Primary Science

Number 179
September 2023

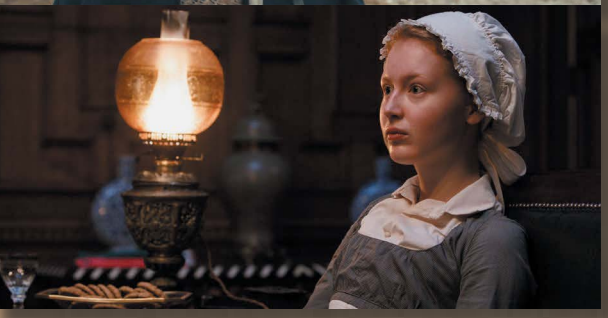
The ASE's journal for primary science

ASSOCIATION FOR SCIENCE EDUCATION

New look!

Mary Anning - A Fossil Hunter's Story

"This project enabled pupils to look at science from a much broader perspective. It challenged their existing ideas and prompted them to raise questions and have very meaningful class discussions"



Our award-winning film, SEA DRAGON, sets the scene for the whole project, introduces trail-blazing paleontologist Mary Anning, and reflects the themes and main ideas being addressed through the learning activities.

This interactive resource features a series of nine core and six enrichment activities which give insights into Mary's life, explore the science of fossils and reflect on the influence of historical, cultural and religious thinking in changing ideas.

The activities are designed to be used flexibly, mainly in science lessons but in some cases are equally appropriate in history, religious education and English. Each activity includes key questions, curriculum links and vocabulary, what children do and learn, classroom resources plus background information for teachers.

Access the resources and award-winning film at:
ase.org.uk/mary-anning

ASSOCIATION FOR SCIENCE EDUCATION

BIG QUESTIONS *in* CLASSROOMS

TEMPLETON WORLD CHARITY FOUNDATION

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ASSOCIATION FOR SCIENCE EDUCATION

Primary Science

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Future themes

Generally each issue of *Primary Science* focuses on a theme, but also includes other articles on a range of topics, so if you have something to write about that is not on a theme or responds to a theme already covered, don't be deterred. All contributions are very welcome. Shorter articles are particularly welcome.

Issue 180 (December 2023) Continuing Professional Development, Meet the Editor and Write for us (deadline for submissions 8 September 2023).

Issue 181 (March 2024) Biology (deadline for submissions 8 December 2023).

Issue 182 (June 2024) Open theme with the results of Write for us (deadline for submissions 8 March).

Writing for Primary Science

Primary Science publishes articles on all aspects of primary science education, including early years, and we welcome articles that:

- support effective classroom practice in teaching, learning and assessing science;
- give practical classroom ideas;
- interpret (rather than simply present) research;
- address issues relating to primary science education;
- comment on controversial articles, issues and debates;
- challenge teachers' thinking about important changes.

Short contributions are very welcome, including notices, letters and short responses to other articles. It may help you if you read one or two articles in *Primary Science* before beginning your own.

The Editor is very happy to advise and support new authors. Contact: **editor.primaryscience@gmail.com**

Detailed guidelines for writing for the journal are available on the ASE website: **www.ase.org.uk/submission-guidelines**

Contributions and comments:
Please send as an email attachment to:
Janehanrott@ase.org.uk

Primary Science is the primary journal of the ASE and is published four times a year.

Safety: Reasonable care has been taken to ensure that articles in this journal do not suggest practices that might be dangerous, and safety warnings are given where appropriate. However, the ASE has not tested the activities suggested and can therefore give no guarantee of safety. For further advice on health and safety matters in primary science education see *Be safe! Health and safety in school science and technology for teachers of 3- to 12-year-olds* (4th edition, ASE, 2011).

The ideas and opinions expressed in this journal are not necessarily those of the Association for Science Education.

Focus

Welcome to *Primary Science 179*. This issue is an un-themed one and contains an inspirational plethora of articles we have gratefully received, which did not fit neatly into any particular theme. However, they are all insightful and useful contributions. Although disparate, by happy coincidence these articles make up a set of mini-themes and so this issue has made use of this to help shape a cohesive whole.

As with our last issue, readers will see that our *'In conversation with...'* piece is again a little different. This opinion piece by class teacher and STEM communicator, Stuart Naismith, on the topic of introducing STEM careers education to young learners, certainly gives some food for thought.

Moving on from this, it seemed logical that articles investigating how children might get the opportunity to view science outside the school setting may prove equally interesting. With this in mind we present two intriguing approaches from new authors. Kay-Lee Dinsdale-Sherrington recounts her school's experience of working with the Ogden Trust, supporting a local community partnership in developing physics in a low socio-economic area. This is followed by a piece by Andrew Bell and his team on partnership working with local researchers and a university to help young learners understand more about microorganisms and disease. Both articles not only evidence the power of such work, but crucially also offer very practical advice on how teachers might establish partnerships and even secure additional grant funding for their endeavour.

Environmental issues are never far from our minds at *Primary Science*, so it will come as no surprise that we have also included articles about biodiversity and renewable energy in this issue. Anne Ford, chair of a wind energy company in Northern Ireland, discusses her team's school workshops, which introduce pupils to renewable energy and culminate in them making their own model wind turbines. The aim is to support science and technology learning while fostering understanding and positive attitudes to wind farms. In the next article, Verity Jones and Marian Hill explain how the arts might reinforce science learning and change attitudes towards insects through engaging in close observation and collage work. Bringing both ideas of partnership working and ecology together, we then have Mark Stead of the Wildfowl and Wetlands Trust talking about Generation Wild, a project aimed at connecting 5- to 11-year-olds with nature. Whether talking high-tech or low-tech, I am sure readers will gain inspiration from these articles.

Science capital and Earth materials are always popular choices for submitted articles. For this issue we have chosen two in particular. In the first, Mary Ennis introduces her own 'school of rock' – using actual rocks! As a new writer for *Primary Science*, Mary offers a passionate insight into how her mixed key stage 2 class created a 'rock and fossil museum' event for their parents and community, learning a great deal in the process. Finally, Jane Essex offers a tribute to the late Professor Chris King through a re-working of some Earth material lesson 'old favourites' – a worthy and thoughtful tribute to her good colleague.

I hope that you enjoy this issue and that it may inspire you to contribute an article sharing your own work and experience with fellow primary teachers.

Robert Collins

In conversation with... Stuart Naismith

Stuart Naismith is a primary teacher in Gartcosh Primary School in North Lanarkshire, Scotland, as well as being a STEM communicator across social media platforms. He has a passion for engaging people of all ages in STEM education and is the creator of the social media education brand '*STEM with Mr N*'. Here he comments on the idea of introducing early careers education to primary-aged children.

The need for talk

There seems to be some debate as to whether science, technology, engineering and maths (STEM) careers should be discussed in primary schools, or whether this is too early for children to be involved in such conversations. Instead, some follow the mantra of 'let kids be kids' and so overlook the topic.

I am old enough to remember not having internet in the house, having a mobile phone that could only do calls and texts, and watching the re-mastered editions of *Star Wars* and thinking how cool the droids were – visions of a far-off future, if we were to ever get there. Recently though, I have had colleagues that have never known life without broadband and pupils with smart phones; I have spoken with a New York fireman about the FDNY's use of drones, and watched robots from Boston Dynamics doing parkour, including flips!

So like it or not, technology is advancing at an incredible pace, impacting across the whole STEM spectrum. There are jobs that exist today that did not exist when I was a child. There is also an increasing gap between the skills that industry requires and the skills of our young people

Opinion ● **STEM careers** ● **Equality** ● **Inclusion**

coming through the education system, as well as a lack of diversity of genders and ethnicities within certain industries. Statistics recently reported by WISE (Women into Science and Engineering) show that, in September 2022, just over a quarter of the STEM workforce were women (WISE, 2022). This was even lower for the engineering and technology sectors specifically, where the numbers are 13% and just over 19% respectively.

When I was being assessed for the Primary Science Teacher Award in 2022, my classroom was visited by two members of the Primary Science Teaching Trust (PSTT). My class were excited to be visited by 'real scientists'. Following their visit, one of my primary 3 (year 2) pupils said to their mum, *'There were two scientists in my class today and none of them were men!'* At face value, this could seem like an innocuous statement made by a 7-year-old; however, I feel that it is a symptom of a much wider issue and that many others would agree.

Equally disturbing is that a report launched by the charity Education and Employers in 2018 (Chambers *et al*., 2018), surveying 13,000 UK primary pupils aged 7 to 11 about their career aspirations, found that children start to rule out STEM career options at an early age. They found that multiple factors affect the children's decisions, including gender stereotypes, socio-economic backgrounds, lack of role models, and representation in media.

With career aspirations starting to form at such an early age, surely children should have the opportunity to learn about different career possibilities, and encounter people who work in these roles, regardless of their gender or background? Wouldn't this be even more helpful if it took place in primary school to help broaden children's horizons as they progress through their educational journey? I feel that it is critical that teachers and parents are also aware of the changing career landscape and options; otherwise we run the risk of many children self-limiting their own future choices – especially those from marginalised groups. I believe therefore that primary schools and teachers have a critical role to play in this from an early age.

Who and what might help?

Providing context

At a very basic level, one way to easily introduce STEM career discussions in the classroom is to link the knowledge and skills being developed with those required for different careers. For example, here are some ways I have used to associate classroom topics with careers in the past:

- Numeracy and mathematics – I teach about contexts in which budgets would be used, such as by a financial accountant.
- Literacy – I teach about functional writing that can be used for a career in journalism.
- Physics, specifically refraction – I talk about lens technicians.
- Algorithms, sequencing and debugging in computing – when teaching these I also introduced the world of software engineering and coding.

Role models

Role models also play an important part in raising the career aspirations of children. One of the key things I do as a STEM communicator is produce monthly interviews on *YouTube* with people working in different STEM careers (search *STEM with Mr N* online). This exposes children and young people to a diverse range of careers they may not have known existed, along with the diversity of ethnicities, backgrounds, genders and routes into STEM of those involved. By hearing from a woman talking about her career in engineering, a Haitian who couldn't speak English when he started school in America, an IT director who quit university to take up an apprenticeship, and a STEM programme leader who quit an apprenticeship to go to university, our young people are exposed to people they may be able to identify with, to careers that speak to their interests, and to opportunities they did not know existed.

Resources

There are various resources out there that can also expose children to different role models, such as the STEM Ambassadors programme (www.stem.org.uk/stem-ambassadors), and the resource *A scientist just like me* from the PSTT (Johal, Trew and Eley, 2021). There are also now books that integrate learning STEM skills in immersive and interactive stories, so children can get involved early in enjoying STEM subjects and learn how they might follow a STEM career.

Dr Thomas Bernard and Lisa Moss, owners of QuestFriendz, a STEM-focused children's book publisher that produces books and educational resources such as the *SuperQuester* series (Figure 1) to encourage and nurture a love of STEM learning, suggest:

> *'Educators, parents and the media should now all turn their attention to engaging a younger generation to build their confidence and curiosity of what STEM is and how a career in STEM is accessible, achievable and exciting. The classroom provides a perfect balanced environment for a discussion about careers in STEM, where accessible and diverse role models, both real life role models and fictional role models e.g. in books and movies, can be used to inspire and spark an interest from a young age.'* (www.questfriendz.com)

Figure 1 Children enjoying the *SuperQuester* book series designed to encourage and nurture a love of STEM learning

Learning resources and programmes from providers can also help. One such is the charity Tech She Can (www.techshecan.org), which produces free learning materials to inspire a younger generation of girls and women to study tech subjects and pursue tech careers; their animations make the subject accessible for age 5 onwards (see *References*). Research carried out by PwC UK (2017), which was the driving rationale behind the formation of the charity, showed that only 3% of females would consider a future career in STEM; this would seem to evidence an immediate requirement to help redress the imbalance.

