



questions and base predictions on experience. Letting children lead the way is made less scary by emphasising that children do not need to come up with the 'right' or expected results; unexpected or unusual patterns lead to more interesting discussions, to real science enquiry. For example, in New Zealand, children and teachers are working collectively to gather evidence to inform our understanding of the natural world. Maybe we could ask children of the world, or those that live near the sea for example, to actually start measuring the sea level or the daily level of the tide flow to see if there are any differences or patterns?

We need first therefore to remind ourselves of what science is and then talk about why enquiry is important. We start from the idea that science provides tentative explanations of our experiences and the processes used to reach that understanding, and then move on to the point where we need to enquire in order to explore phenomena and seek explanations. As a class, children can explore and hopefully in the process challenge and test out existing ideas; this may lead them to some new thinking about the phenomena. So 'creative exploration' can start with an observation we make when we are doing something else, whether it be doing the dishes, washing clothes, walking on the beach, or weeding the garden.

For many children it will come from play. We notice something and we 'wonder' about it; perhaps we notice a pattern or sense a cause and effect. Science enquiry can provide us with a framework that we can use to test our explanations. The enquiry has to be authentic for the learners; that is, they need to be testing ideas that they have some ownership over. The exploratory phase is important: when children notice something and offer a tentative explanation. Younger children can do this as a class, by taking one of the children's explanations and testing it. Older children can work in groups with teacher scaffolding and support. But at all levels, the exploratory phase should be extensive and provide the experiences that will generate real authentic enquiry.

The key is that science enquiry gives the opportunity for lots of exploring and practical hands-on work that children love. Give the children equipment to play with and they immediately come up with lots of little investigations as they say, 'I wonder what will happen if I...!'. Enquiry creates questions that lead to more enquiry so children need to be given the chance to come up with their questions. Science enquiry is the keystone for effective and successful science across the board. Yet just because an activity is 'practical' or 'hands-on' doesn't mean that the children are actually enquiring. We have seen many practical 'investigations' where the children follow the teacher's recipe and yet have not enquired themselves into anything. How often have we seen children filling a table of observations, only for the teacher to then dictate the conclusion? Where is the enquiry?

We start from the concern that science enquiry has been lost in many classrooms, where the focus is on content. Teachers are almost frightened to do 'practical', or believe that 'hands on' means enquiry, rather than the thinking behind it. Since the UK government's policy document advocating 'science for all' (DES/WO,1985), enquiry has been a requirement in primary science. This simply means doing what scientists do: behaving like scientists and appreciating this process as a distinct way of interrogating the physical environment, as compared with how, say, a historian or an artist might make sense of the world. But how many of us have a true appreciation of scientific endeavour? Many primary teachers are relieved after a training session to realise that Sc1 of the National Curriculum for England means more than 'fair testing' and are pleased that some of the observational and exploratory work that they do counts as well.

It is therefore important that we provide some security for the novices or less-confident teachers when developing enquiry work. Fair testing is important; but maybe we have ended up with children doing the same investigations with the same results. We need to see this as but one facet of investigation and enquiry. If we continue to insist on getting children to write down everything for an investigation, then not only are we creating more marking, but children are not going to make progress in conclusions and evaluations, as we usually run out of time at the end of the lesson.

A good example of enquiry was the 'spring bulbs' study carried out by Welsh schools (Cowell and Watkins, 2007), which is being followed up this year. It illustrates what 'enquiry' means in a real-life context, that is, asking questions about our surroundings and finding out answers. But what makes such activities examples of good science enquiry?

