



Figure 1 Science Week activities engaged the children but preparations highlighted narrow perceptions of science enquiry

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explores the importance of content and exploration in a child- and enquiry-led curriculum

HOW THE FAIR TEST NEARLY KILLED ENQUIRY

I think most of those involved in science education would agree that science is essentially about finding out; we would probably concur with Ofsted's (2013) report, *Maintaining curiosity*, that putting 'enquiry at the heart of science teaching' is imperative. In fact, the strongest arguments against the written national science tests (SATS) in English schools were that they were inadequate in assessing what was seen as science's most important aspect – enquiry – and that their removal would provide opportunity to increase the focus on practical science and the skills associated with asking scientific questions and carrying out investigations.

Perhaps primary science teachers should have had misgivings, however, both about the removal of the

science tests (we have been fighting to maintain the status of science in schools ever since) and the denigration of factual knowledge. Of course we do need to engage children and much research points to their preference for practical lessons, but science has a vast body of enthralling content that we ignore at great cost to the children's interests. If we want to approach the holy grail of 'child-led enquiry', then we need also to take note of the second bullet point in Ofsted's list of best teaching practices:

set out to sustain pupils' natural curiosity, so that they were eager to learn the subject content as well as develop the necessary investigative skills. (p.5)

Natural curiosity

I was lucky to have had a wonderful junior school grounding in practical

science. When I was 10, I was delighted to have the privilege of removing the antelope skeleton from the 'soup' it was in, and displaying it for exhibition, learning vast amounts about mammalian anatomy along the way. At 11 I was visiting the local tropical diseases clinic and talking to technicians about how to maintain a laboratory population of mosquitoes to study. These were the experiences that tapped into my 'natural curiosity' and did indeed make me 'eager to learn the subject content' as well as leading to a lifelong love of science.

It is with this in mind that, during British Science Week, I run our own science week in school, culminating in an exhibition. In theory, the focus is child-led enquiry, and our 'Warwickshire Young Scientists and Engineers' (WYSE) event, which was

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Box 1 Some ideas for initiating child-led enquiry

- explore the science resources
- talk about hobbies, sports, after-school activities
- take a walk around the grounds
- discuss science in class topic
- explore the non-fiction section in the library
- discuss photographs of playtime activities
- share favourite films and discover the science
- share science ideas from current reading books
- question aspects of the class text
- watch some short science videos online
- look at news of the day

run during our application for the Primary Science Quality Mark (PSQM; www.psqm.org.uk) silver award, was the first example for this on the Primary Science Teaching Trust (then AstraZeneca) website. For a couple of years it was the only one! Perhaps examples of child-led enquiry were not easy to find in primary schools.

Children's own interests

Our 2015 science week seemed to be, as always, a success in terms of engaging the children (it coincided with the solar eclipse, which didn't hurt!). But as science subject leader in our school, I found this time fascinating for the issues it highlighted in terms of fixed perceptions of enquiry (of children and teachers) and highly variable levels of confidence in how it could be 'child-led', particularly in key stage 1 (ages 5–7). Foundation stage teachers (ages 3–5) were not so daunted by the idea, possibly because their children spend much of their time carrying out their own version of independent enquiry.

Leading up to the week, I ran staff meetings to clarify purpose and logistics and discovered that many teachers held a narrow view of enquiry: scientific questions that must be answered with a fair test. To some extent I had anticipated this, so broached different ways of initiating enquiry in the classroom, based on sparking and developing the children's own interests (Box 1). Hoping to exemplify this in my year 5 class (ages 9–10), I prompted the children to think about and discuss their own interests and then to share some of their ideas. Like the teachers, the children were initially fixated on such primary school science activities as testing to see which ball would roll most quickly down

a slope and what conditions would cause an ice-pop to melt most slowly. I was slightly taken aback as I knew that these ideas did not represent their actual interests: dinosaurs, horse-riding, F1, Minecraft, and so on. It was at this point I realised how deeply ingrained was our formula for 'doing science'.

There's more to enquiry

The perception that enquiry is all about the fair test is not really surprising, given the emphasis on the fair test in all primary school science documentation for at least two decades. As Jane Turner has written, '*fair test investigations have historically been promoted in national assessment, published curricula, schemes of work and assessment criteria*' (Turner, 2012). I had never been very happy with the term or the focus; it was not something I personally had heard used by any actual scientist and I considered that it was only one aspect of scientific enquiry, as well as a poor proxy in primary schools for what happens in

real research. It can be quite difficult for teachers to find meaningful fair test investigations within primary school constraints and they are not always appropriate. The authors of *It's not fair – or is it?* (Turner *et al.*, 2011) pick up on misperceptions around the fair test and seek to clarify the whole process of investigative science. Turner points out that '*fair testing is only one of several ways of learning through science enquiry*', alongside other hugely important aspects, including observation and research (Turner, 2012).

Real scientific enquiry

I went on to think about what happens when science is done in real life, and how this might be reflected in our teaching. For a start, the skills of practical enquiry are important, but equally important should be the recognition that these are a means to an end and not an end in themselves. For example, activities such as comparing the melting rate of ice-pops in different conditions are useful for teaching certain processes and concepts, but in isolation they have little point, are of limited interest in outcome and are meaningful only as part of a larger investigation.

In my model of science investigation in the real world (Figure 2), there are two interlinked and recursive stages. Both are important, but I feel that part 1 has recently tended to be neglected in primary science.

