Cutting-edge science research and its impact on primary school children's scientific inquiry

● Alison J. Trew ● Lucy Bird ● Craig Early ● Rebecca Ellis
● Tim G. Harrison ● Julia Nash ● Katherine Pemberton ● Paul Tyler ● Dudley E. Shallcross

Abstract
Cutting-edge science research can provide incredible stimulus to primary school children's emergent ideas in science. Devising science investigations that are allied to this cutting-edge science research helps to contextualise research. In this paper, we describe the methodology used to write articles for a primary school audience and some preliminary observations of class activities and responses.

Introduction

Teachers are encouraged to prepare children for careers they may undertake in the future that do not yet exist (e.g. Rocard *et al*, 2007). Creating resilient learners who are problem-solvers, able to gather and assess data, can work in teams and on their own, will facilitate just some of the traits that support children in any future career, whether or not it now exists (e.g. Archer *et al*, 2010). Providing a wide range of experiences, including outdoor learning, can also aid students in their advancement and preparation for the future.

It would be great to use current science research as exemplars and stimuli for teachers when doing science at primary school level. This would also help to prepare children for the future and enrich their science experience. But how can we achieve this? We could look at the news and follow up on relevant science articles, but this limits what we might look at. How can we obtain access to the science research in more detail if we need or want to? We could use the Internet or social media to track down articles, but where would we start? Would we be able to understand the science if we could, and how could we be sure that sources are reliable? Do we have the time or confidence to link this science to an investigation or discussion at a primary school level?

In an emerging project, PSTT (Primary Science Teaching Trust) Fellows (teachers who have won the UK Primary Science Teacher of the Year Award) (Shallcross *et al*, 2015) who have obtained a PhD in a science discipline and are now primary school teachers have been working with the PSTT CEO, who is a university-based scientist, to gather together recent research papers containing science, which can be used as exemplars in primary school science. In this article, we briefly look at some of these articles and discuss their impact on the emergent science understanding of children in the class. We define 'cutting-edge science research' here as research papers that have been published within the last two years in peer-reviewed journals.

Methodology

Access to current research is changing, as many journals are now open access, meaning that anyone can go to the journal website and read the papers. However, this is a time-consuming process and there is no guarantee that it will yield a paper that matches with the primary science curriculum in any country, let alone in the UK. Therefore, we have established a team of primary school teachers who have been research scientists and, working with them, PSTT is now building up a bank of research papers that have been summarised into an accessible article, together with ideas for investigations that can be carried out in the classroom and which support students in understanding the research paper. At present, these articles appear in the PSTT *Why and How* newsletter, but PSTT aims to publish an article on its website at least once every month from September 2019.

Exemplar articles

Greenland sharks (Shallcross, 2017)

In this paper, students are told how, in 2016, Professor Julius Nielsen (Nielsen *et al*, 2016) and colleagues published a paper in which they estimated that Greenland sharks could live for nearly 400 years. They worked out a way to use the length of the shark to estimate its age and the methodology is discussed in the accessible article (Shallcross, 2017). What was the impact on the children in covering this paper? In a Year 5 class (age 10), the children were told about the sharks and how the scientists worked out their age and were challenged to see whether they could construct a graph of age versus height from the members of the class. They were then asked if they could use a graph developed from the study to allow them to work out someone's age if they knew the person's height.