Conclusion

In my opinion, there should never be barriers to people looking to enter into any STEM field. As educators we have the power to remove those barriers by developing different skills, introducing career discussions in the primary school to tackle gender stereotypes and exposing children to different careers and role models. Ultimately, the choice is there for children to make, while we help them discover the passion that lights a fire inside them.

You can find *STEM with Mr N* at:
youtube.com/c/stemwithmrn
and by searching for *STEM with Mr N* across social media.
Email: nlnaismiths@northlan.org.uk

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PwC UK (2017) *Women in tech: time to close the gender gap*. Research report. www.pwc.co.uk/women-in-technology/women-in-tech-report.pdf

Tech She Can animated lessons: https://techshecan.org/animated-lessons

WISE (2022) *Updated workforce statistics*. www.wisecampaign.org.uk/updated-workforce-stats-september-2022

The Ogden Trust Bridlington Partnership

Science Lead, **Kay-Lee Dinsdale-Sherrington,** reports on her positive experience of working with the Ogden Trust in a school community partnership model

Figure 1 Children at Quay Academy built rockets as part of the Great Science Share; funding from the Ogden Trust was used to purchase water rocket kits

Since 1999 the Ogden Trust has been supporting schools across England with teaching and learning physics, with the aim of promoting the future study of physics at A-level and into higher education, as well as supporting the delivery of a high-quality physics education for all (ages 4–18).

Bridlington is a low socio-economic coastal town in North East England. The Ogden Trust provides support in a variety of ways, such as the development of key school community partnerships, providing CPD for teachers and subject leads, as well as funding for programme and curriculum development.

In 2021, the Ogden Trust reached out to me as Science Lead at Quay Academy; they had identified our school and local area as an ideal fit with the criteria for schools they wanted to join their programme for promoting physics in primary education. Subsequently, I reached out to other schools in Bridlington and received a great response, especially from our local secondary school who were extremely keen to be involved. We submitted an application to the Ogden Trust that was accepted immediately and the Bridlington Partnership was formed.

Within our school community partnership we have six primary schools: Quay Academy, Burlington Junior School, Hilderthorpe Primary School, Bay Primary School, Martongate Primary School and Burlington Infant School, as well as one secondary school, Headlands School. We meet on a termly basis to discuss planning across the year; these meetings also provide ideal opportunities for the primary schools involved to complete valuable science moderation sessions with our feeder secondary school.

In this way, the partnership has really enabled us to share ideas, experiences and opinions with other schools in our local area. My school functions as a hub for the partnership and hosts key meetings, such as planning, CPD, report writing and fund bidding.

What we have done

Since the establishment of the Ogden Trust Bridlington Partnership back in 2021, the Trust has supported us in many, many ways.

In the first year of the partnership a science week focusing on space was hosted at Quay Academy. During this week over 500 children, from all of the partnership schools,

Ogden Trust ● Physics ● Partnership ● Community

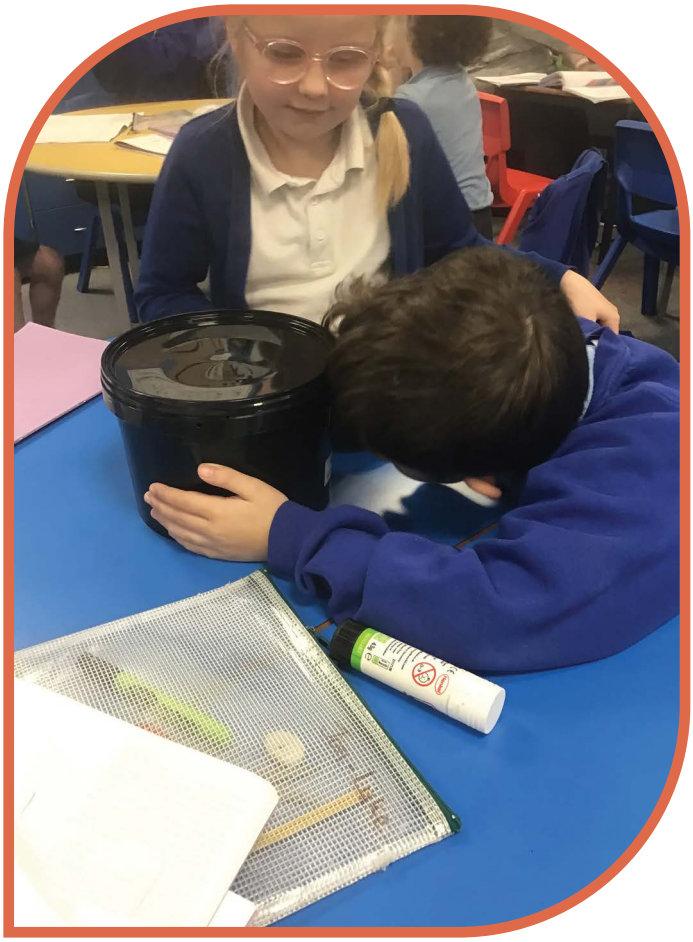

Figure 2 Hilderthorpe Primary School using some of the resources received from the Ogden Trust following our light and sound 'Phizzi CPD' session in year 1

had the opportunity to visit a planetarium, where they were able to experience space as they had never done before. In addition, Professor Brad Gibson, head of the physics department at the University of Hull, delivered a talk about what life is like in space for astronauts. The children were fascinated and asked 'Professor Brad' lots of questions.

After this talk, lots of brilliant ideas and pieces of work were produced around careers in science and more specifically space exploration. Across that year, a variety of different activities were set by the Trust for the partnership schools to complete and share, such as a physics-based photography competition called 'Physics in everyday life'. This encouraged the children to investigate how physics is evident in the world around them and how important physics is in our daily life. The pictures taken and submitted during the competition were amazing, and staff members reported that the competition sparked in-depth conversations with the children.

In Spring 2022, Quay Academy hosted the first 'Phizzi CPD' day, where Science Leads (and additional members of staff) from partnership schools were able to come and receive training on the delivery of light and sound units across all the primary school stages. These CPD sessions are provided by the Ogden Trust free of charge for the first five years of the partnership, with each year focusing on the overarching theme set by the Trust. As a partnership, we also completed the Great Science Share for schools in the same year and intend to do so again in Summer 2023 (www.greatscienceshare.org).

This year we already have plans for another CPD session, run by our partnership's regional representative

Figure 3 Quay Academy children taking part in an 'Astro Camp' day where they learnt about the solar system and what it takes to be an astronaut; the resources can be accessed by all the Bridlington Partnership schools

Bryony Turford, which will again be hosted at Quay Academy; this time the focus will be 'Earth and Space'. From quiet beginnings, our partnership schools now regularly use *Twitter* to share our great ideas and what we have been doing across our partnership schools in science, providing comments and an opportunity to engage our local community and beyond (Figure 4). To date the work with the Trust has been fun and effective in getting the message of 'physics for all' out into the Bridlington community.

The future of the partnership

At Quay Academy and across the Bridlington Partnership as a whole, our experience with the Ogden Trust has highlighted how important it is that future science careers and aspirations, especially those in physics, are at the forefront of our plans for future activities. With such early and immediate learning gains in science education, we really look forward to the next four years. We hope that our partnership will lead to even further development of the science curriculum in general and physics in particular in the partnership schools. It would be great to see more schools joining in partnership working to allow for more collaborative learning in primary science within communities.

Figure 4 The partnership schools use *Twitter* to share what they have been doing and engage with each other and the local community

Quotes from participants

'The Bridlington Partnership with the Ogden Trust has enabled me, as a subject leader, to gain a better insight into the primary science curriculum. The free CPD we have received has enabled us to deliver high-quality science lessons back in school, with children having access to quality resources that aid hands-on, practical lessons. We have been able to collaborate and share ideas within the partnership, which has made our links with other schools stronger.' (S. Robson, Science Lead, Bay Primary School)

'Hilderthorpe has thoroughly enjoyed being a part of the Ogden Trust Partnership. It has enabled both leaders and teachers to take part in high-quality CPD in topics that have quite abstract concepts. As Science Leads, it has given us the opportunity to meet regularly within the partnership to moderate and share good practice. Since having the high-quality CPD, we have adapted our planning to ensure the light and sound topic resources are incorporated into the lessons.' (G. Pugh, Science Lead, Hilderthorpe Primary School)

'Working with the Bridlington partnership as their regional representative has been brilliant this year. The enthusiasm with which Kay-Lee leads the partnership is fantastic; nothing is too much trouble and I know the other schools in the partnership really appreciate this. As regional representative in Yorkshire and the Humber, I am privileged to get an insight into the exciting physics enrichment activities that the partnerships plan as well as deliver the Phizzi CPD package each year. These activities are built around local needs and capacities and include a wide range of activities such as the ones Kay-Lee has outlined. As this partnership grows, more opportunities are developed including funding for a Phizz Lab at Quay Academy, which will benefit the whole town for years to come.' (B. Turford, The Ogden Trust Regional Representative)

If you are interested in starting a partnership in your area, you can find out more on the Ogden Trust website: **www.ogdentrust.com/school-partnerships**

Kay-Lee Dinsdale-Sherrington is a teacher, Science Lead and Ogden Trust Bridlington Partnership Coordinator at Quay Academy in Bridlington, East Yorkshire.
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Bringing science alive in your classroom with a Royal Society Partnership Grant

Helen Hooper, Andrew Bell and **Chloe Mitchell-Lawson**

reflect on the impact of a Royal Society Partnership funded programme of outreach and share some tips on how to apply

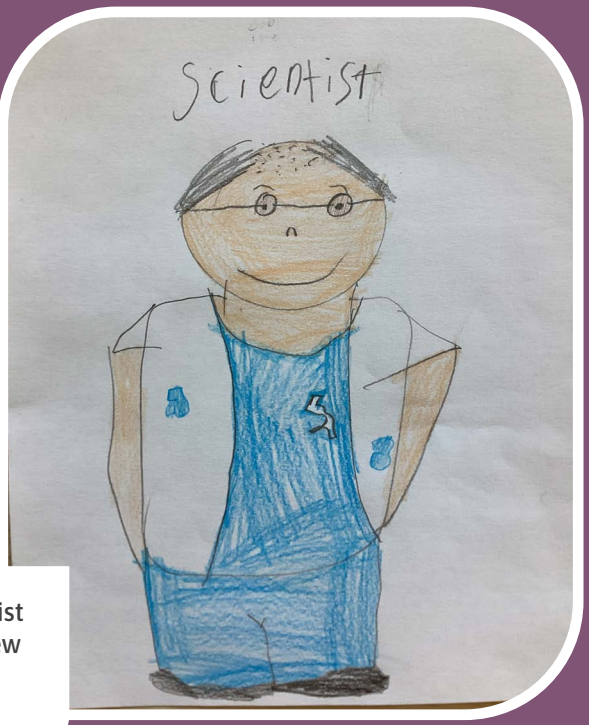


Figure 1 When asked to draw an image of a scientist at the start of the project, most of the children drew happy, but stereotypical, images of bespectacled male scientists wearing a lab coat.

What inspired our project?

Children around the world have lived through the COVID-19 pandemic and have had their lives hugely affected by something that they struggle to comprehend, given that it can't be seen. This simple fact drove our decision to work together to develop hands-on activities that reveal the hidden world of microorganisms to children in an exciting and memorable way.

Ordinarily, bringing this topic to life in a primary setting is a challenge for many reasons: lack of equipment and teachers' specialist knowledge on the subject and worries over health and safety in primary settings are all practical and understandable barriers to moving beyond textbooks and internet resources.

We started by brainstorming a list of learning points pivotal to understanding this subject:

- What are microorganisms?
- Where and how do microorganisms grow?
- How can microorganisms be detected?
- What substances kill microorganisms?

