Primary Science

Number 151 | Jan/Feb 2018

Famous Scientists

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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 152 (March/April 2018) Hidden science What science can be developed through educational visits that are traditionally for other subject areas? Exploring the less obvious locations for science.

Issue 153 (May/June 2018) Science in the arts (copy deadline 2 February 2018). Putting the A into STEAM: how science can be taught and engaged with through traditionally arts subjects.

Issue 154 (Sept/Oct 2018) Science capital (copy deadline 1 June 2018). What children know about science and bring to the classroom has a massive impact on their futures in terms of perceptions of science and careers. What do you do to build upon the science capital children have?

Issue 155 (Nov/Dec 2018) How things work (copy deadline 3 August 2018). Science is all around us and explains how everyday things work. What examples do you use in the classroom to show the everyday nature of science and to help children understand how things around them work?

Writing for Primary Science

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

- 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: **primaryscience@outlook.com**
and detailed guidelines for writing for the journal are available on the ASE website: **www.ase.org.uk**

Contributions and comments:
Please send as an email attachment to: **janehanrott@ase.org.uk**
or post to: The Editor, Primary Science, ASE, College Lane, Hatfield, Herts AL10 9AA.

Primary Science is the primary journal of the Association for Science Education and is sent to all primary members of the Association as one of the benefits of membership. It is published five times a year.

FOCUS ON...

Famous scientists

When we watch television, go to a music concert or visit the cinema it is easy to be in awe of the people we see and what they are doing. There is something that can be so engaging and wondrous about them, it is a challenge to articulate. We all have famous people we hold in the highest regard. Most of us don't meet them or, if we do, it is only fleetingly, and yet their impact on our lives is no less because of that, and we have a sense of knowing them.

There are others we perhaps hear on the radio or interviewed in the media who inspire us: ordinary people who have done great things or succeeded in the face of adversity. People who are not famous, not seeking out the media spotlight, but simply doing inspiring things and changing lives. There are the people who have made significant medical breakthroughs, bringing us the next step closer to identifying the gene for a certain condition or a treatment for a disease; all can inspire and have an impact on us.

Through my career I have been very lucky to meet people who have supported my professional journey and been very inspirational. A few of them are famous; most are not. Some of them are the people I meet at conferences, the teachers who attend courses, the students I train throughout the year. A few of these have really helped shaped my thinking and made me look at life in different ways – either through challenging my thinking, encouraging me or presenting opportunities and opening doors. All of us have these people in our lives. Sometimes we just need to look a bit differently to see them in this way.

This issue has the theme 'Famous scientists' and it has been a great delight to put it together with such a range of articles. There are three focusing on the use of famous scientists as a means for teaching and one that highlights the role that children's television can play in offering the opportunity to find science in non-science-focused programmes. Now, with famous scientists as part of the National Curriculum in England, it is imperative that children have a sense of the contributions made to their lives by scientists from the past and there is great scope for looking at the famous scientists of today. But children should also be made aware of the science going on all around them – the contributions made every day by those who will remain unknown, those who are working to change our lives for the better and those who are behind making the big breakthroughs happen.

It is imperative that children have a sense of the contributions made to their lives by scientists from the past and there is great scope for looking at the famous scientists of today.

Most of all, I think that there should be appreciation of what you, as teachers, do to change and impact on the lives of learners. We probably all carry memories of teachers, some good and some bad! But you are the people who are shaping our children's futures. You are supporting and inspiring the famous scientists of the future. You are nurturing the people who will become the inspiration, the awesome and the wondrous. There are people in your schools who, even if they do not become famous, will become the people who influence others at conferences, attending courses or in their working lives. Being famous certainly permits access into everyday lives with great potential for a sense of value. But being a class teacher of primary school children, in an increasingly technological and scientific world, is priceless.

NOTICEBOARD

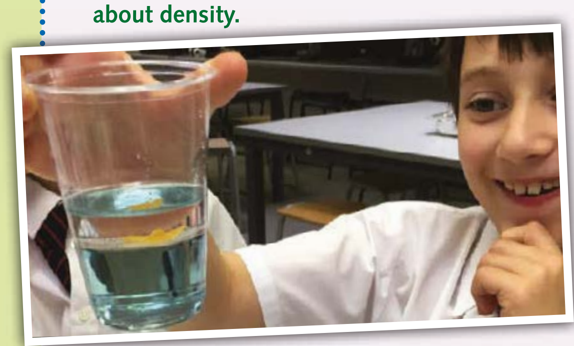
Safety announcement – alternative activities

In *Primary Science* **148**, page 34, in an article on counterintuitive science activities, two practical activities were given within the article that involved using alcohol. This is not something that is recommended in primary schools and therefore CLEAPSS have suggested the alternatives set out below.

For full procedures please visit the CLEAPSS website: **http://primary.cleapss.org.uk**

Floating liquids

This activity enables children to learn about density.



Safety: Remind children not to put any liquids or solids near their mouths.

Equipment needed per child/per pair:

- 1 clear colourless disposable plastic cup/beaker
- Measuring cylinder (ideally 50 ml)
- Plastic pipette
- Food colouring
- 2–3 small plastic pieces

Samples to test:

- 30 ml water
- 30 ml baby oil
- 30 ml glycerine

Notes

- Place the water, glycerine and baby oil in labelled containers. Glycerine is inexpensive and available from local pharmacies.
- Cut the plastic (e.g. coloured milk bottle lids) into small pieces (approx.0.5 x 0.5 cm).
- Have a large container/jug available to tip all the liquids into at the end of the activity.

Procedure

1 Measure 30 ml of glycerine and pour it into the cup.

2 Measure 30 ml of either water or baby oil and carefully pour the sample into the cup; then repeat with the other sample.

3 Look carefully at what has happened to the liquids. Which liquid is which?

4 Add a few drops of food colouring, do not stir and observe what happens.

5 Gently stir the liquids and observe what happens.

6 Drop 2–3 pieces of plastic into the cup. Look carefully to see where the plastic floats.

What you will see

The glycerine sinks to the bottom, the water floats on the glycerine and the oil forms the top layer. When food colouring is added, the drops fall through the oil and water layers and float on the glycerine before slowly mixing with the water. When the plastic pieces are added they fall through the oil and float on the water layer.

Disposal

Decant the top oil layer into a plastic bag containing some absorbent material, tie and dispose of in a general waste bin. After sieving out the pieces of plastic, the rest can be poured down the sink with plenty of water.

Background

The samples form layers according to their density with the densest, glycerine, sinking to the bottom of the cup. The small pieces of plastic are more dense than the oil but less dense than the water so they float on the water layer.

Why doesn't it overflow?

An alternative to mixing water and alcohol to demonstrate that the combined volume is less than the two individual volumes.

Fill a measuring cylinder with water to the very top until a meniscus forms. Then carefully and slowly add salt. Even though the cylinder 'appears' full, you can add quite a lot of salt before the water spills over.

schoolscience.co.uk

The ASE's Schoolscience website has lots of resources and competitions to support your teaching.

Floating garden challenge

www.schoolscience.co.uk/floatinggardenchallenge

A fun hands-on investigation suitable for key stages 2–5 pupils (ages 7–18).

The problem: as a result of climate change there is more rain in Bangladesh than ever before. Land where farmers used to grow their crops is now flooded on a regular basis. The result is families go hungry.

The challenge: to design and build a model structure that will enable farmers to grow crops even in an area that may become flooded.

Beat the Flood: an exciting new STEM challenge from Practical Action

www.schoolscience.co.uk/site/scho/templates/resource.aspx?pageid=792&cc=gb

Suitable for key stages 2–3 (ages 7–14). Pupils use their STEM skills to help them design and build a model of a flood-proof house. Activities to help them with their design include testing materials (for strength and absorbency) and structures.

Plastics challenge

www.schoolscience.co.uk/plasticschallenge

An exciting new challenge for pupils aged 8–14 years to develop solutions to the problems caused by plastics waste globally.

The challenge can be used flexibly as part of the formal science and design and technology curriculum in the UK, or for a STEM club or enrichment day.

Relating school science to real-world scientists

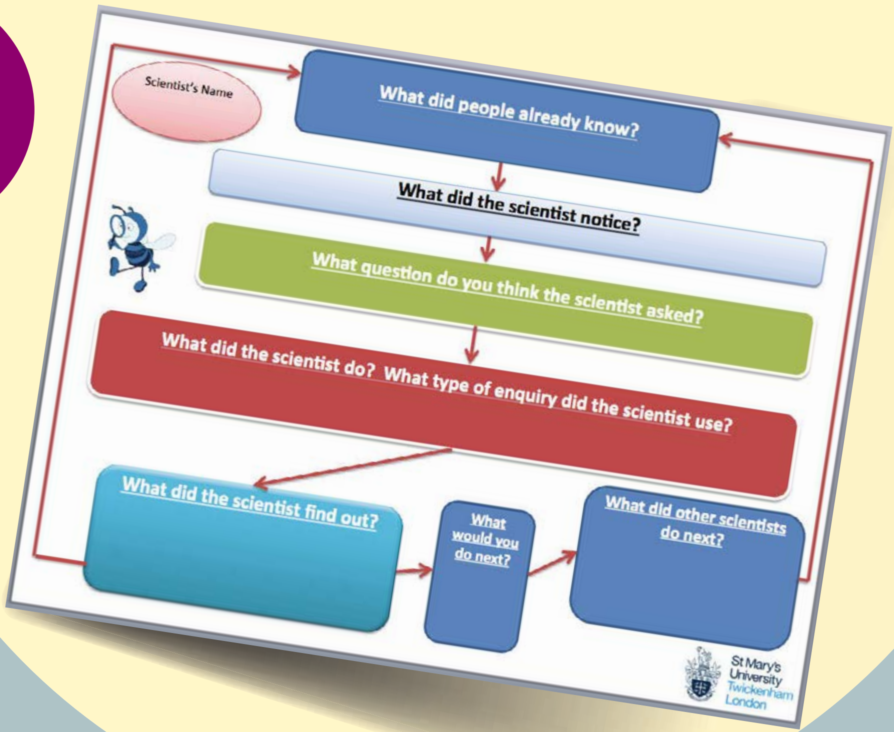


Figure 1 A model to explore enquiry types used by famous scientists (adapted from Sinclair and Strachan, 2016)

Helen Spring considers how making scientists relevant to children supports learning

The approach to teaching children about scientists, described in an article by Alex Sinclair and Amy Strachan in a recent issue of *Primary Science* (Sinclair and Strachan, 2016), inspired me. The key thing for me was that the children do not need to know the life history of the scientist (they have been married three times and had seven children, they were struck by lightning and love cats etc.); what they really do need to know is what the scientists' contributions were to science.

I have adapted Sinclair and Strachan's model to ask which of the five types of enquiry a scientist might have used (Figure 1). This really makes children think about how the science they are doing in school is similar to the science that 'real' scientists do.

Once I had read the article, I contacted the authors to find out more; they very kindly sent me some teaching resources relating to their work focusing on Mary Anning and Charles Macintosh (Figure 2). I used these with my student teachers at York St John University; they enjoyed being involved in the evaluation process, and the resources were very well received.

Women in science

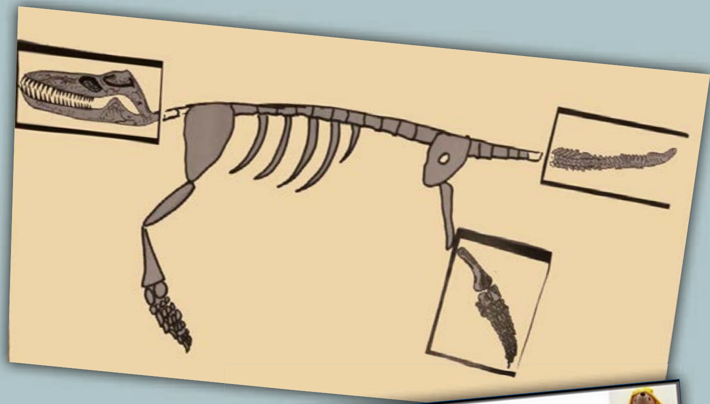
Some time later I was asked to deliver a day's professional development at the National STEM Learning Centre in York on behalf of Northern Lights teaching school alliance (see *Websites*). The course title was Supermarket Science and it was all about using simple, easy-to-obtain resources to support science teaching. One of the things I wanted to do was to explore how readily available materials could be used to make science relevant to young people. I shamelessly shared Alex Sinclair's work with the group, but on this occasion, as I had already planned to focus on women in science and the need to challenge the preconceived ideas that some children (and adults) have of who can be a scientist, I was particularly keen to focus on a female scientist.

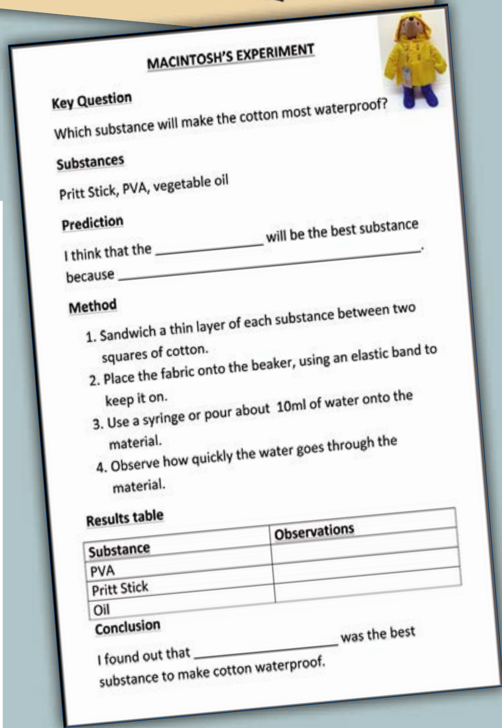
During this session, and many others, I showed a lovely video-clip called 'Redraw the Balance' (see *Websites*) from the MullenLowe Group (which actually made a student cry in one session!). It is an excellent clip and it certainly made me think about the expectations I have of people in different roles. It shows children being asked to draw a fighter pilot, a firefighter and a surgeon; the outcome was that 61 of the children depicted men in these roles and only five drew women. Females in these roles were then introduced to the children.