Figure 1 shows the graph that Class A in Year 5 constructed. Firstly, working in threes, the children measured each other's heights and checked their calculated age. Secondly, they added their data to a spreadsheet and plotted the graph. At this stage, some points looked very different from the rest. This was because, for one student, the height had been measured in inches not centimetres and, for another, the age of the child was 365 days too few. Once rectified, the graph was drawn and used to work out the age of other children and staff. The age estimates for children in other classes were reasonable, but the estimates for the teachers were flattering (i.e. all were too young). The children wondered about the intercept and what that meant? How could you be about 66 cm tall when you were born? The children researched the length of newborn babies and found out that this is on average about 50 cm. So, not unreasonable, but probably a bit large – maybe the children in this class were much taller than average? They considered whether they were longer than average as babies and why the adult's height was not a good predictor of their age. Again, this prompted some interesting discussions, where the children noted that people stop growing when they become adults, and some suggested that this is why we call people 'adults'. They then compared this finding with the Greenland shark, which continues to grow throughout its life. Numerous questions were posed and discussed by the children, such as why does the shark live for so long? Is there something special about the waters around Greenland? Do other sharks live that long? Other interesting discussions were prompted by the large number of researchers who contributed to the research and the fact that they were from many different countries. The children wondered why they were all needed and how they managed to work together.

Making drinking water from salty water using a molecular sieve (Shallcross, 2018a)

In 2017, Professor Rahul Nair and his team from Manchester University published a paper showing that it was possible to use graphene nanotubes

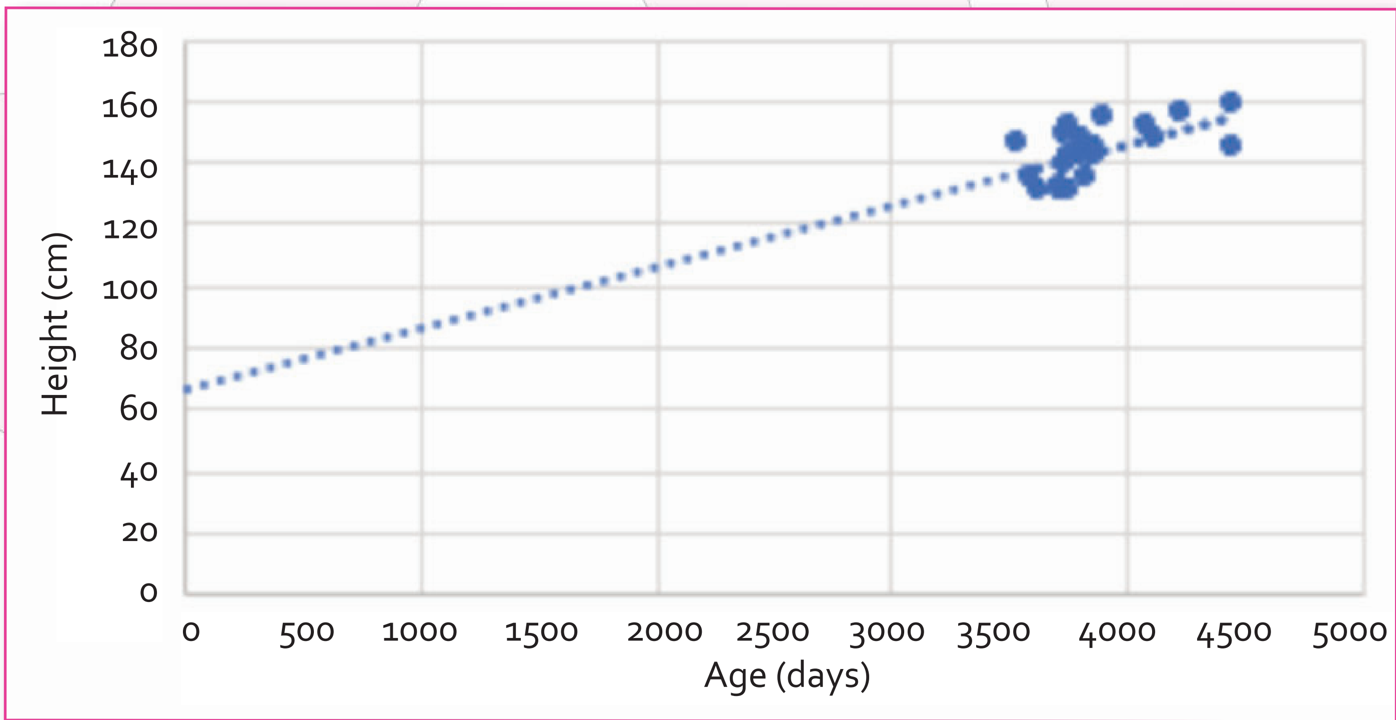


Figure 1: Plot of the relationship between age and height in Class A.