Science project ● **Funding** ● **Royal Society**

This motivated us to seek support from the Royal Society Partnership scheme to develop an enquiry-based programme of activities. A significant advantage of the scheme is an award of up to £3000 to the school to purchase the equipment and resources necessary for the project and ensure that activities are sustainable beyond the project end.

Our project: What is a microorganism and where do they grow?

Our project was designed around the seven key skills for working scientifically in the primary curriculum for our 56 year 5 children (ages 9–10). An initial exercise confirmed that the children's knowledge about this topic was limited but they were very enthusiastic about finding out more, especially by carrying out their own investigations.

An initial draw-a-scientist activity revealed some talented artists and stereotypical perceptions, with the majority of images portraying male scientists (Figure 1). This exercise opened up discussion about the types of people who are actually scientists and about where and how science is 'done'.

University lecturers and undergraduate student STEM volunteers visited the school on four occasions to help children and teachers learn new information about microorganisms and develop their practical and enquiry skills, including how to operate the new school luminometer to detect bacteria (Figures 2 and 3). STEM partner staff and student volunteers helped guide children to design and conduct their own enquiries to explore the following research questions:

- Which areas around school host the greatest number of microorganisms?
- Which antimicrobial agent is the most effective?

Year 5 researchers detected few microorganisms growing on their personal ipads and concluded this was evidence of very good hand hygiene. They also advised teachers

Figure 2 Meeting diverse professionals helps children to understand the relevance of science and challenges stereotypes

Figure 3 Student STEM volunteers helped children and teachers use new equipment such as the luminometer

Figure 4 Using a trans-illuminator in a university teaching lab

to clean their staffroom microwave more often, due to the very high numbers of microorganisms they detected in it! The children also confirmed their predictions about how effective hand sanitiser and disinfectants were at killing bacteria, but were surprised at how effective some natural substances like garlic juice were.

A taster experience of studying science at university

As well as helping supervise investigations in a teaching laboratory using a range of specialised equipment, students volunteered to lead children on a campus tour of key study sites and facilities, including the university library and the students union. Laboratory investigations focused on normal bacteria and bacteria that are genetically modified (GM) with a gene from a bioluminescent jelly fish. They observed that GM bacteria glowed green under UV light and had an additional band of DNA when compared to normal bacteria (Figure 4).

'You can't be it if you can't see it'

Our project, made possible by the Partnership scheme funding, enabled children to learn and apply disciplinary knowledge with guidance from trained professionals, answering questions that they would previously only have researched theoretically. However, an equally important aim of the project was to provide children with the opportunity to meet a diverse range of people studying and working in science. We recruited technicians, undergraduate and postgraduate STEM volunteers and university librarians, in addition to academic staff, to help deliver activities. We asked volunteers to actively discuss and invite questions about studying, working and researching at a university, and talk about their career aspirations (alongside developing disciplinary knowledge and skills). This helps bring alive how science is studied and researched, clearly demonstrating that 'normal' people study and work in science and that science is something to which any child can aspire.

STEM Learning report that teachers who take the leap and work with STEM professionals think that this leads to far better engagement and deeper learning. Children given concrete experience of links between the science they learn about in school and a real-life context often learn more and retain this learning longer term, as the experience is more meaningful and relevant to their own lives (www.stem.org.uk).

Showcasing our project

For science week, the children were challenged to prepare presentations and communicate their findings at a very successful STEAM Community Connections Conference (STEAM includes art in STEM) held in a local community centre. They presented to the wider school community, including over 30 parents (Figure 5). As well as this helping them to develop the key skill of science communication, it was a great opportunity to showcase our project.

Reinforcing learning across the curriculum

We worked with other school subject leads to build in opportunities for the children to consolidate, apply and extend the learning gained to other subjects. For example, children were asked to recall what they had learned about different types of microorganisms by drawing them in art classes and they created an impressive range of ceramic models of different bacterial shapes and structures in a clay-modelling workshop (Figure 6). Microbiology-themed books, such as *The bacteria book: gross germs, vile viruses and funky fungi* by Steve Mould (DK Children) were provided as reading options. Using spreadsheet software, children created tables to record and organise their own data and perform calculations, for example averaging data.

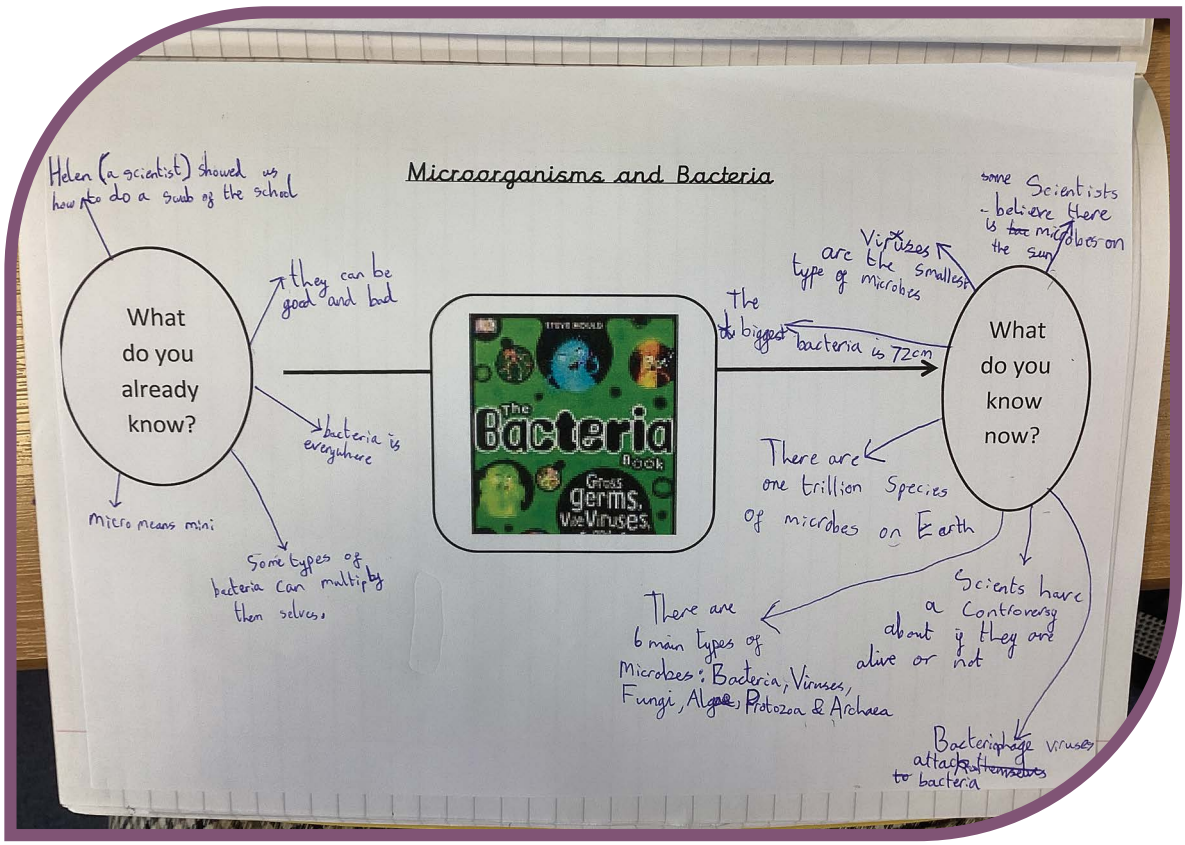
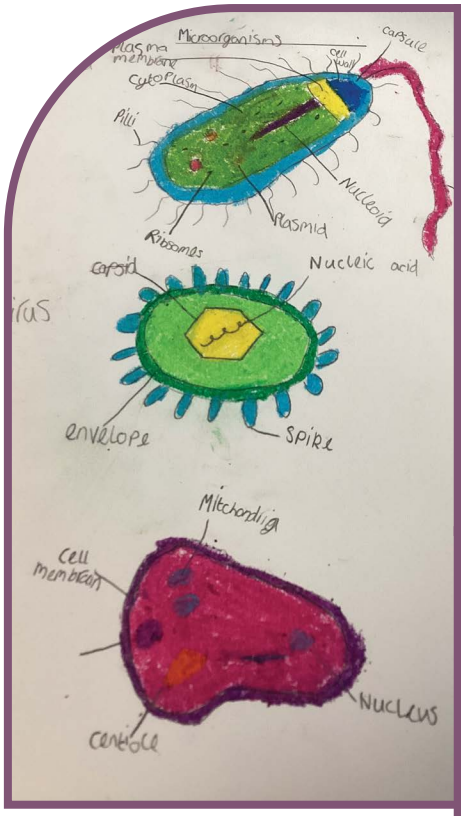
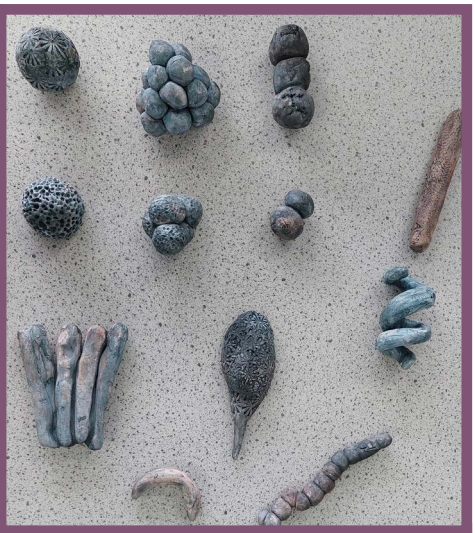


Figure 5 Children developed the key skill of communication by preparing and delivering presentations





Sample	Average RLU (relative light units)
Bacteria control (bacteria + water)	1593
Bacteria + Lemon juice	0.75
Bacteria + bathroom cleaner	280.25
Bacteria + Lab cleaner	19.5
Bacteria + Garlic juice	57

Figure 6 Reinforcing learning across subjects helps children consolidate new knowledge and make relevant links between subjects

Key features of the Royal Society Partnership scheme

Who can apply?

- Two partners must be involved: a UK school partner and a STEM partner from academia or industry. Children must be between 5 and 18; however, reception years are eligible if the project is run in conjunction with other age groups.
- The Royal Society provides a lot of detailed guidance, but they also offer free online training and drop-in support sessions, as they know writing grant applications is often new to teachers.

Finding and catching a STEM partner

- The Geordie proverb 'Shy bairns get nowt!' may be useful to bear in mind here!
- You may be surprised by the range of STEM careers represented in your school's wider community, so try asking families and colleagues about their relatives and friends who have STEM careers in academia or industry.
- The STEM ambassador network is a national network of volunteer STEM professionals from both academia and industry; you can make a STEM ambassador request at: www.stem.org.uk/stem-ambassadors.
- Most universities promote and support staff and students to get involved in (STEM) outreach to improve access and widen participation, so try a direct approach to staff at a local university, and/or get in contact with staff from your own university.
- For industrial partners, try approaching science and technology companies, especially large organisations as they are most likely to engage in outreach and promote engagement, including offering staff volunteering days.

What kind of project is funded?

- The project title must be a scientific question that children attempt to answer by completing their research, that is you must apply for a specific research project rather than a series of activities or experiments for a STEM club.
- Applications that include sustained STEM partner involvement and generate legacy are desirable.
- Examples of previously funded projects to spark your own ideas and illustrate the breadth of investigations are provided on the case studies page, which includes project titles, a project poster gallery and a number of video case studies.

What is involved in making an application and what time is required?

- The school partner leads the application. There is an online application form with sections for each partner to complete separately and collaboratively. We found this useful, as a single 'current' application that is accessible by both partners avoids confusion or delay that might arise from emailing drafts back and forth.
- If you are successful you are required to complete an interim summary report and generate a project poster – remember to take photographs of activities to include! A final report and poster are also required.

