designed to engage children in practical activity, presented within a familiar context or story.

Sentinus
Science Technology Engineering Mathematics

'The Three Little Pigs' workshop uses the story of the same name to help Foundation level children explore the use of different materials in construction. Working in teams, they build houses from straw, sticks and bricks and test each of them for their ability to withstand external forces. As well as developing practical skills, children learn that certain materials are suitable for particular functions and they hear about how engineers help create our homes, roads, bridges and built environment.

Sentinus has developed a wide range of practical workshops to help introduce Key Stage 1 and Key Stage 2 pupils to engineering. These can be used or adapted to support the teaching of numerous topics in the classroom, and they last between 2 hours and a full day. Sentinus also offers opportunities to engage in project-based learning activities which focus on a range of topics, all of which give pupils the opportunity to explore engineering with a relevance to everyday life.

Sentinus programmes are free to schools in Northern Ireland; more information about what is available can be found at www.sentinus.co.uk

STEM LEARNING

Do primary schools really need to teach engineering?

Tanya Shields, Primary Subject Specialist at STEM Learning, discusses the importance of introducing engineering as a career option to children at an early age and provides key pointers for primary teachers.

You may be forgiven for thinking that engineering doesn't really fit within the primary curriculum - but think tanks in the UK and beyond are very clear about the importance of developing engineering skills within our young people. Key references are DfE's '**Skills for jobs: lifelong learning for opportunity and growth**' published in January 2021 and the World Economic Forum's '**The Future of Jobs Report**' from 2020. It's clear that if we are to be successful in preparing our children for a bright future, we must set the foundations of developing engineering skills from a young age.

At STEM Learning, we believe that by applying engineering approaches across our teaching, we can help children make authentic connections to the world of work, and to what they learn in school.

What is engineering?

'**What is engineering?**' is a curated collection of quality assured resources that aim to break down preconceptions (and misconceptions) about engineering, explain what engineering is and what different engineers do. It's a great place to start when introducing children to the world of engineering - make sure you check out the presentation '**Engineers don't all wear hard hats!**'

Engineers make the impossible possible

This brilliant video focuses on the design of a wing suit for base jumping - an extreme sport inspired by the ability of flying squirrels to glide from one tree to another! The teaching activities link engineering to animals, showing how nature sometimes inspires the design and engineering of different products. There are also links to scientific enquiry through ideas and evidence in science, outlining that science is about thinking creatively to try to explain how living and non-living things work, and to establish links between causes and effects.

Bring engineering into your primary school

If you're looking for enrichment activities or resources to help you develop your own engineering schemes of work, STEM Learning can help you. Our dedicated engineering in primary schools page has a range of fantastic resources to get you started, ideas for projects including space exploration and helping people, design challenges and competitions, and details about how to invite an engineer into your classroom through STEM Ambassadors.

STEM Community & awareness events

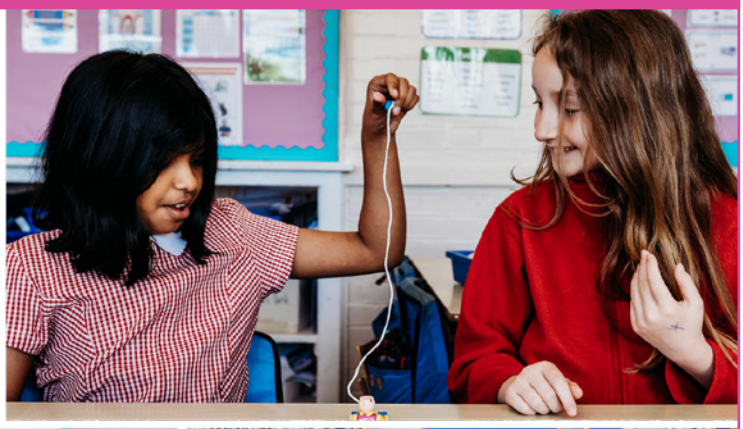
Wherever your primary engineering journey takes you and your children, we would love to hear about it. The STEM Community is a great way to share experiences and learn from others. There are also several key awareness events throughout the school year linked to engineering – details below. Why not join the chat in STEM Community and see how teachers used these days and weeks to inspire young people?

Tomorrow's Engineers Week – usually the 2nd week of November

National Engineering Day – also in early November

British Science Week – 10th -19th March 2023, always a key date in the calendar!

Access STEM Learning's specific support for primary teachers – including high-quality CPD – here.