Women scientists in the curriculum

The English National Curriculum identifies a number of male and female scientists to study, but when I explored the year 2 (age 6–7) topic of 'materials', there were only male scientists listed (John Dunlop, Charles Macintosh and John

Key words: Enquiry Women in science





MACINTOSH'S EXPERIMENT

Key Question

Which substance will make the cotton most waterproof?

Substances

Pritt Stick, PVA, vegetable oil

Prediction

I think that the ______________ will be the best substance because ______________.

Method

1. Sandwich a thin layer of each substance between two squares of cotton.
2. Place the fabric onto the beaker, using an elastic band to keep it on.
3. Use a syringe or pour about 10ml of water onto the material.
4. Observe how quickly the water goes through the material.

Results table

Substance	Observations
PVA	
Pritt Stick	
Oil	

Conclusion

I found out that ______________ was the best substance to make cotton waterproof.

Figure 2 Teaching resources relating to work focusing on Mary Anning and Charles Macintosh shared by Alex Sinclair and Amy Strachan

McAdam). Therefore, I set out to find a female scientist whose work could be replicated (more or less) in a primary school classroom. On a useful website listing women inventors (see *Websites*), I discovered Patricia Billings, who invented Geobond®, a material that is heat-resistant, non-toxic and indestructible – the world's first workable replacement for asbestos. I also found Stephanie Kwolek, who discovered a liquid crystalline polymer solution that led to the invention of Kevlar®, a synthetic material that is five times as strong as steel. There is definitely some potential for developing a children's investigation based around the work of these two scientists.

Patsy Sherman and Scotchgard™

Eventually I settled on Patsy Sherman, a research chemist who, while working on fluorochemicals for jet aircraft fuel lines, made discoveries that led to the invention of Scotchgard™ stain repellent. I used Sinclair and Strachan's flow diagram template to introduce Patsy Sherman to my group (Figure 3).

I asked the teachers on my course to plan their own fair test. Some groups compared the effectiveness of Scotchgard (other brands are available!) with other similar substances. Other groups compared the effectiveness of Scotchgard on different materials. One innovative group did both (Figure 4)! In our example, we put a drop of ink on material that had been treated with Scotchgard, hairspray, hair conditioner or PVA glue; however, our investigation could be adapted in many ways. Children could be asked to compare which products Scotchgard protects against (for example, does it stop Ribena stains?) or whether it could be used to remove stains. But it is also a prime opportunity for children to develop and explore their own questions.

We were all surprised by how effective the Scotchgard was. We were also quite impressed with how well hair conditioner prevented stains – although a little concerned about what it might be doing to our hair! In a school setting, this could have led nicely on to fruitful discussions about whether you would want your clothes to be covered in hair conditioner.

I have found two videos that are really helpful when considering 'what scientists did next'. They are for Ultra-Ever Dry®, a superhydrophobic coating that repels liquids (see *Websites*).

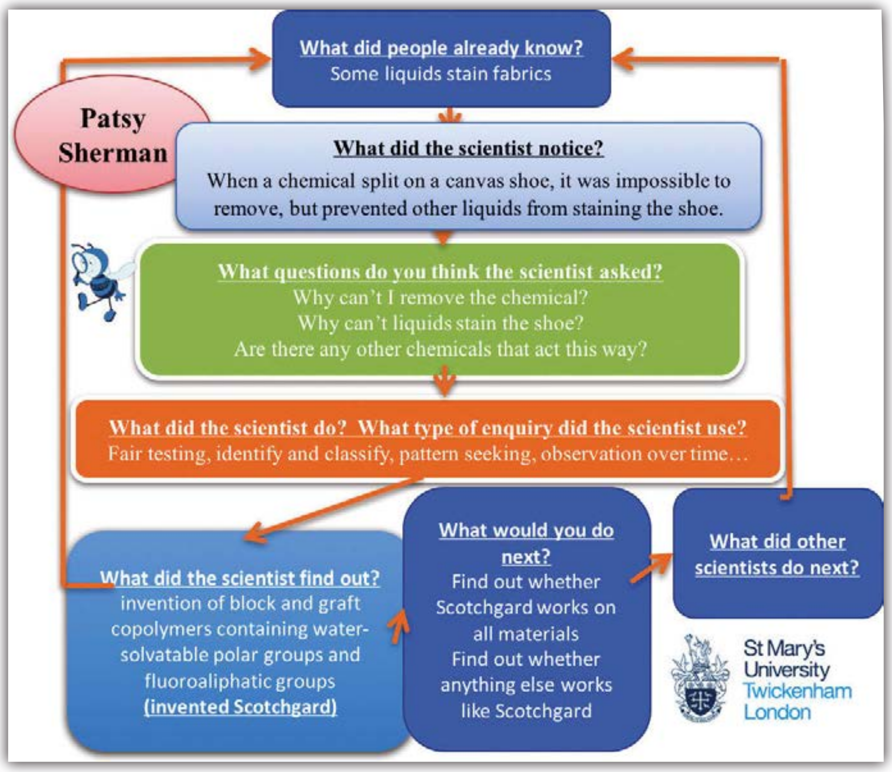


Figure 3 Introducing Patsy Sherman by using the model to explore enquiry type

Figure 4 Teachers' investigations of Scotchgard at the STEM Centre course

Role models in science

There are many male and female scientists out there who deserve to be recognised: you do not just have to stick to those that are listed in the National Curriculum (remember this is a minimum entitlement!).

Depending on your cohort and their aspirations and preconceptions, you may want to focus on people from the local area, female scientists, people from ethnic minority backgrounds or disabled scientists.

Young *et al*. (2013) explored the way that an absence of female role models in STEM may contribute towards young women choosing not to study STEM subjects in later life. I would also argue that it is just as important that we give our boys role models: it is important that *all* children see science as a possible future career, not one that is only open to one particular group of people.

References

ASE (2011) *Be safe! Health and safety in school science and technology for teachers of 3- to 12-year-olds*. Hatfield: Association for Science Education.

Sinclair, A. and Strachan, A. (2016) The messy nature of science: famous scientists can help clear up. *Primary Science*, **145**, 21–23.

Young, D. M., Rudman, L. A., Buettner, H. M. and McLean M. C. (2013) The influence of female role models on women's implicit science cognitions. *Psychology of Women Quarterly*, **37**(3), 283–292.

Safety: Pre-spray fabric with Scotchgard (or other stain protector), rather than allowing children to do it. Always refer to *Be safe!* (ASE, 2011) when using chemicals in science lessons.

Websites

Northern Lights teaching school alliance: **www.Northernlightstsa.org**

Redraw the Balance video: **www.youtube.com/watch?v=qv8VZVP5csA**

Women inventors: **www.women-inventors.com**

Ultra-Ever Dry® videos: **www.youtube.com/watch?v=IPM8OR6W6WE; www.youtube.com/watch?v=BvTkefJHfC0**

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The 'mighty women of science' make an impact in a primary school

Agnieszka Barden describes how a focus on female scientists has raised the profile of science in her school

Figure 1 Not all scientists look like this!

I have been a primary school science coordinator for just over a year and love how science unlocks, in so many ways, how the world works. One of the challenges I faced in my role was to persuade all the teachers in my school to take a fresh approach to teaching science. Back to basics, I thought: every good bit of teaching needs a 'hook' and why should the teachers be any different!

I read around the subject and looked at my colleagues. What would engage them? As in many primaries, the gender makeup in our school is somewhat skewed and that was what gave me my inspiration in the end. Our overall theme, for our March 2017 science week, would be famous women scientists, based on and inspired by Clare Forrest's (2016) book *The mighty women of science*.

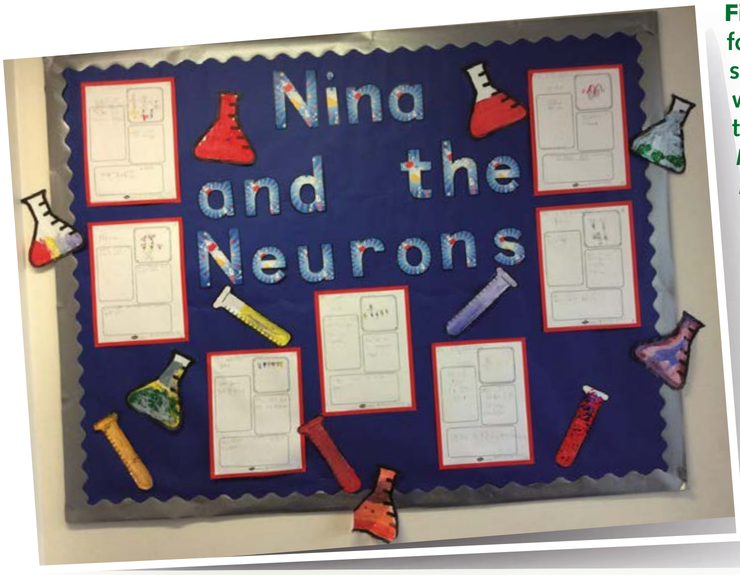

Figure 2 The foundation stage children worked with the context of *Nina and the Neurons*

The book introduces both famous and not-so-famous women scientists in an entertaining and captivating way. It is a testimony to some of the most amazing women scientists, whose discoveries and inventions will empower future generations of girls and women alike. The message I hoped my colleagues, and through them our pupils, would hear from using this book as a starting point is that gender and race are not important when it comes to science!

What we did

Each class teacher chose a woman scientist and planned a selection of stimulating and exciting activities and research projects relevant to their scientist's field of study, to span a fortnight around our science week.

Our foundation stage class (ages 4–5), recreated some of the experiments carried out by Nina in the BBC CBeebies programme, *Nina and the Neurons*, which included explosions and discovering static electricity as well as mixing liquids and reactions with bicarbonate of soda.

Year 1 (ages 5–6) found out about Jeanne Baret, the famous botanist who

Key words: Women in science

disguised herself as a man in order to embark on her voyage around the world (Figure 3) and year 2 (ages 6–7) looked into the hygiene improvements introduced by Florence Nightingale (Figure 4).

In year 3 (ages 7–8), where I have been teaching, we followed in the footsteps of Mary Anning and her contribution to palaeontology (Figure 5). The children discovered how fossilisation happened and created flowcharts explaining the process. We also had great fun making our own fossils using playdough and plaster of Paris.

In year 4 (ages 8–9) the children were introduced to the work of Joy Adamson and the Born Free Foundation, while year 5s looked into supervolcanoes and the work of Kayla Iacovino, whose study of volcanoes and volcanic rocks has allowed a better understanding of the inner working of the Earth.

The year 6 class (ages 10–11) concentrated on the first British woman astronaut, Helen Sharman, and used Tim Peake's Primary Project part 2 resources to investigate life in space and crater formation, including making craters in layers of sand and cocoa powder (Figure 6).

To add a little 'wow' factor to our two weeks of science, we hosted a 'science extravaganza' presented by female science undergraduates from Sheffield University. Their demonstrations of several chemical reactions, such as 'elephant toothpaste' foaming and lighting the 'whoosh bottle' certainly did that!

Figure 3 A display of the year 1s work around Jeanne Baret

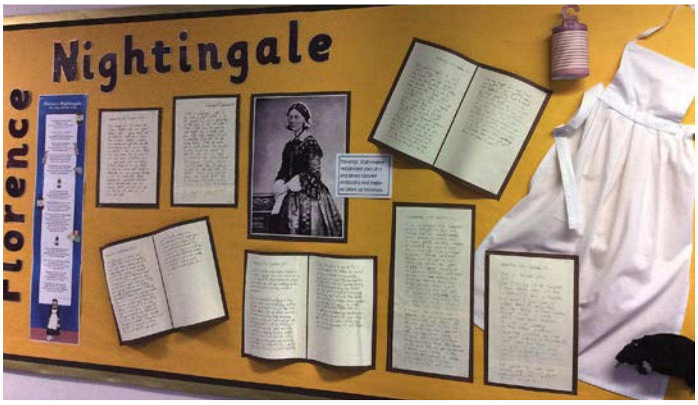

Figure 4 Year 2 looked into improvements introduced by Florence Nightingale

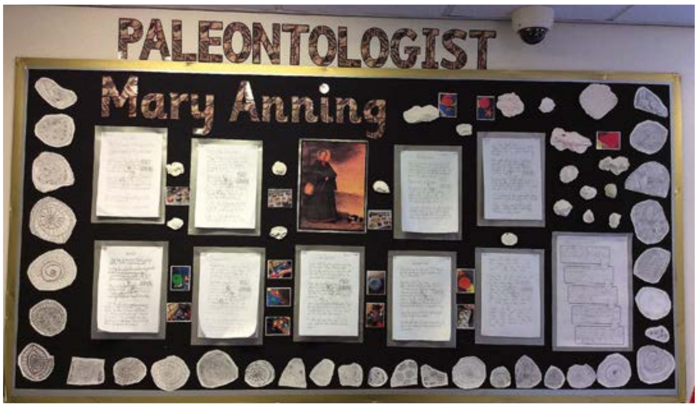

Figure 5 Mary Anning was the stimulus for the year 3 work

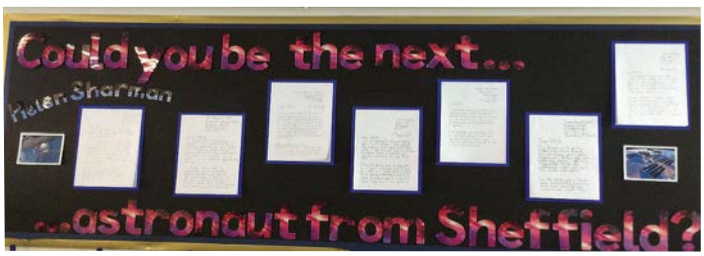

Figure 6 Year 6 learnt about Helen Sharman and life in space

Assessing the impact

The big push we made to engage our pupils, the child-led investigations, independent learning, the hands-on activities and open mornings for parents had some unforeseen, but extremely positive, outcomes. Our teachers have definitely become more aware of the breadth of resources that have become available over the last few years and begun to discover and use practical science activities more freely and with confidence. The children were enthralled and enthused. They loved finding out about the famous women who made and are still making contributions to science nowadays, but most of all they loved 'getting their hands dirty'. Learning happened without conscious effort on the children's part! Almost by osmosis, one could say.