When can I apply?

- There are three submission deadlines each year. The application process is a bit complicated as there are two review stages, meaning you should submit your application at least one term before you want your project to start, to allow time for judging applications and to transfer funding to successful applicants.
- An application timeline that includes indicative deadlines by which applicants should be informed about an application outcome is available. However, we experienced quite a lengthy delay to the final decision, and thus a delayed project start meaning a reorganised schedule of activity.
- If you have an inflexible project start date (e.g. if your project involves early summer fieldwork) it may be prudent to apply two terms in advance of your required project start date in case of any delay to the final outcome decision.

More information about the Royal Society Partnership grants scheme: https://royalsociety.org/grants-schemes-awards/grants/partnership-grants

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Climate creativity in the classroom

Anne Ford, Chair of Drumlin Wind Energy Co-operative, reports on the workshops it provides for some primary schools in Northern Ireland

Figure 1 Primary pupils designing and making their own model wind turbines as they learn about renewable energy

Since 2017, pupils at about 30 primary schools, several situated close to wind turbines in Northern Ireland, have been introduced to renewable energy through the Bringing Renewable Energy to Schools Initiative (BREESI). This initiative has been developed and implemented by an education team supported by the Community Fund of the Drumlin Wind Energy Co-operative (www.drumlin.coop). This citizen-financed cooperative, owns and operates six 250 kW wind turbines across Northern Ireland. The turbines were financed by the investments of the cooperative's over 900 members who are motivated by their environmental and sustainability concerns and their understanding of the threats of the climate crisis for future generations.

The extreme weather events and wildfires of 2022, arising from global warming, have vividly illustrated the urgent need to move away from burning fossil fuels – coal, oil and gas – to a means of generating electrical energy with minimal harmful effects on the environment. Burning fossil fuels produces carbon dioxide, which enhances the blanketing effect of the atmosphere, increasing temperatures near the Earth's surface, melting the ice caps, raising sea levels and changing air and water currents that are major influences on climate.

In December 2021 the Northern Ireland Minister for the Economy published the NI energy strategy, *The path to net zero energy* (Northern Ireland Executive, 2021). This set the target that by 2030 70% of energy used in Northern Ireland is to be produced from renewable resources, leading to net zero energy-related greenhouse gas emissions by 2050. The 2022 Climate Change Act (NI) stipulated that at least 80% of electricity must be from renewable sources by 2030 – an even greater challenge!

Achievement of these targets will necessitate expansion of electricity generation from non-polluting renewable resources and development of new technologies, not only in energy production but also in energy efficiency, heating, transport, environmental management and farming. An essential aspect of this strategy is the need for behavioural change to enable us to meet these targets. Education is critical in meeting future needs: where better to start than with eager young minds in primary schools, open to creating new possibilities?

Renewable energy • Cooperation • Citizenship

The programme

The BREESI programme offers schools an opportunity to learn about renewable energy and to take part in a practical exercise to build a model wind turbine. In a 3–4 hour classroom session, pupils learn about Michael Faraday's discovery of electromagnetic induction and the use of this technology in power stations. Pupils are challenged to consider reasons for moving from fossil fuels to renewable energy and, in groups of three, to design and build their own model wind turbines. They also discuss reasons for using renewable energy sources, like the Sun's radiation and moving wind and water, comparing their effect on the climate and environment with burning fossil fuels.

The class is then given a lesson on how to use their tools safely: low-melt glue guns, bench hooks and junior hacksaws. A range of additional resources is made available to each group, including 600 mm lengths of wood of 10 mm square cross section, dowel rods, small electric motors, batteries and battery holders, propeller blades, 4 mm leads with crocodile clips, and discarded materials such as used cardboard boxes.

Pupil challenge

From these resources, each trio of junior engineers is asked to design and construct a wind turbine, initially developing their ideas on a design sheet on which they must draw and label their design.

Their task is to design and build a tower on a base to support an electric motor and mounting with an attached propeller. Specifically, their design sheets should:

- include measurements and details of the materials to be used;
- show at least two views of the completed wind turbine;
- record notes on any improvements during construction in order to match the detail on the design sheet;
- consider strength and stability, economic use of resources, and aesthetics of the product;
- ensure freely moving propeller blades and a motor and propeller structure that is able to freely turn through 360 degrees;
- enable the tower to be moved with ease from one site to another.

(Design sheet templates, follow-up exercises, evaluation questionnaires and other relevant documents can be found on **www.drumlin.coop/educational-resources**.)

In an electric motor, electric current and a magnetic field are normally combined to provide rotational motion. In the pupils' activity this action is reversed and the motor acts as an electric generator: rotational motion and a magnetic field combine to provide electric current.

Pupils produced a variety of turbine structures. Each turbine, producing electric current, was connected in turn to a multimeter. A hair dryer – with heat switched off – acted as a wind source playing on the propeller attached to the shaft of the motor. After testing their wind turbines and seeing that they did create electricity, the pupils were then provided with batteries to connect directly to the motor. This allowed them to experience the reverse process and explore how reversing the battery terminals caused the blade to rotate in the opposite direction.

Figure 2 Pupils are taught how to use tools safely before getting down to work on their constructions

Feedback from pupils and teachers

Evaluations were carried out by at least one teacher and three or four pupils in every participating school. Pupils' evaluations were very positive. They took great pride in their achievements and reported how much they enjoyed the practical sessions, asking pertinent questions and wanting to know more. They enjoyed their independence particularly in using tools with minimum supervision. Some pupil comments exemplified their desire for opportunities for self-direction:

> *'It helped me work more creatively.'*
>
> *'We got to use our imaginations.'*
>
> *'I didn't have to follow step-by-step instructions.'*

Teachers were equally positive, saying that the programme had increased their confidence in enabling pupils to use tools and take part in practical STEM activity. They felt that they would have more confidence in implementing practical activities in class, and make greater use of group work in their future teaching. They also reported an increase in their confidence in handing more control and decision-making to pupils, and they felt that in future they would try not to structure STEM lessons so tightly. They could see the value in giving pupils greater independence and engaging them in problem-solving tasks. Teachers also stated that following the workshop they would continue to teach about environmental issues and the importance of renewable energy.

Links to the curriculum

The programme is designed to support both a 'hands-on' and a 'minds-on' approach to learning and is thus well suited to the skills-focused Northern Ireland primary curriculum. The curriculum specifies that pupils should be encouraged to explore the effect of people on the environment, to develop skills and capabilities to enable them to contribute to society, and to continue learning effectively throughout their lives. These capabilities include managing information, thinking and learning, problem-solving and decision-making, being creative, working with others and self-management.

As science and technology is not a core subject within the curriculum, it has a low profile within many primary schools in Northern Ireland. Most primary teachers have a limited science and technology background, and may not have the confidence to offer practical STEM activities; they welcome external support such as the BREESI programme. The Northern Ireland economy depends on manufacturing industry. This in turn requires an effective science education at school. Most primary pupils have developed a sense of direction – for or against – in relation to STEM subjects before they leave primary school. So, if they don't experience science and technology here, how are they to decide on their future career? And how will the planet continue to support its growing population if there are insufficient citizens with the understanding, capability and vision to effect solutions to emerging problems?

Figure 3 Student teachers design and construct their own turbine towers in a university workshop

Working with initial teacher education

The programme has recently started working with initial teacher educators to provide workshops for undergraduate student teachers and to encourage them to include these activities during their school placements and throughout their future teaching careers. In May 2022 the Drumlin team led three sessions with about 100 students at Stranmillis University College Belfast. The programme is now included in the College's module 'Teaching sustainability and climate change in the primary school'. Each session included a short description of the nature of Drumlin Wind Energy Co-operative and its commitment to support for education. The workshop also explored the science concepts behind electricity generation and storage, as well as classroom management and health and safety. As with the schools' programme, the students were provided with all the materials and tools they might need and were required to design and construct their own turbine tower (Figure 3). The Drumlin group intends to continue and extend its work with ITE.

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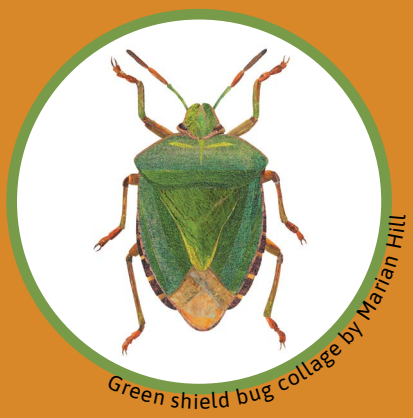
Learning to love creatures that buzz and scuttle


Green shield bug collage by Marian Hill

Primary science teacher educator **Verity Jones** wants children to recognise the importance of insects and learn to love them through close observation as illustrator **Marian Hill** does

The UK has seen a 60% reduction in flying insects in the last 20 years as a result of climate change (Ashworth, 2022). This dramatic fall is not just an echoing death knell for insects, but also for other creatures in the food chain that rely on them. For example, a decline in woodland birds may relate to the decline of insects usually found within their habitat. This decline may well be felt by humans too: as many insects are also pollinators; food we have come to enjoy may see a nosedive in availability. There may be smaller harvests (and therefore higher prices) for products such as pears, apples, cucumbers and the increasingly popular almond – now often used as a plant alternative to dairy milk.

It has been estimated by the UN Environment Programme (2019) that in the next 40 years as many as 40% of the world insect species could become extinct. This includes butterflies, ants and bees. This rate of loss has been estimated as being 8 times faster than that of mammals, birds and reptiles, with the total mass of insects falling by 2.5% every year.

Without doubt we need to protect insects. However, public perception of 'creepy crawlies' does nothing to encourage empathy for their plight, with phobias to insects and spiders among the commonest in the UK. Insects and spiders can induce anxiety and fear to the extent that spending time outside is avoided. We know, however, that spending time outside develops a connection with the planet and helps to embed empathy for sustainable citizenship. We therefore think that it is essential that young learners find out about the wonders of insects as early as possible and have opportunities to find them outside, observe them and discover how we can work towards protecting them.

Gardens and changing public perception

Gardens, in their many shapes and sizes are where many of us have access to insects; it may be at home, the school garden, a planted bed in the local park or window boxes along a high street. Historically, however, gardens have been created for the enjoyment of the rich and powerful rather than representing any authentic eco-guardianship (English Heritage, undated). Although no longer the sole privilege of ancient aristocracy, even today many of our gardens present an artificial version of nature where humans can quite literally weed out undesirable features and create idealised places.

I grew up in the 1980s when a 'perfect' English garden was thought by many to be one full of beautiful, colour-coordinated flowers. Even a slightly rambling cottage garden would be well maintained, with borders neatly edged, lawn mowed in stripes, topiary trimmed, flowers deadheaded and mess cleared away. In these settings no leaf should be nibbled, blue slug pellets would be liberally scattered over well dug flowerbeds, ants exterminated with poisonous powder, greenfly sprayed, lawns fed with fertiliser and weeds killed with an array of chemicals. With all of these chemicals, insects were threatened.

Today, organisations like the Wildlife Trusts are helping to eradicate this old-fashioned view of domestic horticultural practice and protect and grow the estimated 24 million

Biodiversity ● **Science** ● **Art**

gardens in the UK so that they become a refuge for wildlife – including insects. Schools have a part to play in supporting this growing biodiversity. In England, the Government's recent publication, *Sustainability and climate change: a strategy for the education and children's services systems* (DfE, 2022) envisions school grounds and gardens as a 'National Education Nature Park' where biodiversity flourishes, where children can develop connections with nature, increase their knowledge of species and develop skills such as biodiversity mapping.