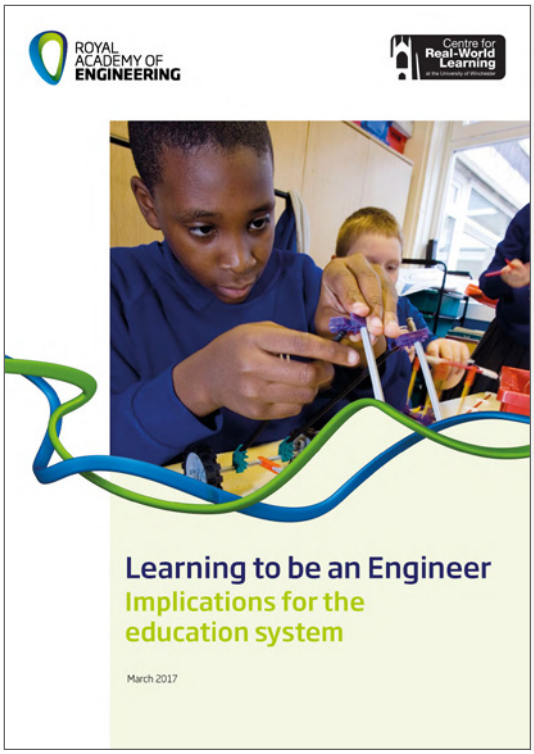

STOP AND THINK!

HOW GENDER NEUTRAL IS YOUR ENGINEERING CLASSROOM?

This checklist might be helpful:

- Are you using gender neutral language when you talk about different types of engineers and engineering? What about other staff in the school?
- Are you using a variety of real-world examples of engineering that will appeal to all genders?
- Have you checked that the school library books that feature engineering (both fiction and non-fiction) aren't perpetuating gender stereotypes?
- Are you using resources and images that reflect all genders in engineering?
- Are you ensuring that girls are contributing equally to class discussions about engineering?
- Are you making the most of opportunities to raise the visibility of women in engineering and to champion their achievements?

FURTHER READING



- **Learning to be an Engineer: Implications for the education system** - a report published by the Royal Academy of Engineering and the Centre for Real World learning, University of Winchester (2017)
- **Inquiry on Equity in STEM education**: a report by the All-Party Parliamentary Group, Diversity and Inclusion in STEM
- **International Women in Engineering** day - 23rd June 2023
- **Challenging unconscious bias** from an early age
- A list of sugessted **Picture books** that promote diversity in STEM subjects
- Seven top tips for **inspiring girls** to get into engineering

THE JAMES DYSON FOUNDATION

The **James Dyson Foundation** offers resources for primary design engineering that encourage children to get creative and inventive.

The **Design Process Box** introduces children to the design process and builds their analytical and problem-solving skills. The box of equipment is loaned to the school for six weeks and the Foundation will deliver and collect it - all free of charge. The supporting resources (teacher notes, lesson plans etc.) are all free to download from the website.

For upper primary children, the free to download **Engineering solutions: Air pollution pack** uses the problem of air pollution to show how engineering can solve global problems.

THE SMALLPIECE TRUST

The **Smallpiece Trust** supports young people to realise their STEM ambitions. Their free resources include virtual live **Meet the STEM Superstar Sessions** in the summer term 2023. The hour-long sessions, which need to be booked, offer children the opportunity to meet and engage with engineers, and to learn more about their lives and the industries in which they work. Their **Engineering@school** resources are a series of challenges for primary aged children, each linked to a different type of engineering, and all with free to download packs.

BBC TEACH

BBC Teach have a **collection of resources** for primary schools from the Year of Engineering 2018, a UK-wide campaign that celebrated the wonder of engineering across the world. The resources are linked to curricula and aim to build children's understanding about what engineers do. The collection is suitable for children aged 7-11.

Key dates

10-19 MARCH 2023

British Science Week

13 JUNE 2023

Great Science Share for Schools

23 JUNE 2023

International Women in Engineering day

01 MAY 2023

RAEng Sustainable Futures Innovation Challenge competition

NOVEMBER 2023

Tomorrow's Engineers week

NOVEMBER 2023

National Engineering Day

www.pstt.org.uk

The Primary Science Teaching Trust (formerly the AstraZeneca Science Teaching Trust) was fully endowed with a grant from AstraZeneca PLC

Primary Science Teaching Trust

Why & How? is the brand name of the **Primary Science Teaching Trust**
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