A science display at Swalecliffe

Finding new ways to record science understanding

Ben Thwaites outlines using questioning to gauge understanding and change the way that science is recorded

I believe that science within a primary school is there to enable children to be interested in the world around them and to help them start to understand it, getting them interested in the very basics, just pointing out things around them that they hadn't considered, so that they can start asking the questions 'why' and 'how' and 'what' and explore those. Explorify fits in so well, because it leads them to do just that.

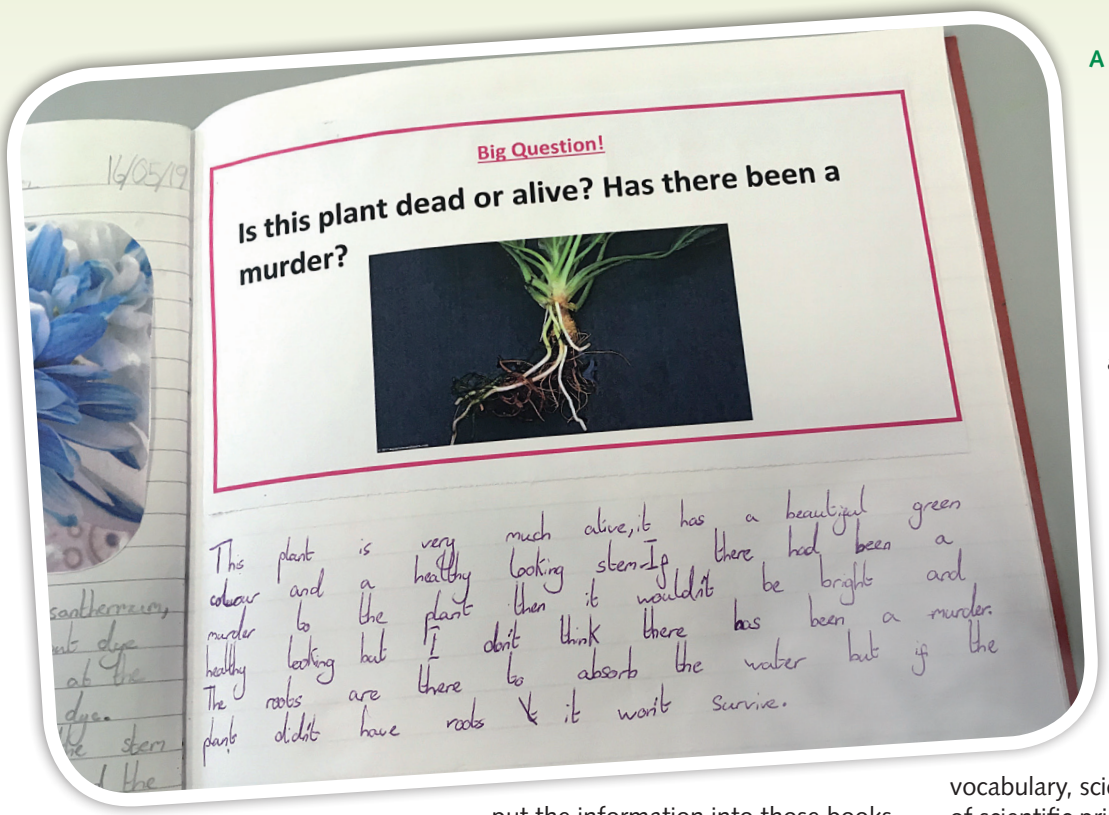
The skills they learn within science will then stay with them – research skills, utilising and applying maths and literacy skills. Science builds on those other subjects and, without it, the world doesn't make any sense, so why learn those other things? Science is something that all children can get involved in. They are all passionate about it, because you can physically go and do an experiment, or you can look at something.

Those that don't excel in maths or English can excel in science. It might be that you have to look a bit harder to see it and ask them for their questions and understanding, or that you allow them to record their data or present their findings in a different way, but science allows for that in a way that other subjects don't. It's great for collaboration, it's great for sharing ideas, it supports and develops language use because it asks them to justify their thinking – it's not simply right or wrong or black and white. It's a profoundly important subject in those terms.