Planting for insects

One way of improving biodiversity on school grounds and in gardens is by deliberately keeping insects in mind so we no longer rely on chemical controls. By also carefully choosing pollinator plants that have flowers, scents and rich colours we can create nectar stations for insects to thrive. Keeping piles of rocks, tiles and logs creates rich habitats in which insects can live. You will also find that some beetles eat slugs and snails, while others compost for you. Children soon realise that these lovely creepy crawlies are helping the garden to thrive!

Flowering plants will attract many other, often beautiful, insects into the garden. Spotting and recording these can become a useful and fun educational game for children, either during formal lessons or, more often than you might imagine, during time spent in the school garden with their friends. Having a short checklist of garden insect visitors will help them identify the biodiversity present. Some of the more common species they might spot are shown in Box 1.

Categorising plants, growing specimens from seed and observing growth over a season are all great ways to educate and enthuse young learners about biodiversity and the importance of insects. But, if you want children to become really familiar with an insect, nothing beats taking a really close look at them. If you have the opportunity for a bug hunt in the school grounds, using magnifying glasses (or even borrowing microscopes from the local senior school) is a great way of looking at how insects are the same and different from other species and organisms.

A family insect collage workshop

Box 1 Common plants and the insects they attract

- **Nettles:** Red admiral, peacock and small tortoiseshell butterflies
- **Thistles:** Painted lady butterfly
- **Wild grass (left to grow tall):** Gatekeeper, meadow brown and skipper butterflies
- **Garlic mustard:** Orange tip butterfly
- **Bird's foot trefoil:** Common blue butterfly
- **Holly and ivy:** Holly blue butterfly, ladybirds and ground beetles
- **Alder and buckthorn:** Brimstone butterfly
- **Dock leaf:** Dock beetle
- **Marigold:** Hoverflies, parasitic wasps (they don't sting)
- **Dandelion:** Lacewings (they eat aphids)

2-spot ladybird collage by Marian Hill

Art and science

Such close observational work could culminate in an art project. You could explore art pieces such as Martin Wells' *Insect Dissection* which captures both the inside and outside of the insect through painting, Mandu Mmatambwe Adeusi's untitled artwork of a bird about to eat a fly, Michael Kidner's abstract representation of *Mosquito Larvae*, Millie Marotta's intricate line drawings or Thrussells' *Ladybird* sculpture.

The collage technique used by Marian Hill for her insect illustrations may also inspire the children. Marian's love of creatures that buzz and scuttle began during lockdown when she took to looking more closely at her tiny garden and began to collage each beetle she found. Before long she couldn't believe the huge amount of diversity she had found hiding under leaves and between the rocks. Inspired by this biodiversity, Marian's illustrations are created by looking really closely at insects and then collaging together many snippets cut from old magazines and photographs. She says:

> *'I like the clean edges and textural quality which collage brings to my work, creating illustrations of insects that are vibrant, eye-catching and can look very realistic.'*

The collage technique Marian uses to make her insect illustrations is easy for children to grasp and emulate. Collaging with old magazines is a cheap and simple process that can create wonderful results. It requires only very basic craft equipment: scissors, glue and coloured paper scraps.

The creativity involved brings learning about our national biodiversity to a new level, as such activity has often been linked not only to employment of cognate processes by children, but also to enhancing mindfulness and positive mental health. Essentially, when they are engaging with the natural environment of the school garden, do not be surprised to see children thoroughly enjoying chatting about the insects they have spotted, and taking their time to look carefully at the individual characteristics of specimens. They may even have grown to love the 'creepy-crawlies' they once feared!

Top tips for successful insect collage work

- Have high-resolution photographs of insects, or parts of insects for the children to look at, identify and name.
- The look of the final product will depend on the materials provided so gather as much material as time allows – photos, textural material, magazines, odd snippets from the photocopier and paper cutter all make good resources.
- If you are observing live specimens be mindful of the animal's wellbeing. Keep handling to a minimum, provide water and shelter and release back into a safe habitat as soon as possible.
- Never glue until the very end! This allows pieces to be moved and adjusted – using sticky tack can be helpful if children want to see what the piece will be like once fixed.

Verity Jones is Associate Professor of Education and **Marian Hill** is a Senior Lecturer in the Illustration Department, at the University of the West of England, Bristol. Marian has been an illustrator for over 20 years, creating images for magazines and books.
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Instagram: @Marian.Hill @VerityJones_Edu
Twitter: @Hill_Marian @VerityJones_Edu

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Resources

To get involved in the Wildlife Trusts' Gardening Survey and access free guides on how to help insects go to: www.wildlifetrusts.org/wildlife-gardening-survey

Marian's posters of general invertebrate species for grassland, woodland, gardens and parks as well as seasonal guides for spring, summer and autumn that can be used in seasonal bug hunts can be freely downloaded for educational use from her website: **www.buzzandscuttle.com**

Figure 1 A visit to a wetland centre can be a springboard to further activities connecting children with nature

Generation Wild: Connecting disadvantaged children with nature through storytelling and adventure

Mark Stead from the Wildfowl and Wetlands Trust reports on an exciting project it is running to connect children with nature

Nature ● Storytelling ● Reconnecting ● Learning

What is Generation Wild?

The Wildfowl and Wetlands Trust (WWT) is the UK's largest wetland conservation charity. Connecting people to nature has been central to our work since Sir Peter Scott founded WWT at Slimbridge in 1946 as a centre for science and conservation. Uniquely at the time, he opened it to the public so that anyone could enjoy being close to nature; an opportunity that our wetland reserves now offer thousands of people each year.

Generation Wild is WWT's free nature connection project for primary schools, children and families in economically disadvantaged areas. Aimed at children aged 5–11, the project runs across seven UK wetland centres, using free school meal data to determine eligible schools in the areas surrounding each site. Generation Wild is running across three academic years, 2021–22, 2022–23 and 2023–24, and it is envisaged that across that time, 45,000 children will have taken part.

A new approach

The project is based on the five pathways to nature connection identified by the University of Derby: contact, emotion, beauty, meaning and compassion (University of Derby, undated). Traditionally, our learning programmes have taken a largely knowledge and facts-based approach. We now believe that it is not enough to simply learn about nature. If people are to come to truly love and protect the natural world they need to experience it directly: to see, hear, smell, touch and taste it. Most importantly, they need to feel part of nature. We believe it is this approach that will improve children's wellbeing and create the next generation of nature lovers.

We also recognise that we cannot do it alone. We can create the initial spark of inspiration but it is teachers, parents and carers who will provide nature connection experiences for their children in the long term. Generation Wild therefore uses a visit to our wetland centres as a springboard to further activity back in local communities (Figure 1). It aims to show both parents and teachers that nature connection need not be difficult. You do not need to know everything about the plants and animals you see – and you certainly do not need the latest clothes and equipment. Nature connection can be as simple as walking across a field barefoot or rolling down a hill. In fact, these experiences are often much more powerful than looking at a bird sat miles away through an expensive telescope.

How does it work?

We use a story-based approach, effectively melding the arts and the sciences and creating a sense of magic and adventure that appeals to all children. The project is based around the story of Ava the bird–girl (Figure 2). The children are first introduced to her story through an interactive digital storybook that they read together as a class. Ava starts life as an osprey. She is warned not to get too close to humans because they have become disconnected from nature. But when she sees a mysterious giant nest, the temptation is just too great. She lands on the nest and falls into a deep sleep. When Ava awakes, she has magically transformed into a part-osprey, part-human girl. However, she can't remember who she is or how she got there.

The children then visit the wetland centre where they unexpectedly stumble across Ava in life-size puppet form, asleep in her giant nest (Figure 3). She explains that she thinks the animals on site might know what has happened to her and she has made magical listening devices called 'translatorphones' that will enable the children to hear and understand what the animals are saying. She thinks the animals will be distrustful of humans at first, so the children need to complete activities to prove that they are willing to connect with nature.

The children follow a trail where they complete activities and explore some of the secrets of Ava's story. They discover that Ava's destiny is to reunite humans and the rest of the natural world. This task has been endowed on her by the 'Guardians of the Wild', a great movement of animals that works to protect the Earth and all its inhabitants. If the children connect with nature where they live, they too can become Guardians – the first human members for thousands of years. Because Ava is an osprey, she needs to migrate to West Africa. On the way, she must recruit other children as Guardians, creating a mass movement of children in support of nature.

Back at school, the children log in to our specially designed website. Here they track Ava on her journey and provide evidence of nature activities completed in their school grounds, gardens and local green spaces. Any child who completes ten activities becomes a Guardian and receives a certificate and membership badge in assembly. This element aligns strongly with the National Nature Park and Climate Leaders Awards being developed as part of the DfE *Sustainability and climate change strategy* (Department for Education, 2022). Children also have the option to return to the wetland centre for free with their family. There, they can share the wonder of Ava's

Figure 2 Ava, a part-osprey, part-human girl, demonstrating humans' connection with nature, greets children visiting a WWT centre

story with their families and show them how easy it is to connect with nature.

Why was the project developed?

At WWT, we believe that nature is for everyone, not just the privileged few. Evidence shows that children from economically disadvantaged communities have fewer opportunities to connect with nature, while potentially having the most to gain from this connection. Nature connection has been shown to improve wellbeing while developing a love and care for nature; a win-win for both children and the natural world.

Figure 3 Children enjoy Ava's giant nest before setting out on the activity trail to explore the wildlife

What impacts has the project had so far?

During the first year of the programme, 12,500 children took part. They completed 25,000 nature activities in school grounds, gardens and local green and blue spaces. 1000 of these children went on to become Guardians of the Wild. Teachers reported a range of behaviour and wellbeing benefits experienced by the children. A big part of this was the changes they had seen in children with behavioural or emotional difficulties:

> *'He was one of the children with the most severe behavioural difficulties I've ever seen in 17 years ... but he would sit and he would build this bug hotel beautifully, and even make little beds to put in it, in case they wanted to go to sleep ... you know, and so for a child who is incredibly difficult ... and you know, he doesn't show emotions. Well, he's now showing a lot of empathy!'*

Children also reported mental health benefits. Many children referred to moments of calm that they do not often get in their lives. Nature provided a space to escape the stresses and strains of everyday life as well as providing opportunities to slow down and reflect. It has also given the children a sense of freedom, fun and happiness and many talked about how carrying out the activities had made them feel good about themselves:

> *'It got my brain working, while it keeps me calm on another level, distracting me from my bad thoughts.'*

> *'I liked how live and free I felt whilst rolling on the field.'*

> *'It gave me a moment to just feel happy.'*

> *'It made my heart feel good inside.'*

It has helped children to appreciate the wonder and beauty of nature and provided real moments of magic, awe and wonder. Most importantly, it has made them feel part of nature where before many felt separate from it:

> *'It was so overwhelming for me. It was magical.'*

> *'It felt like nature is close.'*

The children have come to appreciate the importance of nature and many have overcome a fear of creatures that they now love but would previously have tried to destroy.

For many children, the programme has led to a sense of kinship with nature. They have come to see other creatures and even plants as their friends. One of the activities was to make friends with a tree by experiencing it with all your senses. For some children, this tree developed a special meaning for them and a special place in their lives. It became somewhere to go when they were feeling lonely, something that was always there for them and made them feel safe.