First, it is important that we let children lead the way. It really makes a difference when teachers let the children 'play' with the materials before they start discussing what they can investigate. This was highlighted in the article 'When are you too old to "play" in science?' (Phethean, 2008). Once the children have explored parachutes, etc., they are able to pose



The 'Perspectives' report summarised in this issue (pages 31–32) looks at the current idea of Inquiry-Based Science Education (IBSE), which has generated international currency and which is more than just doing the odd enquiry. It implies basing science education programmes around the process of enquiry, rather than basing them on the need to learn facts, concepts and skills. Mike Carroll and Nick Pratt then both go on to explain how 'communities of collaborative enquiry' involves teachers working and doing enquiry together, in order to learn what it means to be part of a science endeavour – the community of practice we associate with real science.

The new Welsh curriculum also spells out six areas of scientific work children have to undertake: yet many staff are very unclear about enquiry, which is still relatively poorly developed. Teachers tend to 'teach' enquiry, rather than letting children explore first. Perhaps this might mean that it is just as important for teachers to play: include toys and play in continuing professional development (CPD) sessions and you will be amazed at how long a group of adults can investigate (and we mean investigate) bubbles! Nearly every subject has a programme of study that suggests 'asking questions', but we provide no core structure for children to do this effectively in science. In some schools, open-ended enquiry is off the agenda, quite simply because staff are in 'recipe science' mode. One teacher became puzzled at the suggestion that the children may want to record and plot variations in body measurements. His concern was whether it would give him a 'nice pattern' or 'show something happening'. The possibility that he could allow children to raise a question, plan and carry out their own investigation over a whole afternoon or week, and then not emerge with 'a good result' at the end seemed unacceptable to him. Yet much of real science is like this. Some teachers appreciate this but we still have a long way to go. This may be difficult as long as the key stage 2 tests remain in England, as emphasised in the Perspectives report.

Young children should be *doing science*, that is, exploring and experiencing phenomena, which leads to them asking questions and understanding the process of enquiry from within. Their questions provide a rich context for working together to identify ideas that may explain or answer the question. This will lead to some form of testing ideas out and applying the new thinking to other contexts within the child's experiences and environment. This is science enquiry. Let's promote it.

References

- Cowell, D. and Watkins, R. (2007) Get out of the classroom to study climate change – the 'Spring bulbs for schools' project. *Primary Science Review*, **97**, 25–28.
- DES/WO (Department of Education and Science/Welsh Office) (1985) *Science 5–16: A statement of policy*. London: HMSO.
- Phethean, K. (2008) When are you too old to 'play' in science? *Primary Science*, **105**, 12–15.

What others said

Richard Watkins (advisory teacher):

Amidst the haze of gloom around practical enquiry work in schools, a ray of hope; in response to our new curriculum [in Wales] I've been racing around countless schools responding to requests to contextualise science work into a series of meaningful challenges for the week or half term. I demand that the teacher's starting point has to be diagnostic and formative and allow pupils to raise questions to be investigated. It is like a penny dropping with many teachers, but we really have benefited enormously here from the absence of a test-driven curriculum. Teachers are at last taking their time with science!

Ian Richardson HMI:

Children need to work as scientists, with their ideas being valued.

There needs to be a variety of activities which are more open ended, not 'following instructions'.

Fewer experiments that 'illustrate' knowledge and understanding.

Enquiry needs to drive the curriculum.

Progression in enquiry and science skills is paramount.

Talk needs to be encouraged at all stages.

HMI do not expect to see starter, main, plenary in every context ... if pupils are engaged.

Outcomes [are the bit that] count.

Githui Kimamo (teacher trainer, Kenya):

In upper primary classes, the desks are neatly arranged in rows such that movements are restricted. Discussions are curtailed as 'unnecessary noise'. The teacher commands students to 'fold your arms and listen!' such that no manipulation or non-verbal communication can take place.

The teacher draws and describes parts of a flower using the chalkboard, but does not allow students to examine the flowers just outside their classroom. The teachers labour to teach about friction and ways of reducing it, yet the screeching from the classroom doors and window hinges can be heard 10 metres away.

At the same time ... in lower primary classrooms, the children's curiosity cannot be contained. The teacher has no choice but to allow and guide them as they find out through scientific activities that are very rewarding to the children.