Overall, I must say we made science 'rock' at our school.

Reference

Forrest, C. (2016) *The mighty women of science*. Glasgow: Black Hearted Press.

Agnieszka Barden is a year 3 class teacher. Initially trained in Poland, she has worked in a variety of education settings within the UK. She has been coordinating science at Sacred Heart School, a Catholic Voluntary Academy in Sheffield, for just over a year.
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Standing on the shoulders of giants:

contemporary scientists bringing your science curriculum to life

Alex Sinclair and **Amy Strachan** discuss how the use of contemporary scientists in the classroom can help us learn from the approaches of yesterday's famous scientists

We wrote in issue 145 of *Primary Science* (Sinclair and Strachan, 2016) about the value of studying the famous scientists noted within the National Curriculum for primary science in England. We suggested that, rather than spend time researching the scientists' lives, there should be a far greater focus on their work. This emphasis provides children with the opportunity to understand that there is no such thing as 'the scientific method' and that a variety of enquiry types are, and have been, used. We also recommended that the scientists' work be placed in context so that children can see how scientific ideas have changed over time. We believed that part of this process was to identify what other scientists did to show how the famous scientists' ideas had been developed.

We have been lucky to share our work with a number of teachers and gain valuable feedback about what has worked for them. It has been lovely to hear about all of the wonderful questions children have asked and about those that have dressed up to role-play some of these famous scientists. Seeing classes bring these scientists to life through drama and 'hot-seating', as well as re-enacting their investigations, has demonstrated how they provide a vehicle for science learning opportunities. However, the biggest response from teachers was about how they could approach the integration of the work of contemporary scientists into their planning and demonstrate the dynamic continuum of scientific thinking.

This article provides a way of engaging with contemporary scientists and suggests how to contact them and utilise their expertise. You can also find a list of modern scientists (see Table 1) that could be used to show how contemporary science is related to the work that the children are learning about. This approach differs from the one demonstrated in our previous article (Sinclair and Strachan, 2016), in that it does not start with the famous scientist but asks the contemporary scientist *'How have you stood on the shoulders of giants?'* (a sentiment attributed to Isaac Newton who was referring to how his discoveries had built on the work of others before him).

Key words: Scientists Nature of science

By making this shift in emphasis we hope that the human element of being a scientist can be promoted. We think that the modern scientists can act as more attainable role models. The Wellcome Trust (2017a) has already identified the positive effects on the motivation of children and young adults to learn science when they are introduced to 'real' scientists and STEM ambassadors. In addition to this, it can help to meet one of the aims of the National Curriculum which states that children '*should be equipped with the scientific knowledge required to understand the uses and implications of science, today and for the future*' (DfE, 2013: 1).

We believe that there is no hard and fast rule for introducing 'real' scientists into your curriculum. They could become a regular part of your school's science week or could help to bring a programme of study to life. You could simply spend two minutes chatting about a scientist at the end of a lesson, or a whole afternoon preparing for and interviewing a local scientist. However you do it, our guide may give you some ideas along the way.

Step 1: Find your scientist!

Box 1 provides a list of ways in which you could get in touch with a scientist. Our experience tells us that the most productive way is to email parents at the start of a term, asking for help. We were lucky enough to work with cardiologists, dentists, botanists, engineers and a gemologist (look that one up!).

Box 1 Where can you find your contemporary scientists?

- **Parents:** Send out a letter to find out whether any of your pupils have parents who work in areas of science and technology.
- **I'm a Scientist** (https://imascientist.org.uk): Not only does this website provide a bank of current, emerging scientists, but it also provides a forum through which to explore their approaches and areas of science.
- **Skype a Scientist** (www.skypeascientist.com): Matches scientists with classrooms around the world! Scientists will skype into the classroom for 30–60 minute Q and A sessions that can cover the scientist's expertise or what it's like to be a scientist.
- **STEM Ambassadors** (www.stem.org.uk/stem-ambassadors): Volunteers from a wide range of science, technology, engineering and mathematics (STEM) related jobs and disciplines across the UK.
- **Local community:** Are there any science-based establishments local to your school? These could be universities, pharmaceutical companies or even botanical gardens.
- **The Crunch** (https://thecrunch.wellcome.ac.uk/get-involved/ambassadors): Ambassadors who are researchers and communicators interested in the area of food and health science.
- **Scientist in your Classroom** (www.zsl.org/zsl-london-zoo/schools/education-sessions/scientist-in-your-classroom): Interactive online chat with Zoological Society of London scientists.
- **Soapbox Science** (http://soapboxscience.org): Promotes women in science through live interactive 'soapbox' events.

Box 2 Guided questions that the children could ask the scientist to learn more about how they work

- Which scientists have inspired you?
- What made you want to work in this area?
- What do you look for?
- What questions do you ask? What do you hope to find out?
- What are you doing?
- What other scientists do you work with?
- What have you found out?
- Why does it matter?

(Note: You might want to prepare your contemporary scientist first by giving them these questions to think about.)

Step 2: What might you do?

Box 2 provides a list of guided questions for children to ask their scientists, which could be answered by email, video-link or in person. Of particular importance is the question that asks them to identify which scientist has inspired them. This will help the children make the link between the scientist's work, a famous scientist and the topic that they are studying. We feel that this is also an opportunity to help reinforce the view that science is just as much about asking questions as it is about learning scientific content. The curious nature of the scientist can be demonstrated by asking what questions they are asking in their research and why. Although we have identified individual scientists in this article, most of them work in collaboration with others and this is a key aspect of the nature of contemporary science, which should be considered in the exploration of the scientists you choose.

Step 3: What next?

Box 3 shows how the above could then act as a stimulus for scientific enquiry. Another report from the Wellcome Trust (2017b: iv) reveals that '*young people often do not understand the purposes behind the practical work they do in science lessons*'. We suggest that thinking about their own questions in relation to scientific developments may help children see their place in the continuum of new discoveries and advancements.

Box 3 Harnessing the next generation of scientists

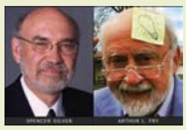
Ask your pupils these questions after interviewing contemporary scientists:

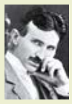
- What would be a good question to ask now?
- How would you find an answer to that question?
- Why is that question important (who will be interested in the answer?)

Over to you

We hope the suggestions and resources that have been provided are useful starting points. We have created a database of resources related to both contemporary scientists and those named in the National

Table 1 Contemporary scientists, how their work relates to school science and the 'giant' on whose shoulders they stand

Year group / Learning outcome	Content area	Contemporary scientist	Scientist (giant)
Year 1 **(ages 5–6)** Describe the simple physical properties of a variety of everyday materials. Compare and group together a variety of everyday materials on the basis of their simple physical properties.	**Everyday materials** 	**Martin Brock** XelfleX inventor, nanotechnology engineer  Martin Brock works with a team to develop smart fabrics, which use bend-sensitive fibre-optics that are stitched inside the clothing to provide intelligent feedback for athletes without being too bulky.	**Charles Macintosh** Inventor of waterproof fabric 
Year 2 **(ages 6–7)** Identify and compare the suitability of a variety of everyday materials, including wood, metal, plastic, glass, brick, rock, paper and cardboard for particular uses.	**Using everyday materials** 	**Julie Brusaw** Solar Roadways inventor, material engineer  Not only do they have all of the properties of ordinary roads, but solar roadways have been designed in an attempt to use the Sun's energy to provide power for highways.	**John Loudon McAdam** Inventor of macadam road surfacing 
Year 2 **(ages 6–7)** Give reasons based on evidence from comparative and fair tests for the particular uses of everyday materials. Explore changes that are difficult to reverse.	**Materials** 	**Joe Zekoski** Goodyear engineer, mechanical engineer  Developer of the BH03 tyre, which is fitted with materials that change heat into energy to charge an electric car without the need for a charging station. When parked, sunlight heats the tyre and this heat is transformed into electricity using the thermo-electric material.	**John Boyd Dunlop** Developed inflatable rubber tyres 
Year 3 **(ages 7–8)** Describe in simple terms how fossils are formed when things that have lived are trapped within rock.	**Rocks** 	**Holly Betts** Palaeobiologist  Holly is researching whether fossils are best for establishing a timescale for recent and ancient episodes in our evolutionary history.	**Mary Anning** Palaeontologist and fossil collector 
Year 4 **(ages 8–9)** Recognise that environments can change and that this can sometimes pose dangers to living things.	**Living things and their habitats** 	**Seirian Sumner** Evolutionary biologist and behavioural ecologist  Specialises in social evolution and social behaviour in insects (bees, wasps and ants).	**Jane Goodall** Primatologist 
Year 5 **(ages 9–10)** Explain that some changes result in the formation of new materials and how chemists create new materials.	**Properties and changes of materials** 	**Joe Keddie** Professor of Soft Matter Physics  Professor Keddie is interested in fundamental processes in soft matter, especially polymer thin films and nanoparticles. He researches into the nanostructure of pressure-sensitive adhesives.	**Spencer Silver** Inventor of Post-it® notes 
Year 5 **(ages 9–10)** Understand how the geocentric model of the solar system gave way to the heliocentric model. Describe the Earth and other planets relative to the Sun in the solar system.	**Earth and space** 	**Maggie Aderin-Pocock** Astronomer and science communicator  She is working on and managing the observation instruments for the Aeolus satellite, which will measure wind speeds to help the investigation of climate change.	**Nicolaus Copernicus** Proposed that the Sun was the centre of our universe 

Year 5 **(ages 9–10)** Work scientifically to research gestation periods of other animals and compare with humans. Find out about the work of naturalists and animal behaviourists.	**Animals including humans** 	**Sarah Fowler OBE** Marine biologist Sarah's research identified the global threat to sharks and shares strategies of how we can protect them. 	**Sir David Attenborough** Naturalist and broadcaster 
Year 5 **(ages 9–10)** Explain that unsupported objects fall to the Earth because of the force of gravity acting between Earth and the falling object.	**Forces** 	**Emma England** Aerospace engineer Emma works with a team to design the wings of aircrafts. 	**Galileo Galilei** Polymath 
Year 6 **(ages 10–11)** Recognise that living things have changed over time and that fossils provide information about living things that inhabited the Earth millions of years ago.	**Evolution and inheritance** 	**Professor Nazneen Rahman** Human geneticist Her research involves identifying genes and genetic factors that increase the risk of cancers developing and she has used this research to develop clinical improvements in patient care. 	**Alfred Russel Wallace** and **Charles Darwin** Proponents of evolution by natural selection 
Year 6 **(ages 10-11)** Understand that light travels in straight lines and that objects are seen because they give out or reflect light into the eye.	**Light** 	**Ernesta Jonkute** Nanotechnologist Developed Vantablack®, a super-black coating that holds the world record as the darkest human-made substance. It is used in applications ranging from space-borne scientific instrumentation to luxury goods. 	**Alhazen** Pioneer of modern optics 
Year 6 **(ages 10-11)** Compare and give reasons for variations in how components function, including the brightness of bulbs, the loudness of buzzers and switches.	**Electricity** 	**Peter Rawlinson** Engineer Working on the development of electric vehicles, providing clear vision for a highly differentiated, next-generation product. 	**Nicolas Tesla** and **Thomas Edison**  Battled over competing electric power transmission systems (a/c and d/c) and developed the electric light bulb
Year 6 **(ages 10-11)** Describe how living things are classified into broad groups and give reasons for classifying plants and animals based on specific characteristics.	**Living things and their habitats** 	**Chris Nelson** Horticulturalist  Horticultural Director of Growing Underground, which uses hydroponic techniques to grow pesticide-free crops in a former central London underground air-raid shelter. Typically green herbs and salad leaves such as pea shoots, coriander, and red amaranth are grown. The plants grow on mats made from recycled carpet, are watered mechanically and lit by ultraviolet light itself powered by renewable electricity sources.	**Carl Linnaeus** Developed the modern system of classifying and naming organisms 

Curriculum (see *Website*). It would be great to hear from you about any inspirational experiences you have with your children so that we can add and share them with the rest of the primary science teaching community.

Acknowledgement

The ideas in this article have arisen from conversations with Ben Dickey and Beth Newell (from Cornucopia TV, www.cornucopia.tv). They also helped provide the names and contexts of some of the contemporary scientists.

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Website

Contemporary scientists database:
https://padlet.com/StMarysresources/contemporaryscientists

The PS interview

Leigh Hoath asks TV presenter **Andy Day** about his encounters with dinosaurs, baby animals and how he problem-solves with science

I didn't know there were so many different species of dinosaur. It was only through my own children becoming (rather overly) obsessed with watching *Andy's Dinosaur Adventures* on the BBC's *CBeebies* channel that I realised how much learning takes place through television. Imagine a sunny day in the garden: my son comes hurtling round the corner shouting *'Help! I'm being chased by an Allosaurus!'*, closely followed by his twin sister yelling equally loudly *'No! It's a Velociraptor!'* They were two-and-a-half years old and it struck me how much they were absorbing and learning without realising it.

Children's TV seems to have developed hugely since I watched it as a child: there are many programmes with a strong educational focus. So I decided it would be worth exploring the opportunities to engage children in the foundation stage and key stage 1 (ages 3–7) through the science in these programmes.

In his programmes, Andy Day is an avid scientist who has 'worked' in the Natural History Museum and used its grandfather clock as a means of travelling back in time to solve many a crisis that ruins part of his wonderful display. He has explored many prehistoric contexts and found himself in battles between different animals and often challenged in returning to the clock. As well as going back in time he has also had many *Wild Adventures* with Kip, who flies him around the world to understand more about how a certain animal is adapted to its environment. More recently, Andy has entered the world of *Baby Animals*, looking at different skills they gain as they grow.

Whatever the context, one thing is evident: there is a lot of science in all the programmes. Whether this is considering the feeding patterns between carnivores and herbivores, using forces to return Andy to the clock, or how animals are adapted to their environments, the links are easily established.