Generation Wild runs across seven WWT wetland centres in the UK:

Arundel Wetland Centre, West Sussex
Castle Espie Wetland Centre, Co. Down, N. Ireland
Llanelli Wetland Centre, Carmarthenshire, Wales
London Wetland Centre, Barnes
Martin Mere Wetland Centre, Lancashire
Slimbridge Wetland Centre, Gloucestershire
Washington Wetland Centre, Tyne and Wear

If your school would like to take part in this programme, you can see whether you are eligible and book onto it at: **www.generationwild.org.uk.**

Mark Stead is Head of Education at the Wildfowl and Wetlands Trust.
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School of rock: Enthusing children by celebrating science curriculum links

Mary Ennis describes how curriculum links and science capital were developed through hosting a celebratory 'Rock and Fossil Museum' event

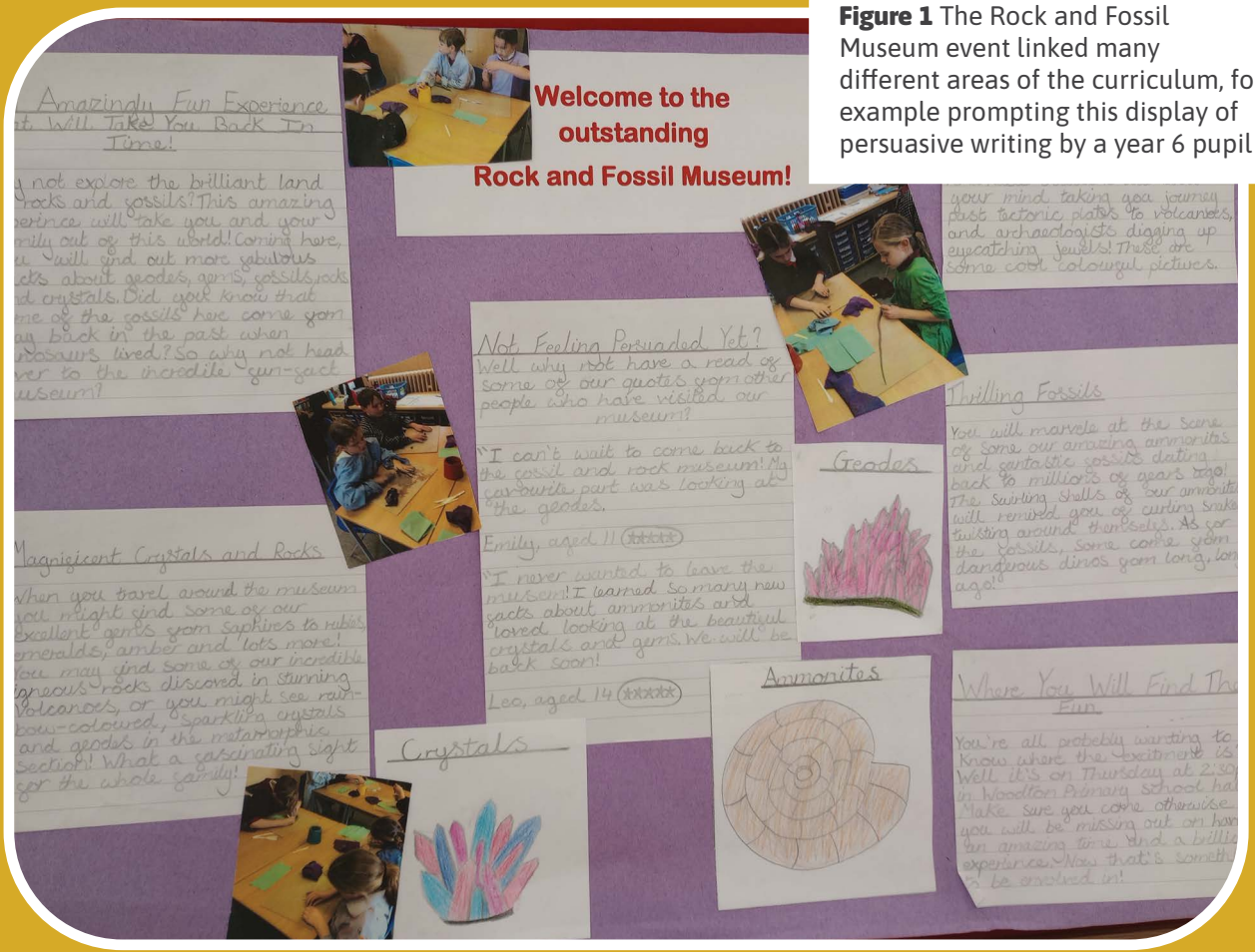

Figure 1 The Rock and Fossil Museum event linked many different areas of the curriculum, for example prompting this display of persuasive writing by a year 6 pupil

Geology ● **Curricular links** ● **Fossils** ● **Showcase**

When my mixed-age key stage 2 (ages 7–11) class began the topic of 'rocks and fossils', I was delighted with how enthusiastic and engrossed the children were with the subject. Perhaps the school's proximity to Norfolk's Deep History Coast (see *Weblinks*) was a contributing factor, as many of the children in the class were used to fossil-hunting trips to the beach with their families, often finding belemnites and other intriguing items strewn across the shoreline. Whatever the reason, the children were keen to engage in this fascinating topic and to bring in their treasures and finds to show and share. This interest was the catalyst for our class decision to make the most of the children's finds as a learning opportunity. Together, the children and I agreed that we should share our rocks and fossils, and celebrate our learning during the topic with as wide an audience as possible. We decided to create and host a 'Rock and Fossil Museum' for our friends and families.

From my perspective as science coordinator, this was a perfect opportunity to make the most of the children's captivation with the topic and to involve them further by giving them a focus to demonstrate their knowledge. I am always looking for means to boost their science capital and to allow the children to see themselves as scientists. The subject had relevance to many of them in their lives outside the classroom through their fossil-hunting expeditions. Even for those children who had never taken part in such activities, finding out that our local coastline had such rich links to the distant past opened their eyes to the science in the landscape around them. Opening the doors to our museum also created the opportunity to share our science with the wider community.

The term's theme of 'rocks and fossils' was based on the year 3 (ages 7–8) science topic of 'rocks' but we were making links in our learning to many different areas of the curriculum and we were keen to showcase them all.

Cross-curricular links

Design technology and geography links

In their design technology topic, the children were learning about levers and linkages, a topic that had been planned into the curriculum to reinforce their science learning from the previous year about forces. They decided that they would like to design and create posters with moving components for our museum. The images would demonstrate and explain key aspects of the science and geography they were learning. The children were really proud of their finished posters, which included an erupting volcano, a palaeontologist at work, tectonic plates moving and sedimentary rocks being formed. They used the knowledge that they had gained in design technology to construct pictures with elements that slid, oscillated or even rotated (Figure 2). The children then used their IT skills on laptops to write captions for the posters, giving further details about what was being shown.

Art links

During the term, the children had been learning about modelling and creating with clay in their art lessons, developing such skills as joining, shaping and decorating. They had become very confident in creating with clay and this gave me the idea to include some of their work in our museum. For their final piece in our art unit, I therefore asked them to research a commonly found fossil and to create it ready for the museum. The children responded enthusiastically and before long, ammonites, trilobites and even raptor claws were ready to be included among the displays (Figure 3).

Literacy links

With the national tests (SATs) approaching for my year 6 children (ages 10–11), I was keen to give them an opportunity to produce some quality writing linked to a clear purpose, so tasked them to produce persuasive posters advertising our museum. I was thrilled with how the children threw themselves into the challenge; their pride in the project clearly contributed to the quality

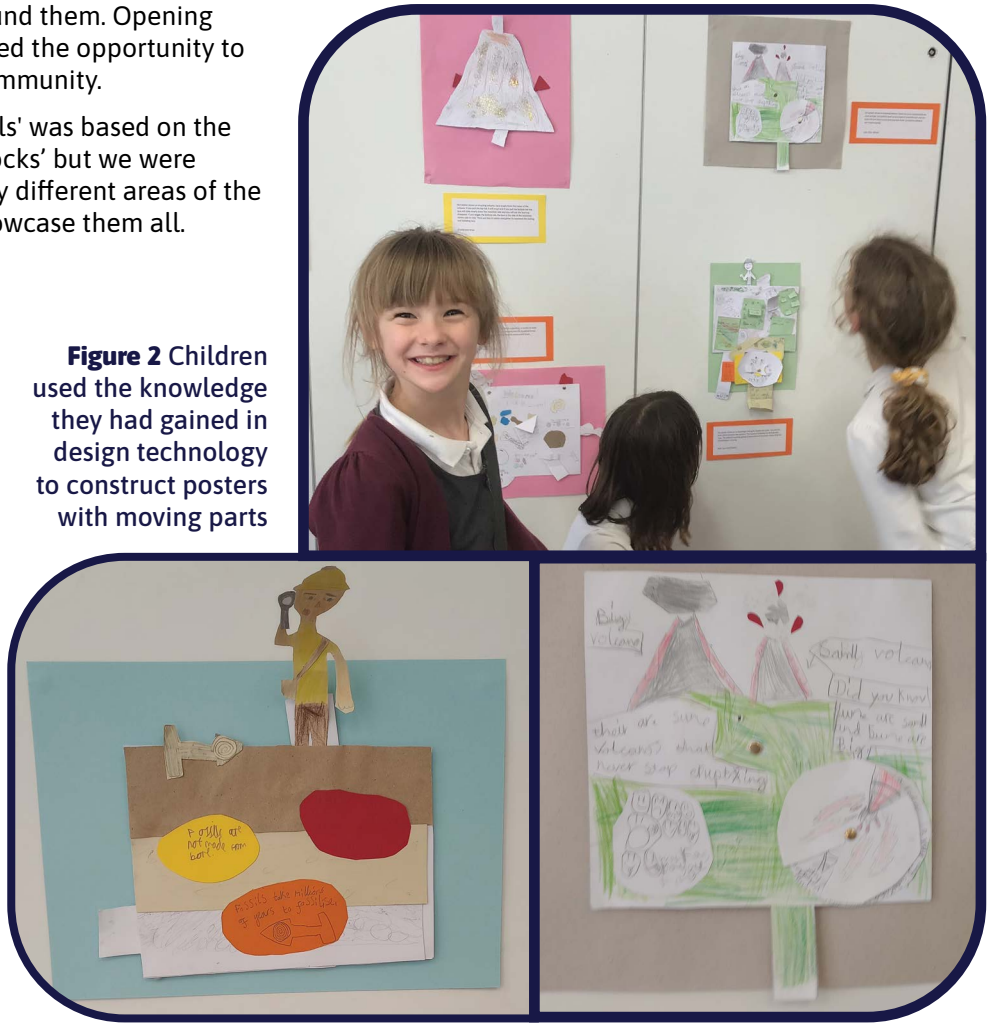

Figure 2 Children used the knowledge they had gained in design technology to construct posters with moving parts

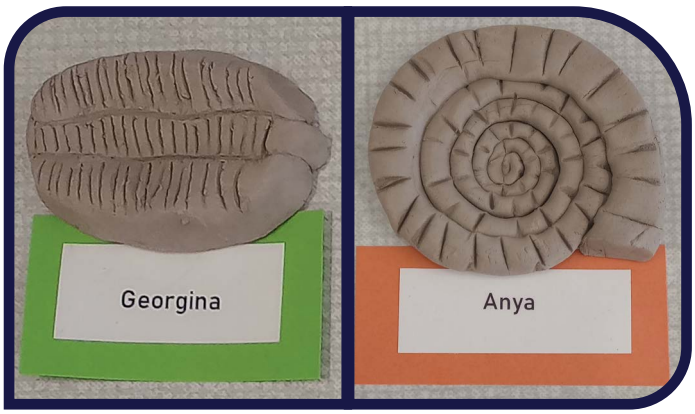

Figure 3 Children researched and made clay models of fossils for the museum displays

of what they wrote. The children used their science knowledge to enhance their writing, for example by highlighting the links between igneous rocks and volcanoes or how metamorphic rocks are created by intense pressures and forces within the Earth (Figure 1).

Science and literacy were also brought together in the captions the children wrote to give more details about the exhibits. Children used their scientific research skills to gather facts about the objects in the museum for their writing. We had recently written non-chronological reports in class and the children were able to apply this learning to create clear and informative captions.