Enquiry is at the heart of science, but it is kick-started by *interest*. This is what fuels real scientific investigations. *Interest* is fed by and feeds into *observation* of the world. I consider these to be basic behaviours common to many animals and, crucially, they may lead to *exploration*, an important

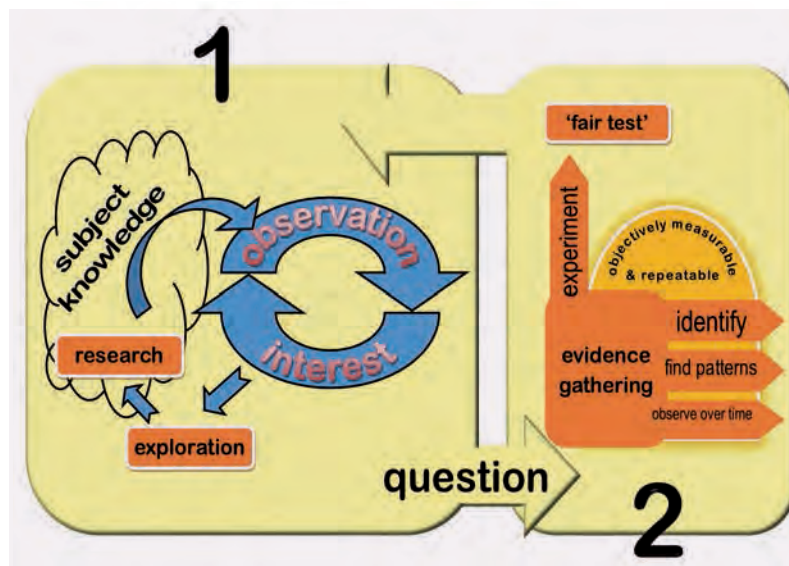


Figure 2
A model
of science
investigation
in the real
world



Figure 3 Children were able to talk confidently about subjects in the area of interest they had chosen

here investigation can take on a life of its own. The teacher has a key role to play in guiding children to different resources and to see the scientific links and questions related to their

aspect of primary science that is so embedded in the foundation stage but often side-lined as children move up the school.

It has been tempting, because of the constraints of time and curriculum demands, to focus on how to ask and answer scientific questions, but without exploration it is difficult for children to generate these questions and so investigations may often be largely teacher-led. Exploration, by its nature, requires the teacher to relinquish some control, particularly if there is the likelihood of off-topic digression. This is not an easy choice in a culture obsessed with specific learning outcomes, but given this freedom, I have found children eager to advance their own knowledge. When interest is sparked, they can be guided to begin actual research, finding out what is known about their subject. It is a mistake to shy away from this important aspect of enquiry for fear of it being too 'academic' and 'boring'; discovering what others have written is a major part of enquiry. In practice, I have rarely seen children bored by reading about topics that genuinely interest them. It is really only when we have some knowledge about a subject that we can begin to develop the kinds of questions that we can investigate in a more systematic way. This would take us to the next stage and the second part of the diagram: carrying out other types of enquiry, including, sometimes, a fair test!

There's science everywhere!

Wider research also helps children to realise that science is not just a school subject, but a lens on the world, and

interests; for this reason, teacher subject knowledge and confidence is crucial.

During our science week, under the tutelage of an enthusiastic and scientifically literate year 1 (age 5–6) teacher, every child in her class was able to discover science in their area of interest. These included such topics as football (of course), ballet, explosions (as always), and Minecraft (so people really dig up emeralds) [see Carol Bostrom's article in this issue of *Primary Science*]. The teacher used a sequence of clear steps to develop the children's work. These involved strong cross-curricular links (particularly with English) and a self-reflective approach to give guidance and support but to maintain the child-led nature of the research. Visiting them during the exhibition, my year 5 children were particularly impressed with how confidently these 5 and 6 year-olds could talk about their subjects (Figure 3).

Balance

The narrowing of the curriculum had been an unfortunate outcome of the high-stakes nature of the written tests, with the detrimental impact of squeezing out 'hands-on' investigations (Collins, Reiss and Stobart, 2008). Following their removal, teachers naturally sought to do the right thing by practical science. However, many turned specifically to the fair test as the way to do science at primary school. Ultimately, it turned out to be another narrow alley.

If teachers lack confidence and subject knowledge, they may try to follow advice, but often in a formulaic way (Appleton, 2013). Advisers should be wary of offering simplistic solutions

or catchy titles as science is more than a 'set of tools': it is a way of thinking that is built in, rather than bolt on. In hindsight, we needed to make sure all teachers understood the nature of variables and reliability, but also that much of science is not amenable to fair-test types of scientific experiment.

Some science writers have begun to address the need for balance (e.g. Harlen, 2010; Turner *et al.*, 2011), and there is also a renewed emphasis on subject knowledge in the new (2014) National Curriculum for England. However, we should guard against the type of reactive pendulum swing that seems to drive us too far one way or another. To thrive, enquiry should involve the exploration of rich and diverse subject matter, reflecting the all-encompassing nature of science, as well as the application of scientific thinking, including questioning and scrutiny. Teachers, too, need this attitude to reflect on our own practice, and we must be confident enough with the subject to identify misconceptions and issues, not only among the children, but also in the advice and resources provided for us.

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