A friend's daughter (age 4) was very enthusiastic about the programmes and, when asked what questions she would like to ask Andy, she came up with: *'Why does Triceratops have horns?'* and *'Why do some dinosaurs walk on four legs while some walk on two like T. rex?'* There is a strong focus on starting with children's questions; using a short television programme might just generate more than you thought possible.

Interview with Andy

How did you end up in a role where you are presenting programmes with such a strong natural history focus? Do you have a science background?

My amazing commissioner at the time, Michael Carrington, knew I wanted to do my own show. I had pitched different ideas quite frequently, so I guess I was fresh in his head when the BBC Natural History Unit pitched the idea of *Wild Adventures* (which then carried on to become *Dinosaur Adventures* and *Prehistoric Adventures* of course). Originally it was going to be a cartoon character called Max going on these adventures, but Michael said that if it was made as a live action series with me in it then he would commission it. I got the email while away travelling, which was very apt I thought! I was over the moon to be asked to do a pilot. I love adventure and I love natural history but I'm afraid I do not have a science background - just a love and appreciation of it.

When the episodes are put together is there a conscious emphasis on enhancing learning around the species involved?

Absolutely! This programme is made by the Natural History Unit and its makers are made up of zoologists, natural history filmmakers and just very creative filmmakers who know how to execute a good adventure. The best way to learn in my eyes is through having fun. This is the most successful way of educating our children and, in fact, adults too. That is why having a story that they can engage with is so important; in my eyes, just facts doesn't 'cut it' with everyone even if they are interesting facts. Even the BBC *Planet Earth* series is edited and filmed in a dramatic story-driven way: it is what we humans like to see.

Key words: Science in the media

What has been your favourite series to make to date and why?

For me, it has been *Prehistoric Adventures*. Because it was the third series, we knew exactly what we were doing from the other programmes. It involves not just dinosaurs but a range of interesting prehistoric animals and amazing facts and also touches on lots on evolution in a child-friendly way, as well as how creatures have changed over the years. I got to be a caveman version of myself, which I loved! [Leigh: *I know that episode and I could never quite work out whether it was really you or not!*]

Would you like to see your programmes used as means of developing children's knowledge and understanding in the classroom? Do you think there is a value/link between what children watch at home and what they do in school?

Yes, in fact I have spoken in many schools and the teachers tell me that they do show the programmes quite often to teach the children about natural history. Even the raps about dinosaurs and prehistoric creatures have become quite popular in school classrooms; children learn facts from them and get used to learning the names. It is amazing to hear this as both I and the guys at the Natural History Unit are very passionate about engaging children with learning these things.

If you could choose to be any dinosaur which would it be and why?

I would be the *Titanosaur* that was recently discovered. Scientists believe it could have been the biggest one ever, so I would like to be that one, as I'm used to being tall!

You often have to solve many problems when it comes to getting back to the museum, which solution has been your favourite?

I enjoyed having to replace a sand dollar. That was the episode where I flew on the back of an *Oritheceirus*! What better way to solve a problem!

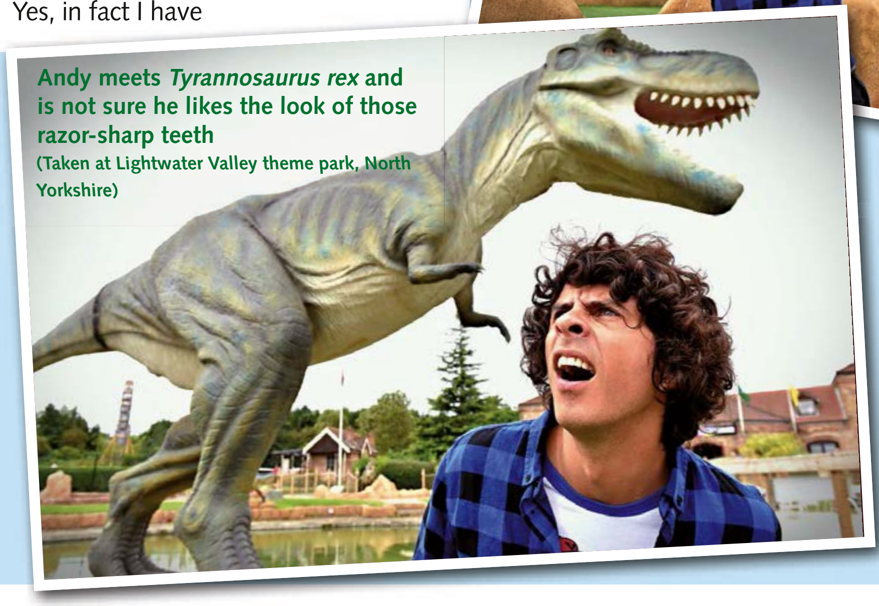
What can you tell my friend's daughter about *Triceratops* and *T. rex*?

Triceratops is a herbivore; it had three great horns on its head that it would have used to protect itself from dinosaurs like *T. rex*. Its name in Greek means 'three-horned face'.
T. rex had razor-sharp teeth; its name means 'tyrant lizard' and it grew to about 6 metres tall. It was a very dangerous meat-eating dinosaur that lived 65 million years ago.

In the *Baby Animals* series, which adaptation or skill impressed you the most?

There are so many, but I found the mandarin chicks having to jump out of their nest from a great height to follow their mums, risking their lives after just being born, is quite an incredible thing. I find it fascinating what *all* animals, including us humans, do to survive.

Triceratops confronts Andy – those horns could do some damage!
(Taken at Lightwater Valley theme park, North Yorkshire)



Andy meets *Tyrannosaurus rex* and is not sure he likes the look of those razor-sharp teeth
(Taken at Lightwater Valley theme park, North Yorkshire)

If you could learn more about any part of science what would it be?

Space would be a big and interesting one to tackle in the knowledge department. I would like to know more about the wonders of space.

This issue's theme is 'Famous Scientists' and I think it is really interesting that, despite not having a background in science, Andy's enthusiasm for it has driven him forward to present a number of series that focus on science – probably not dissimilar to many science coordinators in school!

I would like to thank Andy for giving his time to complete this interview and for being such a great enthusiast for children learning from an early age. I know I cannot wait to see where his next adventures take him!

Andy Day is a television presenter and **Leigh Hoath** is Editor of *Primary Science.*

SCIENCE SWAP SHOP
four-page pull-out
ages 3–5

Florence Nightingale – Hand hygiene

Florence Nightingale was a British nurse famous for the work she did caring for soldiers during the Crimean War, but she was also hugely influential in changing how hospitals were run, improving cleanliness and patient care. Florence is considered to be the founder of modern nursing. The soldiers she cared for called her 'The Lady with the Lamp' as she worked all night taking care of them. Florence was the first woman to be given the Order of Merit, the first woman to become a member of the Royal Statistical Society and also received the Royal Red Cross.

Children can learn about the importance of hand hygiene in preventing the spread of germs with a simple hand-washing activity.

You will need:

- glitter
- hand cream
- water and soap
- paper towel

Instructions

1 Split the children into groups of two and ask one child from each pair to rub a little hand lotion onto their hands.

2 Sprinkle a little glitter onto the hand with hand lotion and ask the children to shake hands. They should see that they both now have glitter on their hands.

3 Ask both children to try to remove the glitter using just a paper towel. Does it work?

4 Next try washing with just water, followed by water and soap to see which method of hand washing is most effective.

Charles Darwin – Making fossils

Charles Darwin is most famous for his work on natural selection, the evidence for which came from his voyage on HMS *Beagle*, observing and collecting fossils, birds and whatever else he could find.

You will need:

- air-drying clay or salt dough
- rolling pins
- small toy animals
- paint

Instructions

1 Roll out a thick circle of clay slightly bigger than the toy animals you want to use.

2 Gently press the animals down so they leave an imprint.

3 Once the dough has been baked or left to air-dry, the fossils can be decorated using paint.

SCIENCE SWAP SHOP ages 5–7

Caroline Herschel – Model comets

Caroline Herschel was a pioneer of her time. She was the first woman to discover a comet, the first woman officially recognised in a scientific position and to receive a salary, and the first woman to receive honorary membership of Britain's Royal Society. She made huge contributions to the field of astronomy in her lifetime, both independently and alongside her brother William Herschel.

What is a comet?

Comets are big balls of ice, rock and dust left over from the beginning of the solar system. They are generally thought to come from the Oort Cloud and the Kuiper Belt and orbit the Sun. When comets get close to the Sun, they start to release gas and dust, forming a head (or coma) and a tail. The tail always points away from the Sun.

You will need:

- foil or small ball
- stick
- three colours of ribbon

Instructions

1 Attach foil made into a ball or a small ball to the end of a small stick. The ball represents the nucleus of the comet.

2 Wrap one colour ribbon around the ball. This represents the coma.

3 Attach the other two colours of ribbon to the nucleus. These represent the two tails of the comet. One is the gas tail and one the dust tail.

Extension idea

Do you think you could live on a comet? What issues might you face?

Nicolaus Copernicus – Sun, Moon and Earth

Nicolaus Copernicus was an astronomer born in 1473 who realised that the Earth orbits the Sun, an idea that was strongly opposed at the time. The model proposed by Copernicus was called heliocentrism, where the Sun is motionless at the centre with other planets rotating around it. Copernicus's ideas marked the beginning of modern astronomy. This easy activity helps children visualise how the Sun, Earth and Moon move around each other.

You will need:

- black cardboard
- yellow, blue and grey paper or card
- stapler

Instructions

1 You will need three children to take part in the demonstration. One will be the Sun, one the Moon and one the Earth.

2 Make three hats to represent the Sun, Earth and Moon, using cardboard and a stapler or glue.

3 Ask the Sun to stand in the centre and the Earth to walk around the Sun in a circle. The Moon should then walk around the Earth in a circle as the Earth circles the Sun.

Extension idea

- How many other planets can you add to your demonstration?
- Think about how long it takes the Moon to orbit Earth and how long for the Earth to orbit the Sun. Ask the children to change their walking speed to reflect this.

Galileo Galilei – How fast does it fall?

One of Galileo's most famous observations was that two same-size objects of different weights hit the ground at the same time when dropped from the same height. This is because the force of gravity acting on both objects is the same. We can test this with a simple activity.

You will need:

- 2 small empty plastic water bottles
- sand or water
- weighing scales

Instructions

1 First you need to make sure your water bottles are empty, dry and both the same size.

2 Half fill one with sand (or water) and record how much each weighs.

3 Hold the bottles up as high as you can and drop both at the same time.

4 Do they hit the ground at the same time?

More fun

Experiment by putting different amounts of water in the bottles, do they still hit the ground at the same time?

Leonardo da Vinci – Mirror writing

Leonardo da Vinci is perhaps most famous for painting the *Mona Lisa* and *The Last Supper*, but as well as painting he kept journals full of drawings and scientific notes. These included studies of human anatomy, designs for flying machines, musical instruments, bridges, churches and war machines. Leonardo wrote his notes using a kind of shorthand he invented himself, and also mirrored his writing, writing from right to left. It is thought he only wrote normally when his writing was intended for other people. Try mirror writing. Is it easier or harder then you expected?

You will need:

- paper
- pencil
- mirror

Instructions

1 Try to write your name backwards using the hand you normally write with.

Do you have to think much more carefully? Check you have done it correctly using a mirror.

2 Now try writing backwards using the hand you don't write with. How do you find that?

3 Is it easier if you use a mirror? Which letter is the hardest?

Extension idea

- Is it easier if you write with both hands at the same time, with one writing backwards and one forwards?

SCIENCE SWAP SHOP ages 9-11

Isaac Newton – Theory of light

Isaac Newton discovered that white light is actually made up of a range of colours. You can easily demonstrate this using a prism.

You will need:
- right-angled prism
- thick white cardboard
- dark coloured cardboard
- tape or glue

Instructions
1 Cut out two equal-sized pieces of dark cardboard and bend over one edge of each (about 1 cm).

2 Stick the bent edge to your thick white card leaving a gap between the two pieces big enough to let a small stream of light pass through.

3 Tilt the cardboard so sunlight can flow through the gap. This should give a very fine beam of white light.

4 If you place a prism over the light, you should see the light split up into the colours of the rainbow.

Why does this happen?
When white light enters a prism the light waves are refracted as they enter and leave the prism. Shorter wavelengths are refracted more than longer wavelengths, resulting in white light spreading out to form a spectrum of all the colours of the rainbow.

Isaac Newton – Film canister rocket

Isaac Newton changed how we understand the world. He is most famous for discovering gravity, but also developing the laws of motion, calculus and the reflecting telescope! A film canister rocket is a great activity that demonstrates all three laws of motion in action.

You will need:
- 35 mm plastic film canister or similar
- effervescent tablet (e.g. Alka-Seltzer, vitamin tablet)
- water
- safety goggles

Instructions
1 You will need a safe flat, hard area of ground to launch your film canister rocket from.

2 **Wearing safety goggles**, half fill the film canister with water and place one tablet inside. Replace the lid quickly and place the canister lid-down on the floor. **Stand well back** and wait for your rocket to fly.

Extension idea
- Repeat the launch using different amounts of water. Does it make a difference to how the rocket flies?

Why does this happen?
When water is added to the effervescent tablet it starts to break down, releasing carbon dioxide gas. The build-up of carbon dioxide inside the canister creates pressure, which eventually becomes strong enough to force the cap down, which in turn forces the canister part upwards (Newton's Third Law).

Lights, camera, science!

John McCullagh and **Andrea Doherty** describe how using digital storytelling can support enquiry

Figure 1 Minions set the scene

As soon as Gru, the villainous character from the Disney film *Minions*, appeared on screen the children were hooked (Figure 1). When he slowly turned his head and spoke menacingly to the class, the children could barely contain their excitement!

Listen carefully year 3, I have a task for you. I have heard that the pupils at St Oliver Plunkett Primary School have been studying the topic of 'Space', and I need your help. I want to steal the Moon! Do you think you can help me build a rocket ship to get there?

This lesson was part of a project aimed at exploring how digital storytelling could support enquiry-based science. As iPads have been found to have a positive impact on children's reading, writing, and numeracy skills and to provide a more engaging and exciting learning experience than traditional approaches (Gray *et al*., 2017), we wanted to explore what a digital approach to learning might offer science.