(see Shallcross, 2018a for an explanation) to separate salt from seawater. There is still a long way for the research to go to develop a commercial device that can be used by people, but the principle is exciting and, if it can work, it will make drinking water available to many people around the world.

This research was introduced to children in a Year 2 (age 7) class. They discussed what a sieve was and how it might be used to purify water. The children then got into teams and made their own sieves from a wide range of materials and used them to separate a wide range of mixtures. Figure 2 shows some examples of the sieves that the children in Year 2 devised.

The children had access to whatever they could find in the class to make their sieves. They found objects that were already sieve-like, they tested materials to see whether they could weave them into a sieve (as they had noted that fabric might make the best sieve: fabric has holes and is woven), they constructed tube-like sieves out of Lego and tested whether objects would pass cleanly through or get stuck. One child observed that, if a tube was 'wiggly', objects would be more likely to get stuck and therefore would make a better sieve. The children tried to make the holes as small as possible but still let water through. Once they had made their sieves, they tested them with dirty water.

As you might guess, some sieves worked better than others and more questions were then posed. The children carried out their own investigations and came up with a variety of conclusions. They linked these conclusions back to their initial predictions themselves, avidly trying to explain the science. The teacher had a 'wow' moment here, as this normally requires a teacher to explain to 6 and 7 year-olds what is happening.

Planetary hide and seek: is there a ninth planet in the Kuiper Belt? (Shallcross, 2018b)

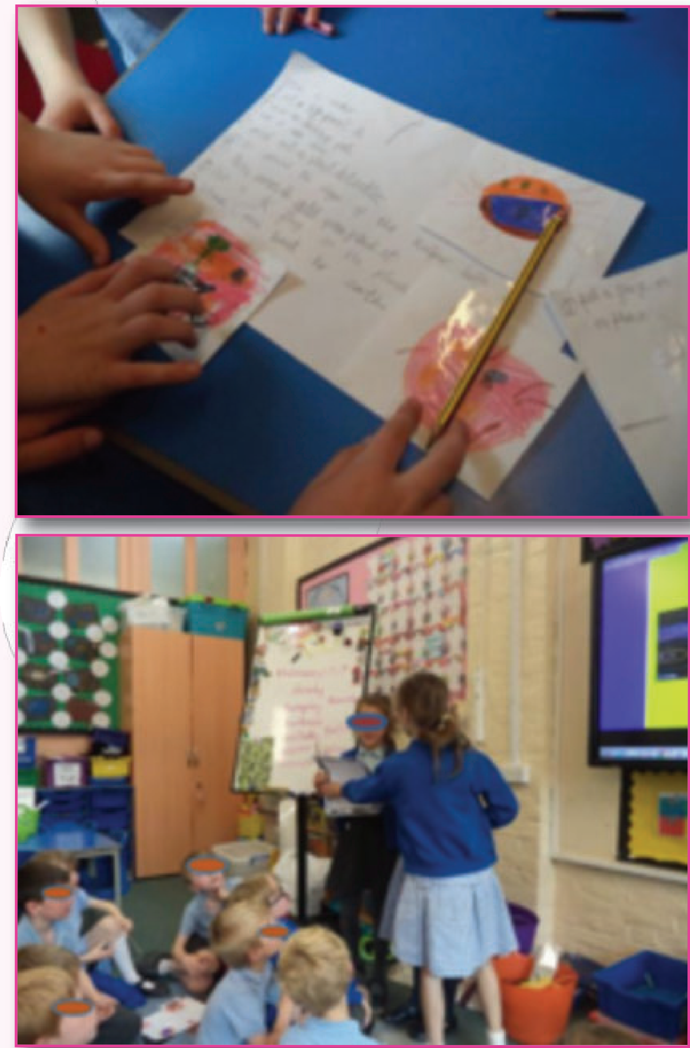
The Kuiper Belt is a ring of rocks of varying sizes at the edge of our solar system, beyond the planet Neptune. Scientists have wondered whether there is a planet hiding in the Kuiper Belt – why do you think that it is hiding? The Kuiper Belt is a long way away and telescopes cannot see all the rocks in this zone. Professor Renu Malhotra and Kathryn Volk have studied the Kuiper Belt, using a telescope, and noticed that some objects seemed to be moving in a strange way. The best explanation they could provide for their movement would be that there is a large planet nearby that is tugging on them as they go past through the action of gravity. Through careful analysis, they estimated that a planet approximately the size of Mars may be present.