Having said all that, the single most important thing about science is that it's fun! You can have quite a lot of fun writing up a diary entry or measuring a perimeter, but you can have much more fun chopping up a flower and figuring out how it's all working!

Recording

When I first came to Swalecliffe, all the work for subjects except English, maths and art was recorded in a connector book. We took a topic that broadly connected the work, but mixed subjects page by page, e.g. a few pages of history, then geography, then science. Science was either very 'arty', or really prescribed/controlled; for example, the teacher would set out exactly how the experiment should be recorded and then the children would produce a procedural report of what they did. I felt that this wasn't



giving science a high enough profile, but I also found that, when we were monitoring and looking at the book, you couldn't find particular pieces of work very easily and it was hard to compare year groups and classes. As a result, the development across the year groups was hard to track, so there would be fairly similar pieces of work in Year 2 (age 7), then again in Year 3 (age 8), without easily identifiable progression in the way that they were recording or in their understanding.

The school worked very hard at looking at how to resolve that and it was agreed that we would have individual science books. We did this in collaboration with all the teachers, consulting about what we would want those books to look like, so really avoiding implementing change from the top down.

Change is often a gradual process, so when we first got the science books, we were still doing a lot of recording in a very traditional way – predictions, apparatus, etc. There's still room for saying that 'this is my prediction and this is why I think that', of course, but we have moved towards an approach where we are recording either their understanding or findings, or we pose questions to them after they've done their learning to get their deeper thinking and understanding. So, as a joint effort, at the same time as introducing the books we held CPD with the teachers, where we looked together at ways to record and ways to put the information into those books.

We found that we could give teachers, and indeed the children, more freedom to record in their own way, but the difficult part of that is to persuade teachers to be brave and to leave traditional methods of recording behind. We decided to encourage allowing children to show their thinking and understanding through the use of questioning. This was inspired by the Explorify methods of questioning because the children had responded to them so well in class. We are doing it here and people are being fantastic – we frequently find excellent pieces of work in the books that don't fit the traditional structure, but that we can hold up to the whole school as ticking all the boxes, answering all the questions and clearly showing the progress of understanding and learning.

Using questions to show understanding

We have implemented two types of questions: big questions and deeper thinking questions.

Big questions, for example 'How do we hear?', are given at the beginning of a topic to get a picture of what children know, and we might revisit the same question at the end of the teaching sequence to see how that understanding has changed.

We use deeper thinking questions in a few ways. We started by targeting them to just those children we wanted to show deeper thinking. I'm veering away from that slightly in favour of giving them to all children, because the danger is that so many of the children have great ideas that you never get to hear!

These are designed to be independent pieces of work. We don't teach them how to answer the questions, so it is from their use of vocabulary, scientific terms, application of scientific principles or explanations that their understanding emerges.

The children have been really engaged with these questions and have even started coming up with their own questions to explore as a class. Recently, during a sequence on classification, one child asked *'well, what's a mermaid then?'*, which led to a long piece of cross-curricular work where, in addition to the science behind the question, we looked at balanced arguments and reliable sources of information.

These then become not only something we can use to show progression across year groups, but also to measure ourselves across other schools. We've been working within a local alliance of schools to moderate work, which is easy with writing, etc., as we are all doing the same thing, but it is harder with science. We tried an approach where we set a challenge across all the schools – it was called 'frozen' – and we encased a Lego figure in a block of ice and the children had to write up how to release it and explain their understanding. We found that some teachers asked the children to write diary entries, while others wrote up the experiment, so the responses were too different to moderate.

As long as we get everyone using the same questions and teaching their children to respond in similar ways, i.e. not guiding them through it, then we should get something that gives us a basis for moderation. The temptation

for teachers is that you don't want the children to get it wrong, or to ruin a nice book, so you guide them heavily – you have to step back from that and allow them to be independent and to do that work, otherwise you're not truly assessing their knowledge and understanding.

The team

There's a small team working on science here, including staff and pupils! Three of us (teachers) work together to create the big and deeper thinking questions, we run the science club, and look at allocation of resources. The next big step that we'll take is overhauling the curriculum to make it as engaging as we can, as hands-on as we can, make more local links, and to fit in with the new Ofsted guidelines (see useful links on page 8).