As Academic Collaborators for the Primary Science Teaching Trust (PSTT, https://pstt.org.uk), one of our areas of curriculum innovation and research has been the use of iPads within enquiry-based science. As with many of our projects, we involved undergraduate student teachers specialising in primary science. Previous studies (Tyler and Bianchi, 2014) have shown that iPads can be used to formatively assess children's progress, particularly with respect to 'working scientifically'. We have recently explored how various iPad apps can be used effectively in science. The apps that proved to be the most suitable for science, such as *Puppet Pals*, *Explain Everything* and *SonicPics*, allow children to sequence, annotate and manipulate digital images of their work. This year we focused specifically on the use of the app *iMovie* as a means for children to record and report on a full science investigation.

Before using *iMovie* in their lessons, the students attended seminars supported by Nerve Belfast Creative Learning Centre (www.nervebelfast.org), where they developed their digital skills and explored video-making issues such as the use of storyboards and the choice of film shots. We then discussed the similarities between the composition of science-themed documentaries and the elements and structure of science enquiry. Both begin with a scenario or context from which a problem or question emerges. There is usually a main character and a setting involved, which stimulate interest and generate empathy from the viewer and a desire to help. This focuses thinking towards a possible plan of action and helps identify what might constitute useful evidence to answer the question or solve the problem. During these preparatory workshops the student teachers carried out typical science investigations and produced *iMovies* to report their work.

Project details

The project involved ten undergraduate student teachers who worked in pairs to co-plan, co-teach and co-evaluate a series of five science enquiry lessons in two local primary schools in Belfast. Two year 3 classes (ages 6–7) were involved from one school and three year 4 classes (ages 7–8) from another. During the first two lessons the children carried out science enquiry tasks and used worksheets to record and report their findings. Over the course of the remaining three lessons the children made *iMovies* to record

Key words: Storytelling Enquiry Digital technology

Figure 2 The children recording their enquiries using *iMovie*

and present their enquiries (Figure 2). At the end of the project the student teachers used questionnaires and focus group interviews to access the views of the children. During the lessons the student teachers carried out observation tasks and afterwards sought the views of the teachers through semi-structured interviews. The student teachers were involved in the task of writing the questions and conducting the interviews as we wanted to develop their evaluative and research skills.

The enquiry lessons

Year 3 lessons

The topic for both year 3 classes was space, with one set of children looking at rockets and how they work. The student teachers introduced the enquiry task with a short *iMovie* they had already prepared: the children had to help the character Gru from the film *MInions* get to the Moon. They edited a short extract from the original Disney film and inserted their own clip of Gru talking to the class, using the app *Morfo* to convert an image of Gru into an animated talking cartoon. Their Gru accent was most impressive and the overall effect quite motivating.

The children blew up balloons and then let them go to observe how they moved and explore the concepts of thrust and force. On realising that air was a gas, they began to look at ways of producing gas from simple ingredients such as vinegar, bicarbonate of soda, effervescent tablets, cola and Mentos. The children wrote and drew lots of pictures and completed worksheets as they made their way around a carousel of activities.

The children discovered that the vinegar and bicarbonate produced the most bubbles in the shortest period of time and so chose this as their rocket fuel. This relates to the topic of ‘materials’ and the ‘change over time’ area of the curriculum. One group discovered that when the vinegar was warm it reacted better with the bicarbonate of soda, so they kept the plastic canister under their armpits when they went outside to test their rockets!

To support the children in making their own *iMovie*, the student teachers discussed what should be included in their storyboard and showed the class one that they had made, explaining how it had been constructed from a series of short video-clips. The children then began planning their own storyboards and deciding whether long, medium or close-up shots would be most effective for each part of the video. The children worked in pairs to carry out the activity and record video and still pictures. They loved selecting suitable sound effects and getting the timing to coincide with the launch of their rocket! Putting text over the images required them to discuss and explain their observations and pay particular attention to grammar, punctuation and spelling (Figure 3). It also got them to re-watch what they had done and reflect on their experiment. All this required teamwork, as one child tested the rocket while the other recorded.

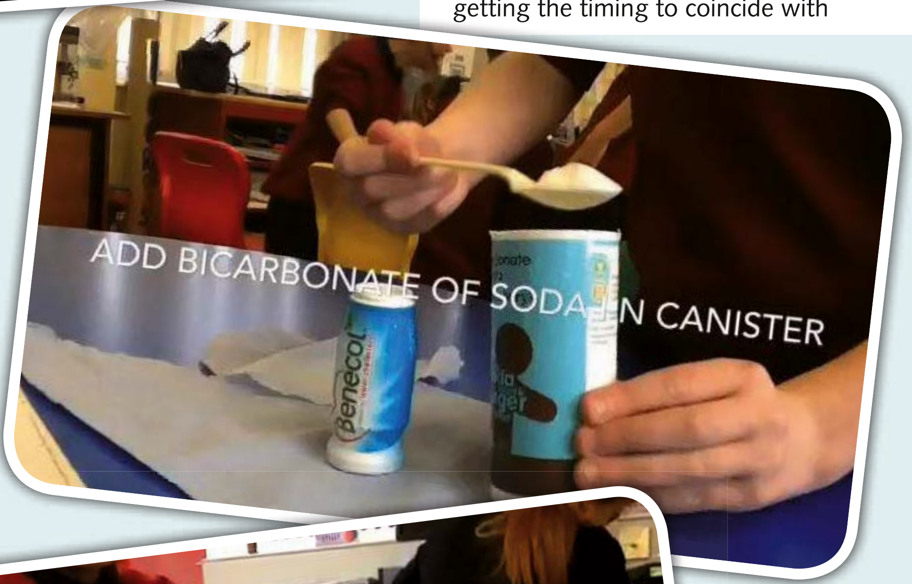


Figure 3 Two stills from the year 3 children’s *iMovie* explaining their rocket investigation

For the other year 3 class, the student teachers prepared a trailer featuring ‘Arnold’ (a happy looking puppet) who was embarking on a journey through space and needed the children’s help to adapt to the conditions on the various planets he was going to visit over the coming weeks. The combination of seeing

Arnold in the trailer and then 'live' in the classroom was a very powerful motivator and caused huge excitement among the children, who raised a great number of ideas and questions for Arnold about his trip into space.

For Arnold's visit to the 'dark planet' the children constructed electrical circuits with bulbs and switches. For the 'wet planet' they investigated which materials were the most waterproof. On the 'ice planet' Arnold carelessly managed to get the keys to his moon buggy trapped inside an ice balloon and asked the class to find out which material from his food supply was best for melting the ice (poor Arnold was living on a diet of salt, sugar and coffee!). The children were new to making *iMovies* so the student teachers showed how easy it was to make a trailer from a collection of video-clips and images and the built-in facility in the app.

Year 4 lessons

The topic of 'healthy bodies' provided lots of scope for enquiry for the three year 4 classes. The first couple of lessons focused on the impact of exercise on our pulse and breathing rate. This allowed the children to get used to using the different features of *iMovie* and helped them to construct their enquiry storyboard and decide what would be the best way to record the results.

The children were then ready for the more challenging investigation into which fruit contained the highest concentration of vitamin C. They were clearly excited to be working like 'real scientists', using measuring cylinders, plastic droppers and the chemical DCPIP (dichlorophenolindophenol) (a 0.1% aqueous solution is classified as a Low Hazard – CLEAPSS), disposable gloves and safety goggles. They were enthralled during the testing of orange, lemon, pineapple and apple juice and comparing bottles of fruit concentrate to the fresh product.

Some groups decided to present their results orally, while others recorded video-clips and images of their table of results. The test involves counting the number of drops of fruit juice required to change the solution of DCPIP from blue to colourless. The larger the concentration of vitamin C in the juice, the smaller the number of drops of fruit juice required.

The children's views

At the end of the project a total of 129 children completed the short questionnaire, the findings of which are presented in Figure 5. The data suggest that the children felt that making an *iMovie* to report on their science enquiry made learning easier and more fun. The *iMovie* task made recording easier, motivated the children to try harder and encouraged more discussion. All the children stated that they would like to use this more in their science lessons. Almost all the group felt that using the iPad had not distracted them from the task of carrying out the science enquiry.

Popular themes that emerged during the focus group interviews were:

- **recording of results took up less time so children felt they could 'do more';**
- **having pictures and videos to re-watch allowed for closer observation;**
- **making the *iMovie* helped sequence their enquiry and 'get organised for the experiment';**
- **the approach encouraged discussion;**
- **the fact that they were making an *iMovie* made the children try harder as it would be seen by more people than a written report would be.**

The teachers' views

The feedback from the five teachers was generally very positive and the consensus was that they would certainly like to adopt this approach in the future. Being able to record work quickly and easily was a major advantage over a more traditional approach. The iPads were felt to be particularly helpful for weaker pupils, as one teacher said:

This approach meant pupils of all abilities produced high level work, which wouldn't be the case with

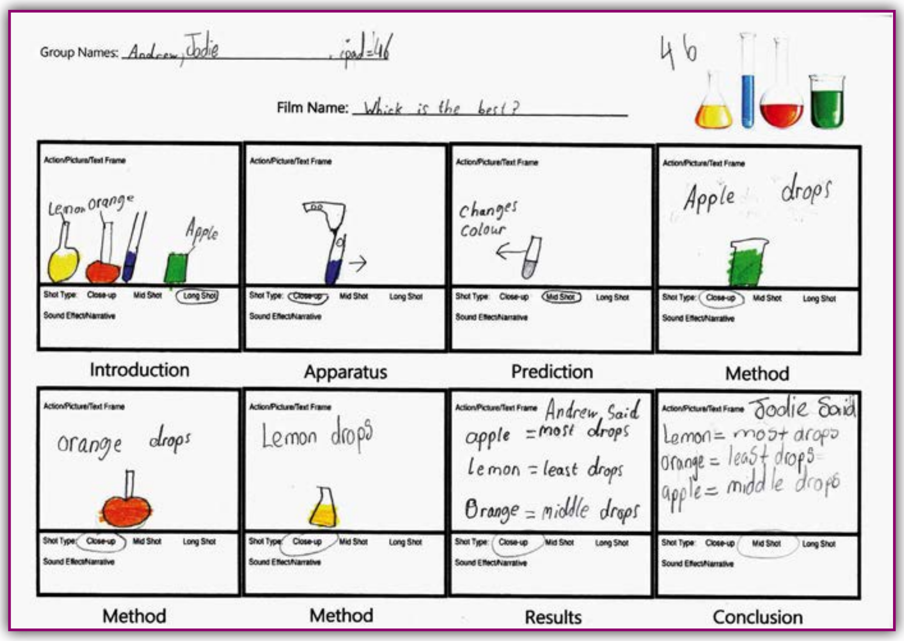


Figure 4 One group's storyboard for the vitamin C investigation

Figure 5 Children's views on making an *iMovie* of their enquiry

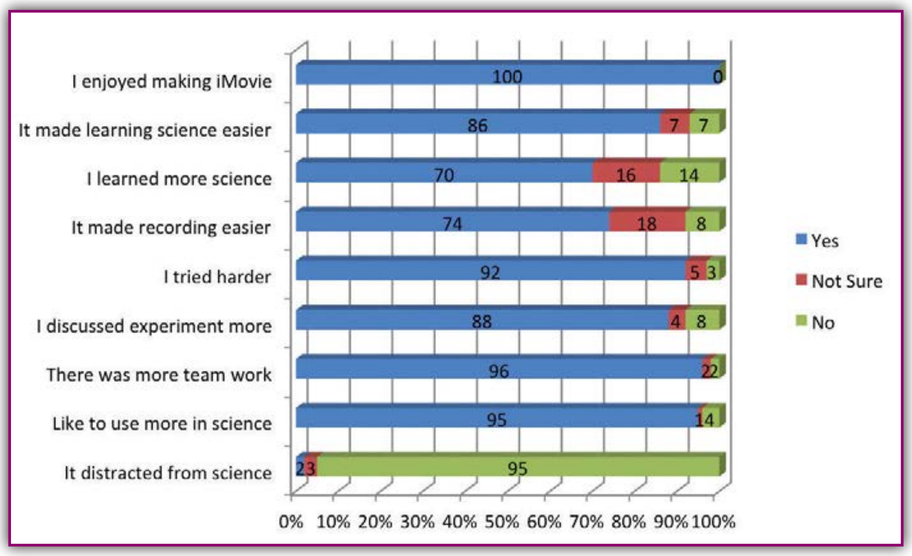


Table 1 Challenges presented by the digital storytelling approach and possible strategies

Challenge	Possible strategy
Developing teacher and pupil skills in using *iMovie.*	Use the 'Trailer' feature to produce a trailer based on images of a previous activity.
Children becoming 'off task' and playing with the iPads.	Allocate a lesson for children to play and explore the features of *iMovie* and share their expertise.
Ensuring all group members contribute.	Assign and rotate roles such as Director (overall narrative and choice of shots), Resource Manager (materials and equipment), Script Writer (produces accurate text and tables), Editor (decides length and order of clips and sound effects).
Lose focus on science.	Identify one or two particular enquiry skills as the focus for the lesson (predicting, observing, recording, evaluating).
Lesson overruns time slot.	Timetable science and ICT together.
Consolidate science focus during plenary.	During peer review require children to feedback on how reliable, persuasive and engaging each video was.

paper-based reports, so it enhanced confidence, engagement and enjoyment.

Another teacher observed an increase in the quantity and quality of pupil talk during the activities and explained:

Often the written report can restrict children to only writing words that they can spell, but when they were recording with the iPads they were enjoying using scientific terminology and more sophisticated language. This approach provides a purpose for communicating and a means for doing so for all abilities.

There were no concerns that using iPads might compromise writing skills. Several teachers reported that pupils were busy writing scripts and quick to review and edit their work. Commenting on the high level of work produced by weaker pupils, one teacher described this approach as a '*great literacy leveller*'. Opportunities for self- and peer-assessment were also valued. Several teachers felt that this use of the iPad provided an authentic opportunity for purposeful teamwork and highlighted how science enquiry is an ideal context for addressing the Northern Ireland Curriculum's *Thinking Skills and Personal Capabilities Framework* (Murphy *et al.*, 2013).