The exhibits

The stars of our event were undoubtedly the rocks and fossils that the children brought in to exhibit. Ammonites, belemnites and sea urchin fossils arrived along with an impressive array of different rocks. These included geodes, rainbow quartz and a good range of sedimentary, metamorphic and igneous rocks. The children were amazed by what was brought in and learned so much from talking to each other and sharing their knowledge about each item. Perhaps the most impressive objects were a mammoth's tooth found on a local beach and a stone axe head, but everything brought in was valued and displayed.

The grand opening

The museum was finally ready to receive visitors in our school hall one afternoon during the last week of term. Parents had been sent their invitations in the previous week and were lined up, waiting to come in at the allotted time. I wanted the children to see themselves as the experts, so once the doors were open, the children acted as tour guides for their parents and visitors (Figure 4). Understanding that not all children might have a parent able to visit, the children had been given some time to guide each other around the museum before the grand opening, an opportunity they embraced enthusiastically.

Figure 4 Junior tour guides explain the museum exhibits to the visitors

The museum was a huge success: the children were delighted to celebrate their work and spent a long time explaining all that they knew about each exhibit. Parents and carers thoroughly enjoyed their visit and were extremely complimentary. Some parents who were also teachers let me know that they would be borrowing the idea!

Reflection

This is definitely an idea I will be revisiting the next time I teach this topic. With the children's interest in fossil hunting, I will help the children to identify with a famous scientist by including learning about Mary Anning. I will also use the opportunity to demonstrate more of the learning that we did in the individual science lessons – perhaps interactive exhibits, sorting some rocks according to their characteristics or a chance to investigate which types of rock are permeable to water or contain crystals. This would give children even more scope to demonstrate their knowledge and to 'be a scientist'. Altogether, hosting our Rock and Fossil Museum proved to be a great idea for boosting the children's engagement and enthusiasm, as well as involving the wider school community. It is also one that could be easily adapted to other science topics.

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Weblink
Norfolk's Deep History Coast:
www.north-norfolk.gov.uk/tasks/your-community/find-out-about-norfolks-deep-history-coast

Earth materials: a fresh look at an old topic

Jane Essex revisits the topic of 'Earth materials' and offers some new and innovative ways to help reinvigorate learning and teaching about this subject

Almost all children notice pebbles when they are out and many are interested in them, while fossils (especially dinosaur ones) hold a near-universal fascination. Meanwhile, local industrial traditions may well depend on the geology of the area. Yet, despite its obvious relevance and frequent links to children's interests, the science of Earth materials is often not well liked by primary teachers. One of the complaints that I quite often hear from my student primary teachers is that there are *'too many [long] names to remember'* or that the scale of the materials and their transformations seem unimaginably huge for them, never mind their pupils. The other issue is that specialists are often keen to identify the numerous different rock and mineral types, so the subject can appear like 'stamp collecting' but in a stamp album with no apparent system for organising the individual items.

One approach that has been well liked by my primary student teachers is that of making simple models of various key ideas – see below. By contrast, focusing on the processes of chemical and physical change, along with the movement of materials in a cycle, introduces or reinforces concepts that are widely applicable. Designing models to illustrate the behaviour of Earth materials, along with handling samples of the materials themselves, enables student teachers and their pupils to understand the properties of the materials and the processes by which they are changed. The key ideas that pupils need to make meaningful sense of Earth materials can be summarised as:

- The stuff that Earth is made of gets changed into new stuff but you can't get rid of it.
- Rocks differ from each other because they contain different materials and are made in different ways.
- Much of the material gets changed and then finally turns back to how it was at the start, that is, it goes round in a cycle.
- Change in Earth materials is usually slow but involves a huge amount of material changing.
- We can do experiments on small pieces of Earth material to understand better what happens to huge pieces.

What children do not need is to learn the names of lots of materials early on. However, building up an understanding may well give them a conceptual framework to which they can start to relate individual examples, especially those they encounter in their daily lives.

The following activities have been tried out with a range of learners, both student teachers and pupils, and found to enhance understanding and interest.

Atmosphere in a jam jar

This is a simple, and widely used model. I most commonly see it being carried out using sealed zip lock plastic bags taped to windows, where the Sun's energy causes the water to evaporate and then re-condense. Both the plastic bag model and the approach described here enable pupils to see the water cycle as a way of circulating water other than by water flow in rivers or seas. This version also helps them understand the key role of the water cycle in purifying water to make it usable.

Method

A clear glass jar with a screw top lid is ideal, but a drinking glass with a saucer over the top works equally well.

- Put a teaspoon of salt into the jar and add some hot water (ideally from a previously boiled kettle). The volume of water is not crucial but if you add a large volume the lid tends to heat up and it takes longer to see the water vapour condense. For a drinking glass, I would use about 100 cm^3 of hot water. The hot salty water represents the sea heated by the Sun.

Earth materials • Practical science • Rocks • Modelling

- Put the lid on top and leave it for about 5 minutes. By this time, pupils should see that water vapour is forming above the hot water and condensing on the lid. The droplets of condensed water represent the water droplets in the clouds.
- Compare the water on the lid and the water it came from by dipping a disposable straw or wooden coffee stirrer into both liquids in turn and tasting it. Pupils will observe that the 'sea' water is salty but the water in the 'cloud' is not. If they collected the rain from the 'cloud' it is safe to drink.

This activity can act as a starting point for discussion of the benefits of harvesting rainwater or the use of solar stills to purify dirty water.

Types of rock

To tackle the issue of the many different types of rock head on, I consider rocks in their three main groups. These are defined by how the rock was formed and that, in turn, affects the properties and uses of the rocks. I also start by using colloquial terms for the three main groups of rock, so that the focus is on formation and properties rather than technical vocabulary. The three groups of rocks are:

- 'boiled' rocks (igneous rocks, made by molten material coming up from hotter parts of the Earth, below the surface);
- 'bitty' rocks (sedimentary rocks, usually made from broken up pieces of 'boiled' rock cemented together);
- 'squashed' rocks (metamorphic rocks, formed from 'bitty' rocks that are squashed by new layers of rock forming on top of them and by being softened as they move closer to the hot core of the Earth).

These three groups can be readily modelled by making sugar glass, to represent the 'boiled' rock. This has to be done in advance but a video clip of the boiling sugar solution is still impressive.

Model 'boiled' rock

To make a piece of sugar glass that is about 20 cm in diameter [to be done in advance]:

- Heat 40 cm^3 of tap water, 25 g of glucose powder (which you can buy from a pharmacy) and 100 g of table sugar (Figure 1). You need to heat the mixture up to 155°C [CARE]. Add a few drops of food colouring if required. If you do not have a sugar thermometer, heat it up until a drop of the mixture forms a hard shiny bead when it is dropped into cold water.

Figure 1 Heating the ingredients for sugar glass

- Pour the mixture on to a non-stick piece of parchment or a greased baking tray (Figure 2). Let it cool and the whole piece of shiny clear 'glass' will lift off in one piece.

Figure 2 Pouring the sugar glass mixture on to a tray to cool and harden

Once it is cool, pupils can handle it and observe that it is very smooth and hard as well as shiny.

Model 'bitty' rock

- A piece of the sugar glass can be put into a plastic bag and broken into pieces; I use a rolling pin to do this (Figure 3). I also show how the 'boiled rock' gets broken down and the bits carried away in the activity described below.

Figure 3 Crushing the cooled sugar glass in a plastic bag

- The small pieces of sugar glass can then be worked into some homemade playdough (Figure 4). This illustrates how chemicals in water can glue ('cement') the broken bits of rock together to make new rock.
- Playdough can be made by mixing the following ingredients together (it doesn't need cooking): 125 g flour, 150 g salt, 1 tablespoon cooking oil, 125 cm^3 warm water, and a few drops of food colouring (optional).

This activity helps the learners to see clearly that some common rocks are made of small bits of other rocks, rather than being a single material and, if you retain the model, can be used to look at what happens when water wears rocks away (weathering). This understanding can be further secured by shaking a few bits of 'bitty' rock (such as sandstone or limestone) together:

- Put the stones into a jar with a screw top, add some water, screw the lid on and shake vigorously.

This shows what happens when rain falls on rocks, or they are carried by rivers along with other rocks. Small pieces will be visible at the bottom of the jar and, if examined carefully, these can be seen to be small pieces of the rock that was put in the jar.

Model 'squashed' rock

For this part of the activity to work, you need 'bits' that are not uniform in shape. If you break the sugar glass

Figure 4 Working the small pieces of sugar glass into playdough to represent 'bitty' rock

carefully, you may get pieces that are non-uniform. As an alternative, work some dried rice into a second batch of playdough. This time the focus is on showing how softening the model rock, by working it rather than heating it, and applying pressure, changes the features of 'bitty' rock.

- Keep a small lump of model 'bitty' rock to one side and squash the rest of it into a thin layer on a chopping board or plate.
- Fold the two edges of the thin layer of rock over the central portion. Squash the playdough again and repeat twice more.
- When you cut the 'rock', pupils can compare it to the original lump that you put aside (a visualiser or hand lenses may be helpful).

The pupils will see that the bits in the playdough are now less randomly arranged; they now tend to be lined up parallel to the surface on which the 'rock' was squashed. If you really want to underline the change from 'bitty' to 'squashed' rock, you can show them a piece of baked playdough to compare to the uncooked dough.

How easily do rocks get worn down?

How easily the different rocks wear away can now be modelled. I use three plastic food boxes (e.g. ice cream tubs) and put a piece of each type of model 'rock' into each. Then the learners slowly pour water on to the 'rocks' and observe what happens. The sugar glass will not change perceptibly (although will, in practice, dissolve if in water for some time). The playdough 'cement' will be softened and start to be washed out from between the 'bits'. The 'squashed' rock will behave more like the 'bitty' rock but breaks up slightly less; if it has been baked, it will resist the water pretty well in the timescale of the activity.

Properties and uses

Having established the three groups of rocks, learners can then consider what they are like and how they are used. I like learners to see the rocks being used, rather than simply as a set of samples in a box. Ideally, this would take the form of a visit to look at old buildings or gravestones in your locality. Failing that, photographs of rocks in use can be combined with any relevant specimens that you can find or borrow. However you approach this, learners can gather evidence on the use of rocks and, with support as needed, infer the properties of the three groups of rocks:

- 'Boiled' rocks are very hard and shiny. They often have crystals (though sometimes they are too small to see with the naked eye) but they are the same in all directions. They do not get worn away easily. This means that they are expensive to cut out from where they have formed and expensive to cut into the shape that is wanted. Until engineers built powerful saws and drills, they could not be cut and made useful.
- 'Bitty' rocks are relatively soft, so easy to cut and carve. This commonly makes them the least expensive rocks to use but also means that they are the most likely to get worn away, for example by rain.
- 'Squashed' rocks have properties in between those of the other two groups. They are harder than the 'bitty' rocks but not nearly as hard as the 'boiled' rocks. They do not wear away nearly as easily as 'bitty' rocks. 'Squashed' rocks are easy to cut in one direction but much harder to cut in the other. This makes them easy to split into layers. They are useful when people want a thin, flat piece of rock, such as roof slates or paving slabs.

Conclusion

Although Earth materials is not always a popular topic with teachers, rocks are an important resource that often shape the life of an area. With carefully chosen models, and explicit links to pupils' everyday lives, they can be made accessible, interesting and provide a valuable context in which to consider some key scientific concepts.

Additional ideas for teaching about Earth Materials can be found at:
www.earthlearningidea.com/home/Tchg_vids_wkshps_primary.html

Acknowledgement
With thanks to the late Professor Chris King for his many ideas on the teaching of Earth materials, generously shared with many.