We also have children who are Science Champions. At the start of the year, we invite everyone who is interested to write a letter of application saying why they would be a fantastic Champion. My current, most active, Science Champions have taken the role of spreading the environmental message about the use of plastic across the school. They went to talk to the kitchen staff about the amount of plastic and food waste generated here – we spend around £4000 a year on food waste (from two kitchens and a restaurant), so now we're looking to buy a digester to reduce that waste. They've written a presentation and have delivered it to their class before they will present to their year group, then across the whole school.

At the beginning of the year, I tasked them with finding out how many science displays we had across the school in the main areas – when there weren't any! They came back astounded that they couldn't find any and we took that to the School Leadership Team (SLT). Having the pupil voices participating in the audit of the school and calling out for science in the main displays was so much more powerful than if the teachers were asking for them. Now we have four displays, and one of them is all about plastic use within the school and the potential to cut down on waste.

Mistakes and misconceptions

There are some subjects, such as science and maths, that can instil fear in teachers. If a teacher is not confident in maths, the temptation is to just ignore the parts in which they're less confident, so some concepts just don't get taught. That's not quite the case with science and I think the really damaging thing with science fear is that concepts are mis-taught, so misconceptions are embedded and stay with children forever. I worked with a teacher in a previous school who had always misunderstood how magnets worked, and had taught several classes that the atoms within a magnet physically move toward an object to which they are attracted. Her class had accepted the model that had been drawn on the board and would have carried this misconception forward with them. The teacher retaught the lesson the next day and the children were part of a valuable conversation about research and questioning knowledge. Regular conversations about science between all members of staff can help to ensure that everyone has the confidence to develop their knowledge and understanding.

I've been lucky enough to go on the STEM subject leader course (see useful links below), which addressed a few of those misconceptions. I've been able to come back and disseminate this to the teachers here. The content was so rich and varied, so I came back with a wealth of resources that I have put on our Virtual Learning Environment, so all teachers can access them. Future CPD sessions will be based on these resources that are addressing all sorts of misconceptions and errors. We have rolling CPD here, so we're using that time to address areas of subject knowledge that need to be developed. We also do classroom observations of teaching, looking at books to identify those areas of subject knowledge that need development. In staff meetings, we then do experiments and talk through what's happened in the same way that the children would. We focus on modelling and allowing teachers to explore ideas in a safe space, just like they do with the children. This collegiate approach to science CPD supports everyone in doing it better.

One of the things that I found was a really quick win was when Year 4 (age 9) were looking at the molecular model of solids, liquids and gases and this is one of the things that we looked at on the course. They highlighted an error that teachers, including myself, often make in the way that it's taught. Now a model of this is on a display board in school and in all our books. I've found that teachers are very keen to improve their subject knowledge, but one thing that people (not just teachers) are reluctant to do is to say 'I don't know'.

We had a really lovely mistake last year: we did the 'diet soft drink vs full-sugar soft drink can in water' experiment. One sinks, one doesn't... why? In one class it went well and there were conversations about why that had happened. But in the next class, we did it and it didn't work! They both floated and that in many ways prompted a much better, more valuable, discussion. The children thought that maybe the company had cheated them and not put enough sugar in, or sneaked in some extra carbon dioxide. They were so enthused to work out why it hadn't worked, rather than explain why it had. We strapped sachets of sugar to the outside to see how much sugar would make a can sink – it was a ridiculous amount, but the children didn't care, they still wanted to drink those fizzy drinks!

Looking ahead

Going beyond primary school, if as a country we want to continue developing and have an industry that thrives, we need to interest children in science now. If they go through school thinking that science isn't an option for them – particularly the girls, and those from different backgrounds who wouldn't associate themselves with the role models they see in science books – then we have no future. If you don't understand the world, how will you care for and value the planet? How are you going to live in it and move forward in it? How will you even be aware that your choices and actions have consequences? Science isn't just there as another subject to be taught, it's there to provide pupils with an understanding of life.

Ben Thwaites is an Assistant Headteacher and Science Co-ordinator at Swalecliffe Community Primary School.

Useful links and references

CPD course at STEM Learning:
https://www.stem.org.uk/cpd/449801/leading-and-developing-primary-science-expertise