Figure 2: Children in Year 2 constructing different sieves.

In a Year 2 class, the children were told about the research and challenged to come up with suggestions of how to detect the ninth planet (see Figure 3). They worked in groups of three and were given just 20 minutes to discuss, and create a presentation. The teacher remarked that this was one of the most exciting experiences in his/her teaching career. The wide variety of ideas presented showed incredible understanding of and insight into science among children in general, something that may not be revealed very easily. The children wanted to add four lenses to a telescope. A magnifying lens makes things bigger and so the more there are the more magnified the object would be. The children also said that they wanted to send the telescope on a satellite closer to the Kuiper Belt and look at it from different directions. They thought about getting rid of the asteroids in the belt but then decided there were far too many. They then used every bit of knowledge about space exploration, the planets and asked a lot of 'What if we did this?'-type questions.

This research was carried out by two female scientists and this prompted some positive discussions too. One girl said *'I know girls can be scientists but boys are still better at finding things out than girls'.* So, we still have work to do, even at this young age, to break down ingrained ideas.

Figure 3: Year 2 children working out ways to detect the ninth planet and presenting their ideas to the class.



Summary

In this preliminary study, we have shown how it is possible to use cutting-edge science research in a primary school setting. Early work suggests that these articles provide science experiences that have purpose and are memorable. The teachers and children enjoyed using them and they provided young children with a connection to science research that is taking place now. We are now producing a supporting teacher guide for each article. Teachers who have used these articles have stated that:

'I used the shark paper this morning and it was brilliant. Having read the articles, when they carried out their investigations, the children showed more commitment than I've seen in previous enquiries because they felt like they were carrying out "real" research. Additionally, pupils who did not normally join in science discussions ventured suggestions.'

'Showing the children a real article and talking about all the people that worked on the paper made science real to them.'

'Children remembered more about the science and there were more wow moments for me as a teacher than I have experienced before.'

For UK teachers, the new Ofsted framework encourages 'reading across the curriculum'; these papers fit in really well with that and were well received by the school's senior management.

We would welcome your comments on this paper and the science articles being produced. If you are a primary school teacher and use these articles, we would welcome feedback, and if you have subject areas about which you would like to have a cutting-edge science research article, please e-mail PSTT at info@pstt.org.uk. We are currently writing the teacher guides to accompany these articles and feedback on these would be very welcome.

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Alison Trew, Craig Early, Rebecca Ellis, Julia Nash, Katharine Pemberton and **Paul Tyler** are primary school teachers and Fellows of the Primary Science Teaching Trust College.

Alison Trew is also an area mentor for PSTT.

Lucy Bird is a final year undergraduate in Chemistry at the University of Bristol.

Tim Harrison is the School Teacher Fellow in the School of Chemistry at the University of Bristol.

Professor Dudley E. Shallcross is a Professor of Atmospheric Chemistry at the University of Bristol and CEO of the Primary Science Teaching Trust.
E-mail: dudley.shallcross@pstt.org.uk

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