The teachers did however identify a number of challenges that this approach presents, such as time and classroom management. Table 1 lists the challenges cited by the teachers and some suggested strategies. All the teachers recognised the cross-curricular nature of the activity and the opportunity to meet a number of the requirements of the ICT curriculum. Although not yet a statutory requirement, the majority of primary schools in Northern Ireland participate in an ICT accreditation scheme. Using *iMovie* to record enquiry tasks was considered to provide an ideal opportunity for children to demonstrate their ability to 'Explore' and 'Express', two of the five 'E's required for the accreditation.

Several teachers commented that *iMovie* added considerable value to the lesson plenary and allowed the children to review and discuss their own and their peers' work. The *iMovies* were also useful for looking back over previous lessons at the end of the topic and, as one teacher put it, '*bringing all the children's work together*'.

Conclusion

The project suggests that digital storytelling has huge potential for enhancing children's enjoyment and engagement with science enquiry. The fact that moving images capture our attention and speak to us in ways beyond that of text or pictures is something that we should make greater use of in science education. The recent increase in the cultural value of science celebrities such as David Attenborough and Brian Cox has resulted from their skilful and creative blending of text and images. The importance of asking questions about our Earth and distant planets is central to their philosophy. For a generation of followers of CBeebies' *Nina and the Neurons* and Maddie, the presenter of CBeebies' *Do you Know?*, digital technology ensures that everyone can not only watch the story but actually be part of the story.

The process of constructing their own narrative of enquiry is also highly effective in developing children's understanding and appreciation of the importance of evidence and the role of persuasion when creating a digital message or argument. As the influence of social media and the notion of 'fake news' continue to grow this may be the most valuable lesson of all!

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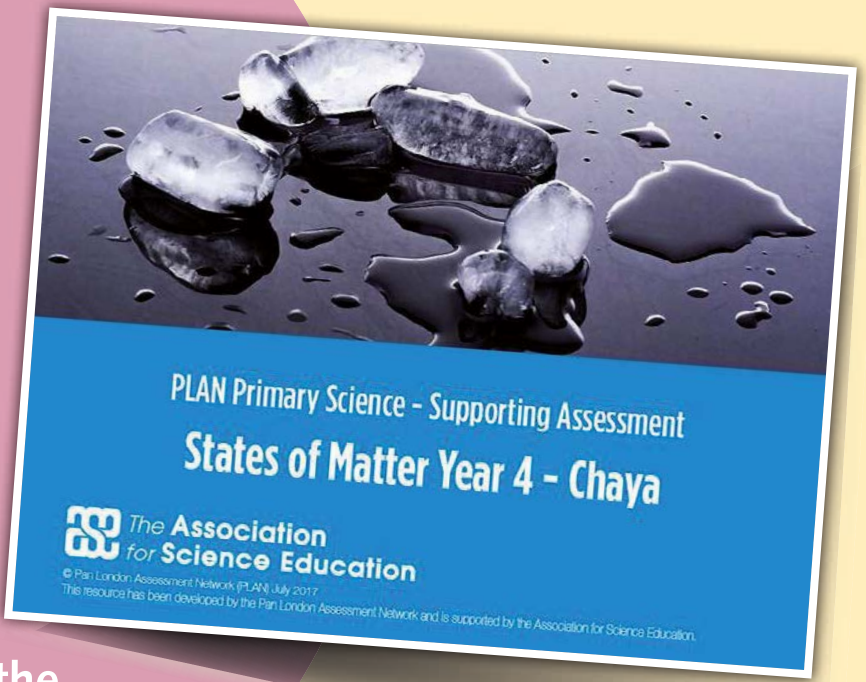
PLAN

What was the need?



Naomi Hiscock outlines the evolution of the PLAN support materials and shows how they can support teaching and learning

The new primary science National Curriculum in England (2013) goes a long way towards making progression through the primary phase much clearer than it was. It eliminates the previously common problem, where all children, irrespective of age and stage, were growing a bean seed or cress seeds. However, it was clear to us, as consultants working with teachers in schools, that the statements in the programmes of study were still ambiguous and therefore open to misinterpretation. This is where the PLAN (Pan London Assessment Network) came in.

Incorrect or incomplete interpretations of the new curriculum statements were leading teachers to plan lessons and enquiries that did not enable children to reach a standard that could be described as 'secure' in a topic.

Should children in year 2 (ages 6–7) be talking about carbohydrates and proteins? The simple answer to this is 'no', as this learning takes place in year 3 (ages 7–8) when they are learning about the nutrients that come from the different types of food (dairy, fruit and vegetables, breads, pulses, etc.) that they learnt about in year 2. Do the children need to know why these are important? No, this is in the key stage 3 (ages 11–14) curriculum, where pupils should be taught about the content of a healthy human diet: carbohydrates, lipids (fats and oils), proteins, vitamins, minerals, dietary fibre and water and why each is needed.

Without an in-depth knowledge of both the primary and key stage 3 curriculum, it is very easy to unwittingly stray into content specified for a later year group and it is possible that this will contribute to two significant issues:

- **Content from later years is conceptually more advanced and we are therefore making it more difficult for children in earlier years to be secure in their knowledge than it needs to be, risking failure for some. We also create a more crowded curriculum, leaving insufficient time for children to demonstrate that they are 'consistently secure'.**
- **We risk children becoming disengaged if they feel they are repeating the same knowledge in subsequent years; there is plenty of interesting science to spread around all year groups!**

The challenge

So, this is the challenge we set ourselves: to produce materials that would make it clear to teachers what 'secure' actually looks like.

Firstly, we needed to determine for ourselves what we would use as a benchmark for security. We established two criteria that helped us to focus our attention, the first related to understanding and the second related to application:

- **Understanding of a concept.** Children need to ***show understanding***

Key words: CPD

of a concept by using scientific vocabulary correctly. **It was evident that we needed to provide further guidance on the National Curriculum statements in order to support the teachers in pitching the work appropriately. We felt that one effective way of doing this was to include a list of key vocabulary. If a word was included, the children should be confidently using it over a period of time. If a word was not included it is not necessary and is an indicator that the subject knowledge is too advanced. For example, the children need to use the word 'blood' but not haemoglobin and white and red blood cells (see Table 1).**

- **Application of knowledge. Children need to be able to *apply knowledge in familiar related contexts, including a range of enquiries.* It is not sufficient for the children to simply state their knowledge, they need to be able to use it in some way. Often they will use their knowledge when they are carrying out subsequent enquiry activities. For example, if they are observing how their pulse rate changes after they have been exercising, when they write their conclusion they will be linking this back to their understanding of the role of the heart in the circulatory system (see Table 1).**

We then produced one-page sheets for each unit of work, which could be used by teachers at the planning phase. The same sheets provide a guide to both summative and formative assessment by checking that children meet these criteria in their science lessons.

The process

Each consultant identified a strong school-based science subject leader with whom they would work. We supported them with their planning, ensuring that sufficient activities were identified to give the children several opportunities to encounter concepts, learn the key vocabulary and then apply and consolidate it in different contexts – in short, we helped them 'plan for secure'.

We later visited the teacher and reviewed the learning of a selected child to ensure they were secure and then looked at the evidence for this. We found that written work on its own very rarely showed that the child was secure in their knowledge, but when the teacher expanded on this with comments the child had made during activities or in response to questioning, there was sufficient evidence. It was therefore clear that it was very important to include various teacher annotations within the PLAN materials and we also chose to include videos of the children talking where these helped to show security.

The outcome to date

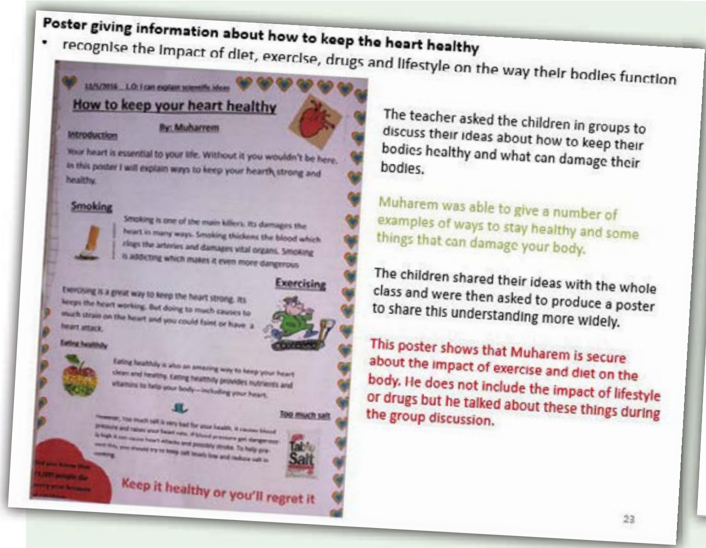
At present we are close to complete coverage of the National Curriculum for England from years 1 to 6 (ages 5–11). We feel that it is important that teachers recognise this is just one way a child can show they are secure, based on one teaching sequence chosen by the teacher. There are many different ways to arrive at the same endpoint

When working with a year 4 teacher I volunteered to carry out a quick electricity assessment activity with a small group of children. To ease pressure on her, I took my own resources in for the activity. It became clear straightaway that the equipment was different, as they grappled with how to connect the battery to the rest of the circuit. Also, when presented with a circuit that was not working and asked to identify why the bulb did not light, the immediate response from the children was because there was no switch in the circuit. In fact, the problem was that there was no battery present. This I found curious and when I mentioned it to the teacher she said it was probably because they had always included a switch in the circuit. This made me think about how easy it is to teach a misconception without realising it simply by not providing sufficient variety.

***Naomi Hiscock** – consultant involved in the PLAN development*

Table 1 Examples of what 'secure' looks like

Assessment guidance	Key learning	Possible evidence
Shows understanding of a concept using scientific vocabulary correctly	The heart pumps blood in the blood vessels around to the lungs. Oxygen goes into the blood and carbon dioxide is removed. The blood goes back to the heart and is then pumped around the body. Nutrients, water and oxygen are transported in the blood to the muscles and other parts of the body where they are needed. As they are used they produce carbon dioxide and other waste products. Carbon dioxide is carried by the blood back to the heart and then the cycle starts again as it is transported back to the lungs to be removed from the body. This is the human circulatory system. Diet, exercise, drugs and lifestyle have an impact on the way our bodies function. They can affect how well our heart and lungs work, how likely we are to suffer from conditions such as diabetes, how clearly we think, and generally how fit and well we feel. Some conditions are caused by deficiencies in our diet, e.g. lack of vitamins. *Key vocabulary:* Heart, pulse, rate, pumps, blood, blood vessels, transported, lungs, oxygen, carbon dioxide, nutrients, water, muscles, cycle, circulatory system, diet, exercise, drugs and lifestyle	Can draw a diagram of the circulatory system and label the parts and annotate it to show what the parts do. Can produce a piece of writing that demonstrates the key knowledge, e.g. explanation text, job description of the heart.
Applying knowledge in familiar related contexts, including a range of enquiries	Create a role-play model for the circulatory system. Carry out a range of pulse rate investigations: • fair test – effect of different activities on my pulse rate; • pattern seeking – exploring which groups of people may have higher or lower resting pulse rates; • observation over time – finding out how long it takes my pulse rate to return to my resting pulse rate (recovery rate); • pattern seeking – exploring recovery rate for different groups of people. Learn about the impact of exercise, diet, drugs and lifestyle on the body. This is likely to be taught through direct instruction due to its sensitive nature.	Can use the role-play model to explain the main parts of the circulatory system and their role. Can use subject knowledge about the heart while writing conclusions for investigations. Can explain both the positive and negative effects of diet, exercise, drugs and lifestyle on the body. Can present information, e.g. in a health leaflet, describing impact of drugs and lifestyle on the body.



Poster giving information about how to keep the heart healthy

- recognise the impact of diet, exercise, drugs and lifestyle on the way their bodies function

How to keep your heart healthy

By: Muharrem

Keep it healthy or you'll regret it

The teacher asked the children in groups to discuss their ideas about how to keep their bodies healthy and what can damage their bodies.

Muharem was able to give a number of examples of ways to stay healthy and some things that can damage your body.

The children shared their ideas with the whole class and were then asked to produce a poster to share this understanding more widely.

This poster shows that Muharem is secure about the impact of exercise and diet on the body. He does not include the impact of lifestyle or drugs but he talked about these things during the group discussion.

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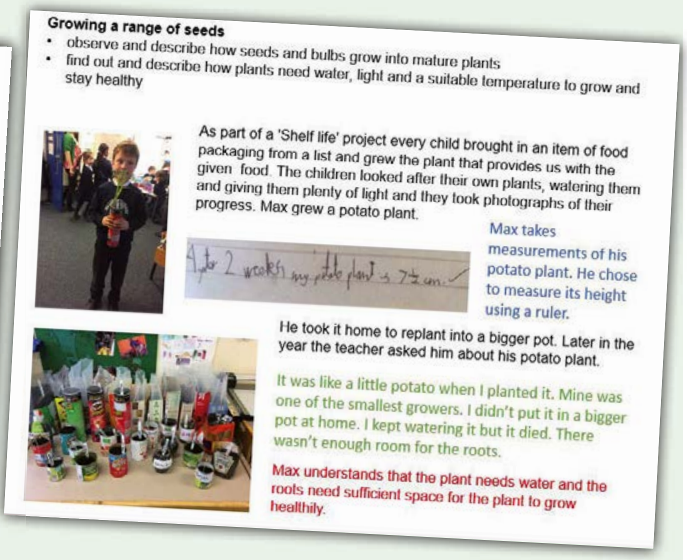

Growing a range of seeds

- observe and describe how seeds and bulbs grow into mature plants
- find out and describe how plants need water, light and a suitable temperature to grow and stay healthy

As part of a 'Shelf life' project every child brought in an item of food packaging from a list and grew the plant that provides us with the given food. The children looked after their own plants, watering them and giving them plenty of light and they took photographs of their progress. Max grew a potato plant.

Max takes measurements of his potato plant. He chose to measure its height using a ruler.

He took it home to replant into a bigger pot. Later in the year the teacher asked him about his potato plant.