Jane Essex is a Reader in Education at the University of Strathclyde. She has researched SEND/ASN for over 35 years and co-chairs the ASE's group for teachers interested in making science learning inclusive for pupils with SEND/ASN.
Email: jane.essex@strath.ac.uk

Saving The Planet One Science Lesson At A Time provides a framework for embedding global issues into primary science learning. Using the UNESCO Sustainable Development Goals, the book provides 17 chapters full of ideas and enquiry activities to add purpose and value to science education.

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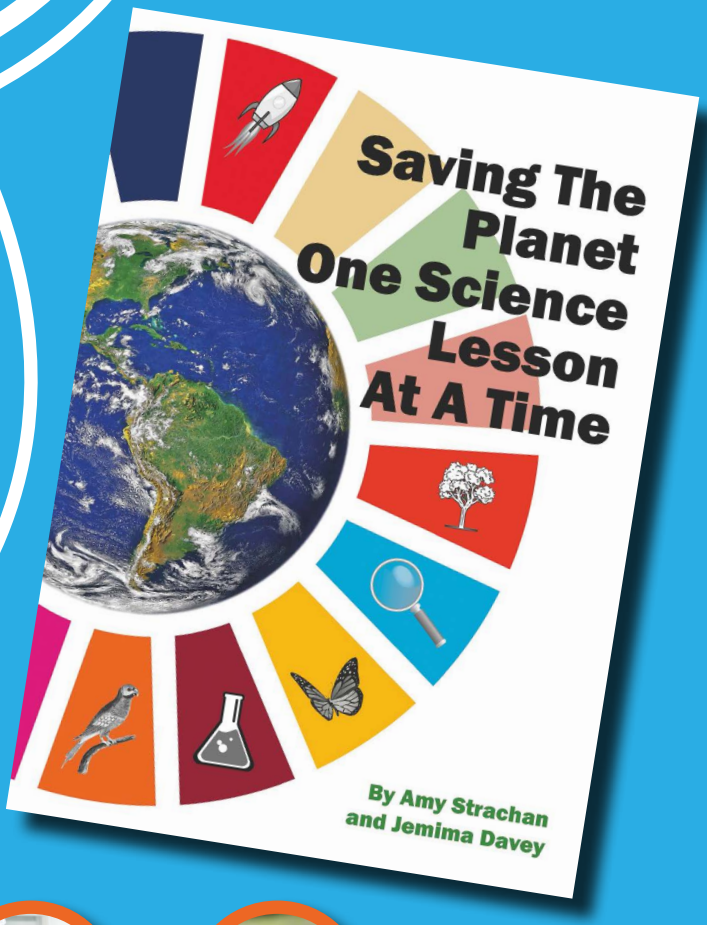




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REVIEWS

SuperQuesters

Lisa Moss and Dr Thomas Bernard

Amsterdam: QuestFriendz, 2022/23

32 pp. £7.99 each

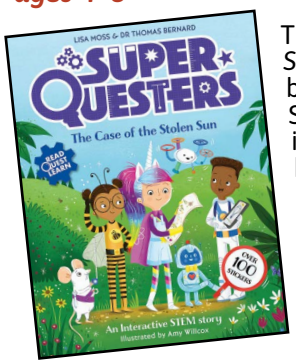
The case of the stolen sun

ISBN 978 90 829940 5 6

The case of the missing memory

ISBN 978 90 829940 4 9

Unique adventure stories and interactive play, designed to develop children's STEM skills; ages 4–8



These two *SuperQuesters* books develop STEM skills in children between 4 and 8 years old, through a fictional story, following three characters named Bea, Lilly and Leo.

Both stories start with the same introductory paragraph but cleverly introduce different settings, such as in a classroom after school and on a science school trip, alluding to *'the real waking world'*. This is an important part, as the characters go into a *'dream world'* to solve the quests by closing their eyes and saying, *'Close your eyes, squeeze them tight ... stars will light the way so bright'*. This chant is a double-page spread, which is very brightly coloured and beautifully illustrated; you can imagine younger children joining in. You can see how the author could develop more in the series and children do love a repeated phrase! The characters are met by the Queen of Questland and she renames all three (Bea Bumble, Lillicorn and Leo Zoom). The quests then begin.

Each book starts with instructions for parents or educators on how to use the sticker system, how to use the reward chart and how to apply the sticker sets' eight quests. The answers and a glossary of STEM skills are also provided.

The story, characters and challenges all work for children aged 4–8 years, but the glossary is more for parents/educators as it would not be easily understood by this age of child. The website is very good and has a more varied array of resources to support STEM skills, which are closely linked to the book, so there is adaptability. A competent teacher could use these resources across the curriculum, for example for character descriptions in English.

The children in a class would love the story; you could develop the characters more and it introduces early skills in problem-solving, spatial perception, trial and error, coding and mental rotation.

A great story, with great potential!

Kathryn Jagger
Assistant Headteacher and Chartered Science Teacher, Spotland Primary School, Rochdale

Utterly jarvellous: 50 primary science activities you can do in a jar

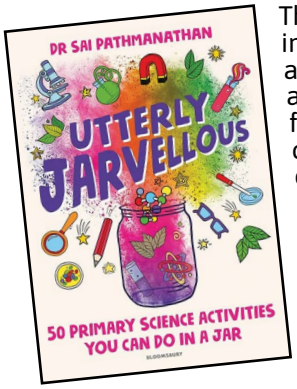
Sai Pathmanathan

London: Bloomsbury, 2021

132 pp, £22.49

ISBN 978 1 4729 8483 8

How to use only sustainable resources in your science teaching with 7- to 11-year-olds



The activities in this book are primarily aimed at fostering children's curiosity about the world, while encouraging them to work scientifically and ask questions that link into everyday situations. All the activities, as you would expect from the title, are linked to using jam jars; therefore, trying to support sustainable teaching rather than using plastic beakers or pipettes.

The book is set out in sections: plants, rocks, properties and changes and materials. There is even a section on evolution and inheritance! – superb for year 6 children. You may wonder, as I did, how can I use a jam jar to teach evolution? Buy the book and find out!

The number of activities presented in each section varies. There are only three activities for plants, whereas for materials there are 13. Each activity is laid out in the same way: curriculum links, resources required, how to run the activity, the background science understanding, extension ideas and a recording template for the pupils to use.

Some of the activities are well known, with a slight twist to incorporate the use of a jam jar, such as the floating needle activity. A few of the others are more unusual, such as creating a barometer.

The book is aimed at teachers, or possibly even parents, of 7- to 11-year-olds. The curriculum links are purely focused on the National Curriculum in England, although the activities could be used, where relevant, in any curriculum. Many of the activities would also be fantastic for use in a science or STEM club.

I have changed my planning for this term to allow me to try out the activity 'Utterly gene-ius' and am looking forward to seeing the children's reactions to what they discover!

Jane Banham
STEM Lead, Friskney All Saints Primary School

Round and round goes mother nature: 48 stories of life cycles around the world

Gabby Dawnay

London: Wide Eyed Editions, 2023

107 pp. £20.00

ISBN 978 0 7112 7976 6

Introduces the reader to an array of life cycles of creatures, plants, and natural phenomena that they may have not come across before; suitable for age 9+ depending on reading ability

This is a fantastic collection of life cycles throughout the realms of mother nature, depicting not just the life cycles of animals, but of space and the stars – even carbon and sand. The life cycles are portrayed through beautifully crafted illustrations by Margaux Samson-Abadie, which bring these incredible life cycles to life. It is as if you could step into the book and be surrounded by the wonders of nature!

This book introduces the reader to an array of creatures, plants, and natural phenomena that they may not have come across before, including, for example, the luna moth, the baobab tree, the squirting cucumber and the black hole. These are just a few of the life cycles covered within the book that are potentially less well known. However, the book also allows its readers to discover the natural processes of more familiar creatures and concepts, to which younger readers may find it easier to relate. These include the chicken, dandelion, the four seasons and the stars – to name but a few. The book opens up the incredible wonders all around them from the sunflower to the Moon and everything in between.

Each life cycle is explained in a clear and detailed step-by-step manner, giving the reader real insight into the processes involved. The bright and colourful illustrations make the content very accessible, although the terminology used is still scientifically accurate and, depending on reading ability, quite advanced. Therefore, I would recommend this book for ages 9-plus or to be read to younger readers, enabling them to access the vast range of scientific vocabulary throughout the book.

Eleanor Wharton
BA Honours Primary Education Trainee Teacher, Northumbria University

Evie: The small garden

Giovanna Cicero

London: Bumblebee Books, 2022

14 pp. £7.99

ISBN 978 1 83934 533 3

Evie, a curious 2-year-old, describes all the different things she can see as she walks around her garden; ages 3–7

Evie: The small garden is a beautifully put-together book by writer Giovanna Cicero and illustrator Alfonso Aimero. The illustrations on the front cover unlock a quaint yet quite wonderfully constructive narrative, that delights at every turn. Evie, the protagonist of this 14-page instalment, is a 2-year-old girl who absolutely adores the outdoors. Her routine on the first two pages is akin to any normal 2-year-old but it is her love for the outdoors that really makes the reader smile!

As she ventures into the garden, we are catapulted into the descriptive mindset of a child experiencing an extremely wholesome garden. Evie describes her garden as 'small' but the way she 'sees' the olive, apple and pear trees is entirely endearing. The repetitive language is excellent and is used to ingrain the narrative into the minds of the young audience – I could see this text being used in any early years or year 1 or 2 classroom. As we move through the text, Evie sees the birdbath, the plum tree, the shed, the lavender flower and the garden mirror. Evie states: *'I can see me in the mirror looking at me'*, an utterly brilliant introspective view showing how we should allow children to experience the outdoors – superb.

The text is short but this is a real positive – it is ideal for teaching young children about the importance of gardening and more generally about plants and trees. This book could quite easily be incorporated into continuous provision in the outdoor area of an early years unit or into a science lesson in key stage 1 focusing on plants.

I have read this book to my daughter and she loved it; I am looking forward to any future instalments of Evie!

Michael Good
Y6 Teacher and Science Coordinator, Stoneferry Primary School, Hull, and member of Primary Science Editorial Board

The world that feeds us

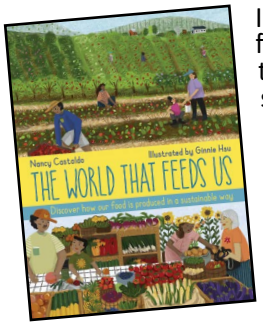
Nancy Castaldo

London: Quarto, 2023

80 pp. £12.99

ISBN 978 0 7112 7769 4

A beautifully illustrated, factual book that gives children an opportunity to understand what sustainable farming is and how they can become involved



If like me, you find it difficult to teach about sustainability, then this is definitely the book for you. It takes the viewpoint of sustainability from different types of farmers. From the introduction, which explains what sustainable and green farming is, you can gain a solid basic insight into this topic. The book is then split into four sections, taking you through each of the four seasons and visiting a plethora of countries along the way, such as Italy, England, Hawaii and New York, to name but a few. The book culminates with advice on how we can 'do our bit' through knowing your farmer, shopping local, growing your own and not wasting food. There is something that everyone can do.

A great feature of the book is the amount of vocabulary it shares; it does this through the most inventive presentation techniques, all accompanied with illustrations, which is good for learners with English as an additional language (EAL). I learnt about different types of heritage cows, chicken breeds, floodplain crops, no-till machinery and different ways to preserve fruit. I particularly liked the sections: *Spring: Free-range; Summer: High tech on the farm; Autumn: Harvest help* and *Winter: Urban indoor farms*.

This book is not limited to learning about science, but features information on traditions, technology, countries and festivals, making it a thoroughly enjoyable and educational read. The glossary gives easy-to-understand definitions suitable for children. In short, it offers 80 pages of fact-filled joy! Great as a library book, gift and teaching tool.

Kathryn Jagger
Assistant Headteacher and Chartered Science Teacher, Spotland Primary School, Rochdale

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