It was like a little potato when I planted it. Mine was one of the smallest growers. I didn't put it in a bigger pot at home. I kept watering it but it died. There wasn't enough room for the roots.

Max understands that the plant needs water and the roots need sufficient space for the plant to grow healthily.

Examples of work produced using the PLAN resources

and therefore we are beginning to create complementary sets of materials for each topic from different schools to show alternatives in planning for secure.

Possible future outcomes

We aim to expand the collection to include examples of children that have been part of the same sequence of lessons but have not reached security. We hope these examples will form part of a continuing professional development package that schools can use to support with moderation.

PLAN resources have been invaluable for showing teachers how all the guidance they receive about curriculum and pedagogy, translates into the classroom. They give teachers a window into other people's classrooms, exemplifying secure learning. Although PLAN is intended as a tool for assessment and moderation, I have also used it as a way into planning. PLAN materials have been prepared with assessment in mind, encouraging teachers to create learning opportunities that are focused on what quality learning is going to look like within each unit. This shift in emphasis, putting assessment into the core of teaching and learning rather than at the end, means that lessons are more focused and that teachers are more mindful of assessment for learning, able to spot and sort out children's misconceptions as they arise.

***Claire Seeley** – consultant*

The value of understanding much more explicitly what 'secure' looks like for a child working through a unit of work in science has been the greatest benefit of the project, both for class teachers and subject leads, both for those involved in producing the materials but even more so for teachers who 'mine' the exemplified units for a great wealth of information. While not dictating a journey towards secure, the units often provide a good idea of what a planned sequence through that journey might look like, which often involves spending more time with any given National Curriculum statement than teachers might have previously done in order to be fully secure. The clarity of the learning in the units has given teachers a great deal more confidence in what is expected from them in the new curriculum.

***Julia Weston** – consultant involved in the PLAN development*

Keeping planning focused and on track is so much more achievable with these quality-assured exemplification materials. Teachers can learn so much more from viewing examples of the expected standard of a wide range of annotated examples of work from years 1 to 6. Planning guidance is included in the files, which include key learning notes, key vocabulary and, most importantly for me, suggestions for 'possible evidence' to help teachers gather evidence of attainment, e.g can name some trees and plants in a year 1. These time-saving, flexible documents have enabled me to deliver more effective lessons (where I no longer stray too far from the National Curriculum) and help me assess the children's work with more confidence and accuracy.

***Evelyn Clawson**, Brambleside Primary School – teacher using the PLAN materials*

The PLAN resources can be found at: **www.ase.org.uk/resources/primary/plan**

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Do 'wow' moments influence future subject choices?

Outreach: beyond 'Wow!'?

Jim Bell explores who 'wow' moments work for, and whether further stretch is needed when reaching out

A formative, inspiring experience of science at a young age, something that makes pupils say '*Wow!*', has long been considered a good way of introducing a classroom science topic or cementing the learning once a topic has been completed. Outreach, in the form of bringing an external person or organisation into school, is one way to provide such a 'wow' moment.

Teachers can build their planning around inspirational moments, and so see the benefits of these activities in the classroom. It is even possible, with hindsight, to build up the story of these moments as having a defining influence on future educational and career decisions. But ascertaining the importance of 'wow' moments in the long term has proved elusive, and one-off, inspirational, 'wow' events or trips are not the only forms of enrichment available. Science clubs, project work and mentoring schemes offer repeated exposure to science, and it may be this kind of extended work with schools that can influence future subject choice in further and higher education.

I run the Midlands base of Explorer Dome, a mobile planetarium and science outreach business, so it is important to acknowledge that I have a definite perspective on outreach. However, having previously worked across the outreach sector in educational institutions and universities, I wanted to look at this form of provision as objectively as possible and see how closely the expectations of outreach providers, teachers and pupils align.

What do we know about the impact of outreach?

A significant measure of outreach impact for institutions such as universities and organisations such as the Institute of Physics (IOP) has long been influence on subject choice post-16. For the IOP, who have undertaken excellent work in challenging lower participation rates in physics post-16 for many under-represented groups, this clearly has to be a fundamental measure of success. Projects such as University College London's UPMAP (Understanding Participation rates in post-16 Mathematics And Physics – see *Websites*) have identified the importance of 'key adults', at home and school, in subject choice at 16. But the project has also been unable to show that any form of outreach influences subject choice, whether 'wow' events, or project work, science clubs, and so on.

Putting post-16 subject choices to one side, there are other indicators of the effectiveness of outreach activities on participants that may actually be of greater importance to teachers. The UK Government's paper, *Review of best practice in parental engagement* (Goodall, Vorhaus *et al.*, 2011), lists

Key words: Outreach STEM

outreach work as a strategy that can '*lead to improvements in completion of homework, learning behaviours and improved attendance*'. Furthermore, National Audit Office (NAO) research found that '*schools using outreach/ enhancement programmes have a greater proportion of pupils studying STEM subjects*' (cited in MacDonald, 2014).

In a considerably more modest way, Explorer Dome has also been asking teachers in the Midlands about the longer-term impact of our own brand of outreach. Since launching our Midlands base during National Science & Engineering Week 2017, we have been asking teachers in our feedback forms a yes/no question: '*Beyond the excitement of today, do you think the experience inside the dome will impact the long-term learning of the children?*' Although it is early days (*n* = 50), so far 100% of respondents have answered 'yes'. We recognise the difficulties of establishing conclusive answers from such recent research and ultimately have plans to develop this. At the moment however, we are taking the feedback and building upon it in order to create experiences to engage and support teaching and learning.

Although this question is currently limited in scope, we see these responses as encouraging, and will be building up a much bigger set of data as we visit more schools in the region. We also have an opportunity to follow up on this question when we return to schools in future years.

Some of the individual comments from teachers that we received were also illuminating:

Children love space and Tim Peake at the moment, so it will be a starting point of interest. (Governor, Nottinghamshire Primary School)

Inspired children to think more about Earth in space and consider future study prospects (i.e. university). (Teacher, Dudley Primary School)

The interaction, lights, sounds, visuals, sensory experiences have impacted on the children's learning and memory far more than reading or accessing the information via another source. (Science Subject Lead, Birmingham Primary School)

The value of primary outreach

When teaching primary science, post-16 subject decisions seem very distant and it is, of course, unrealistic to imagine that a single outreach experience in primary school would set a child off on an unassailable path towards a career as a scientist. Yet outreach activities, particularly when structured or themed, can provide nudges that amount to noticeable changes in young children.

Explorer Dome aims to make a lasting impact through its outreach activities

Three postgraduate chemical engineering researchers explain why they do outreach in Box 1. Aimee Jackson has first-hand experience of how attitudes towards science change over time:

With my Brownies, I make them do sciency things because that's what I enjoy. One of the other leaders, who's a teaching assistant, has said to me that some of the Brownies have become more interested in their science lessons.

When working with children, it is often individual moments that can stick in the mind of an outreach practitioner too, as Aimee explains:

One ran up to me, and I'll never forget her face, she told me she'd made poo in class, and one of the boys was sick, but it was OK because we'd already done something similar – and she was

Box 1 Why do we do outreach?

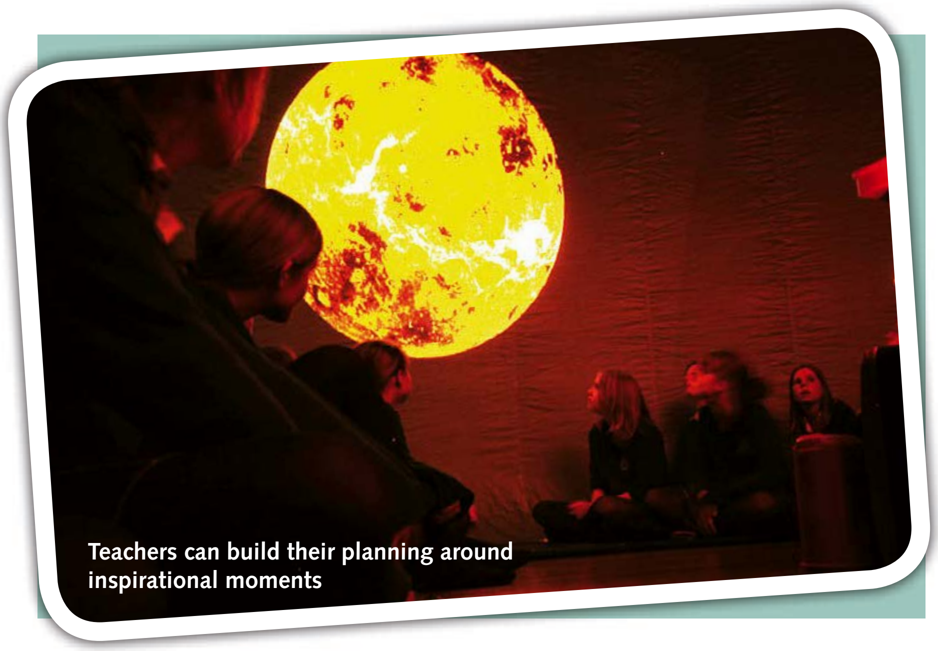
Lois Milner, Aimee Jackson and James Walker are postgraduate chemical engineering researchers at the EPSRC-funded Birmingham Centre for Fuel Cell and Hydrogen Research (see *Websites*) and are all enthusiastic public engagement practitioners. Speaking with them, we started thinking about why working science researchers would want to go into schools. James said:

For us, doing outreach is all about professional development: the presentation skills, the planning, the project management elements of planning an activity. I think it's nice for an audience to hear about current research, but I don't know if that applies to younger [primary aged] kids.

At the same time, all three researchers believe strongly that there are real benefits to outreach or public engagement work from universities, as James outlined:

Outreach or public engagement equips people to engage with and influence research by making it accessible. The more literate people are about research, the less 'ivory tower-like' universities are and the more embedded people are into what we do.

Making some elements of the research process public is an integral part of publicly funded research but, on an institutional level, institutions such as universities have student recruitment in mind as well as researcher skill development or public engagement commitments. Students, of course, benefit from being accepted onto degree courses, and a STEM degree from a high-quality university is beneficial to both the student and society in general. But in the era of £9000+ fees, it is undeniable that universities participating in outreach can benefit financially if they can impact future study choices. However, this level of influence has been very difficult to demonstrate.



Teachers can build their planning around inspirational moments

OK! I think they do remember things, even if it's not forever.

All three of the researchers emphasised the importance of structure and regularity to positively influence the way that pupils feel about science, as Lois pointed out:

For the individuals at school, unless they've had repeated visits from people at school then once isn't enough.

A problem in the pipeline?

The idea of a STEM pipeline, where educational pathways direct young people into STEM careers, is relatively established. There is a well-documented shortage of engineers in the UK, which outreach activities and science education have been trying to fill for many years. But science education also has a wider responsibility to create the scientifically literate public that can engage with research, becoming an active part of the scientific process.

Reflecting on their own pathways to becoming engineering researchers, it was noticeable that none of the three postgraduate researchers (Box 1) really considers themselves an engineer, as Lois explains:

We're all fundamental scientists doing engineering PhDs. I do see the difference still. I do still think of a chemist as being very rigorous, of thinking 'this has 0.15 ml of this …', whereas an engineer would be more like, 'oh yeah, it's got a bit of that in it'.

James suggests that this may be why recruitment of engineers continues to struggle in comparison to other STEM subjects, saying:

I wonder if we're not alone being scientists now working in an engineering environment because there are just fewer engineers who stay on and do research, so the body of people going out to do engineering outreach are in fact 'fraudulent' engineers, who are actually encouraging kids to do science because they are scientists really.

Making the most of 'wow' moments

Whether it is through a university, private company or educational organisation, there are a host of outreach options available to schools. The need for tangible evidence of impact, ideally in the form of future subject study choices, does dissuade some of these providers from working with younger children. To an extent, companies like Explorer Dome exist (in part) as specialists in primary science education that can help to fill this gap.

The call for greater numbers of young people to choose science subjects post-16 is unlikely to diminish in the foreseeable future. It is possible that the limited success of outreach in providing STEM students may see a move away from 'wow' activities and towards building role-model relationships with smaller numbers of pupils. If these kinds of outreach can show a definite impact on participants, then they clearly have a big role to play in science outreach.

It would, however, be a shame to focus just on post-16 choices, and to swing the balance of outreach activities too far towards role-model activities that may have a big impact on an individual but on much smaller numbers of children overall. Not only would this overlook the positives that 'wow' activities bring, and the value that teachers attach to them, but it also narrows down the purpose of science education as just a means to providing STEM graduates.

For us, scientific literacy and understanding is a key skill for everyone. We want to encourage children to see science as a great tool to find out more about the world around them, and as a general source of inspiration for their learning and their vibrant curiosity about our world. This kind of long-term impact is not possible from just one experience, no matter how inspiring. But inspirational moments enable teachers, and the other key adults in children's lives, to use their experiences in creating an environment that allows their curiosity to thrive.

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Websites

UPMAP (Understanding Participation rates in post-16 Mathematics And Physics) *Key Points Summary*. Available from: **www.ucl.ac.uk/ioe/research/featured-research/upmap/pdf/UPMAP_summary.pdf**

University of Birmingham webpage for Birmingham Centre for Fuel Cell and Hydrogen Research Doctoral Training Partnership: **www.birmingham.ac.uk/research/activity/chemical-engineering/energy-chemical/fuel-cells/index.aspx**

Jim Bell is a science communicator and public engagement professional who runs the Midlands base of the science outreach company, Explorer Dome (www.explorerdome.co.uk). You can continue this discussion with him on Twitter: @jimothybell
Email: jim@explorerdome.co.uk

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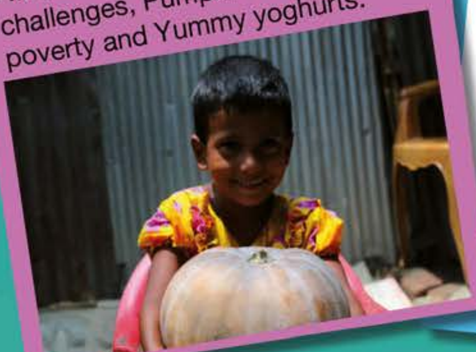

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2017 Great Bug Hunt winners day!

Did you know that there are over 24,000 species of insect in Britain? Or that insects are the only invertebrates that can fly? And that they are by far the most diverse and ecologically important group of animals in land habitats, with hundreds of species to be found in almost every garden and green space?

Work from pupils of Lyncroft House Preparatory School

The winners of this year's Great Bug Hunt competition, Lyncroft House Preparatory School in Cannock, discovered these and many more fascinating bug facts when Luke Tilley from the Royal Entomological Society and Rebecca Dixon-Watmough from the Association for Science Education visited the school on 12 October 2017 for their prizewinning morning. Over 30 excited children got to see and hold Madagascan hissing cockroaches, giant larvae and other fascinating insects during the hands-on morning of fun, in which the children learned all about bugs and the many different species we have here in the UK.

As one of the teachers said:

Year 5 really loved entering the Bug Hunt competition this year. The children all decided on a bug they would like to study and then they worked in pairs to research and draw their chosen minibeast. The project was very cross-curricular. We were able to work it into maths (bar charts and area), literacy (reading and independent writing), art (collage work), science (metamorphosis, global warming and food chains) and PSHE (working together). The children were fully engaged and very proud of the work they collectively produced.

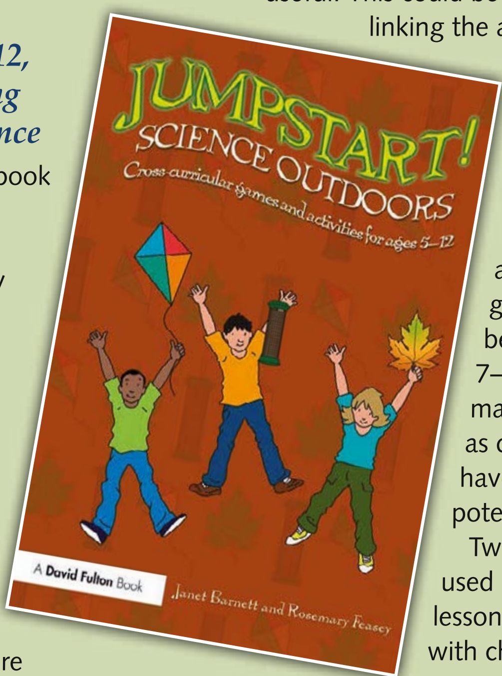
The Great Bug Hunt is an annual competition from the Association for Science Education and the Royal Entomological Society. It is a fun way to introduce children to the world of insects and entomology:

It's so addictive I can guarantee once you've been on a bug hunt you will never ever be bored again. (Nick Baker, naturalist and television presenter)

Jumpstart! Science outdoors: cross-curricular games and activities for ages 5–12

Janet Barnett and Rosemary Feasey
Abingdon: Routledge, 2016
148 pp. £11.99
ISBN 978 1 138 92506 9

Fun and simple-to-use practical and cross-curricular outdoor science activities for ages 5–12, incorporating all the 'working scientifically' strands of science



This is a clearly set out easy-to-use book containing a wealth of fun practical ideas and activities.

The contents page lists the activity titles. The activity pages have a set format, with subheadings: *Science topic, Activity type, Resources, Overview, Activity, Science background, Cross-curricular links* and *On-line resources*.

This book is great for dipping into since there is not one set activity but lots of options to choose from focusing on the same objective or area of study. There are useful facts and questions to focus teaching and learning. The resources needed are accessible to all and the activities are very practical but do not need lots of prior setting up. For example, activity 17, *Observing change outdoors*, involves using a map of the school grounds and plotting on it where the habitats, plants and so on, are. This could involve looking at where the light and shade is and reasons why the habitat is a good one, thereby looking at more than one science strand (living things and light, seasonal changes). It could then involve devising a key for the map (linking with geography). The map is then used later in the year to look at the changes in habitat life in the school grounds and make a comparison (observing over time and pattern seeking).

For any new edition, providing links to the specific science curriculum programmes of study would be useful. This could be done in the contents page by linking the activities into the programme of study strands or just by making these explicit under the science topic subheading. It would also be useful to have more information and links showing how the activities are applicable to particular year groups. This would be especially beneficial for key stage 2 (ages 7–11). In addition, the front cover makes the book look rather dated, as do the pictures inside; it does not have immediate shelf-appeal to the potential reader.

Two teachers in our school have used this resource, both in science lessons and outdoor learning sessions with children throughout the primary age range. Both teachers enjoyed using the resource and the children clearly had lots of fun carrying out the activities.

Cathy Hearn

Primary school teacher and science coordinator, Forest and Sandridge CE Primary School, Melksham, Wiltshire

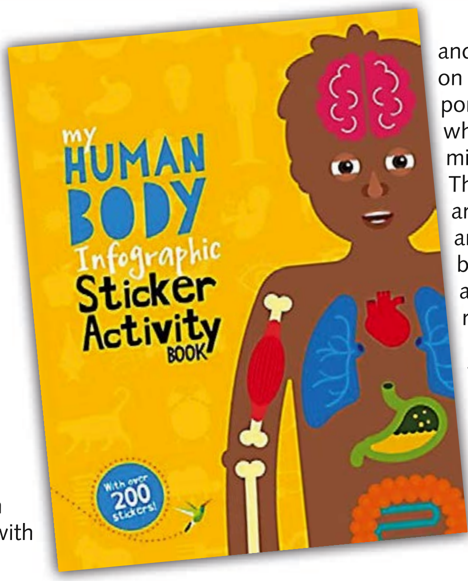
My human body infographic sticker activity book

Jo Dearden
London: Wayland, 2016
31 pp. £5.99
ISBN 978 0 7502 9942 8

A colourful introduction for younger children (ages 6–8) to the human body

My human body aims to introduce young readers to 'brilliant bodies' in a fun way. The sections consist of colourful two-page spreads detailing parts of the body such as skeleton, hair and skin as well as body systems such as digestion and breathing. Each is described in a simple manner with new vocabulary being introduced and explained and pronunciation given for difficult words such as oesophagus and alveoli.

The book looks attractive and will appeal to young readers as each double spread is a different, vibrant colour with clear, labelled diagrams and child-friendly additions such as dinosaurs and a chimpanzee, although children may be unfamiliar with animals such as the narwhal



and sailfish. Unusually, the writing on the pages alternates between portrait and landscape formats, which I found frustrating but it might appeal to other readers. Throughout the pages there are fun facts about humans and child-friendly comparisons between ourselves and other animals, which will engage the readers.

The book has two aspects to it: the knowledge-based diagrams and text, and the 200 stickers and activities. The two, however do not sit well together as the activities do not match the intellectual level of the written content, making it difficult to gauge the age range for which the book is suitable. In the section about bones, for example, the reader is introduced to terms such as 'bone marrow' and 'compact' and told that a cube of bone can support 8618 kilograms, the same as five cars. The matching activity is then to stick three cars on to a cube. Similarly, when talking about the importance of sleep, the activity is to colour in a duvet cover and add a sticker of a unicorn. There is also an instruction to '*stick these animals in your book so they can have a rest*', but there are no corresponding animal stickers. Readers are also encouraged to look for five hidden bats on the pages, which is really a pre-school activity.

At £5.99 the book is probably good value but I feel that it would have made a better addition to a class library if there had not been such a disparity between the text and the activities.

Lesley Hunter

PSTT Fellow and Primary Science Consultant

Wildlife wonders

Pat Jacobs
London: Franklin Watts, 2016

Why do insects have six legs?

ISBN 978 1 4451 5085 7

Why do fish have gills?

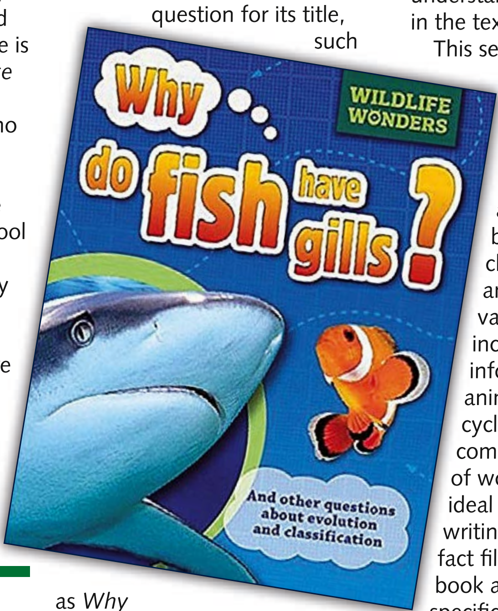
ISBN 978 1 4451 5089 5

32 pp. £8.99 each

An eye-catching series of information books, ideal for supporting children's learning about living things and their habitats, for ages 9–11

These two books are part of a series that provides children with a range of information on the evolution, classification and adaptation of insects, birds, plants, mammals, reptiles and fish.

Each book from the series has a question for its title, such as *Why do fish have gills?* or *Why do birds have feathers?* This allows the reader to know what the content of the book will be about, while also creating a sense of intrigue so you want to find out the answer to the question.



Having read these two books from the series, *Why do fish have gills?* and *Why do insects have six legs?*, it is apparent that there is a similar structure and layout to the books. Each page covers a specific area, such as classification, reproduction, senses and so on. This makes it easy for children to locate particular information via the contents page. Each page is also a different colour, with a balance between text and images.

Rather than reams of text, which can be off-putting for some children, the text is broken down under subheadings making it easy for children to engage with and read. There are also additional 'interesting facts' given on each page. Some words, such as parasites, fertilisers and barbs, are in bold font, indicating that the word can be found in the glossary at the back of the book. This allows children to discover meanings of new words independently, while also widening their vocabulary bank.

Each page has a variety of photographs and/or diagrams, which complement the text and bring it to life, providing the children with visual support to understand the information given in the text.

This series of books would be ideal to use or have available in the classroom when covering a unit of work based on living things and their habitats. The books would support children's knowledge and understanding in a variety of ways, as they include such a range of information, from classifying animals and plants to life cycles. They would also complement an English unit of work, as they would be ideal for children to use when writing non-fiction reports or fact files, with the layout of the book allowing them to locate specific information.

Lucy Lightburn

Year 2 class teacher, Great Moor Infants School

100 Steps for science: why it works and how it happened

Lisa Jane Gillespie
Illustrated by Yukai Du
London: Quarto Books (Wide-Eyed Editions), 2017
64 pp. £12.99
ISBN 978 1 847808 05 9

Exciting science facts presented in an engaging and accessible way, for ages 7–10

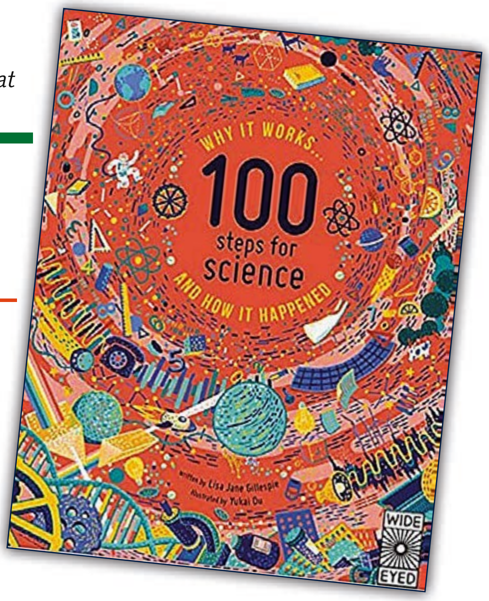
This is an exciting way to help children learn more about the world around them. The book is clearly organised into 10 areas of science or STEM learning. With everything from space to medicine and even mathematics covered, there really is something for everyone. Cleverly, each area of the book is also subdivided into ten excellently and carefully selected facts. These facts not only stand alone in developing children's curiosity about science, they allow children to do so independently, allowing their curiosity to flourish. The careful use of illustrations brilliantly enriches each fact to highlight the wonder of each area of science. In addition, the 'bitesize' nature of each fact supports children in developing their knowledge of science, meaning they can dip in and out of the book when the time suits them. This is further supported by the consistent layout throughout the book.

It is a pleasure to dip into this book, to learn new facts about the world around us in an engaging manner. It is a brilliant book which lends itself easily to many areas of the curriculum, as well as satisfying children's natural curiosity without the need for an adult to support them.

I can't wait to learn more exciting facts about our amazing world, and human achievements in STEM subjects.

Dave Church

ASE Primary Science Committee



The reviews published in *Primary Science* are intended to provide you with an honest opinion from an end-user's perspective. Thus, they are not ASE recommendations, but genuine reviews and comments from readers such as you.

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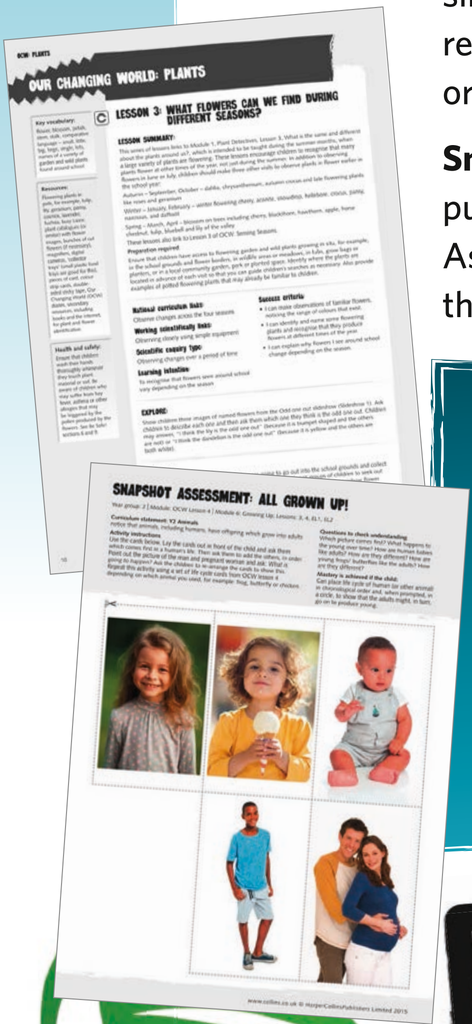

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Sign up today, email us: education.support@harpercollins.co.uk

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