

Debbie Myers, with Maria McGrory and Cathy Westgate, has over two years, developed a whole-school programme of child-led enquiry

'CURIUSER AND CURIUSER': SUPPORTING CHILDREN'S INDEPENDENT ENQUIRY SKILLS



Figure 1 A visit to our 'friendship garden' prompted lots of questions

it's no use going back to yesterday – because I was a different person then.

(Alice's adventures in Wonderland, Lewis Carroll, 1865)

Hey Miss, come over here and look! Look at the fungus we showed you. It's eaten up most of the log; there's hardly any of it left now! So squealed several teams of excited young scientists welcoming me to their exhibition of science enquiry projects. As part of a project funded by the Primary Science Teaching Trust, I have been working with staff at Hudson Road Primary School, Sunderland, to support children to work more authentically as scientists, and this was the finale. During my initial visits to the school children were exploring the plants and animals in their 'friendship garden' and were

very excited to discover a strange-looking material growing on a damp log, which prompted lots of questions. Instead of answering these questions directly their teacher skilfully planted the seeds of enquiry in these fertile young minds: 'Hmm, I wonder what's going on here. We are going to have to watch very carefully to find out what's happening.' And, just as Alice navigated her way through Wonderland using questions as a compass, these equally curious children have begun to make sense of the scientific wonderland all around them by raising questions, investigating and discovering the answers to their questions.

But why is this important? Maria McGrory, their teacher explains:

Many of our children come to school and in terms of developing scientific explanations they behave as if they are 'world blind'; they don't know why things are the way they are. The world of scientific phenomena is all very mysterious to them. To children the answers to questions are not known so the excitement they experience at being

able to investigate their own questions is priceless.

And Ofsted (2013: 5) agrees, identifying the best science teaching as that which 'set[s] out to sustain pupils' natural curiosity' by equipping children with the investigative skills required to make sense of the world around them. However, this involves a change in the way we as teachers think and such whole-scale change requires visionary leadership and agency, reflection and enactment by participating teachers (Clarke and Hollingsworth, 2002).

The journey to Wonderland – CPD signposting

Murphy and Beggs (2005) observe that the most important factor influencing primary teachers' confidence in teaching science is their experience of participating in continuing professional development (CPD) activities. I designed a programme of CPD in which the head teacher and staff were supported to identify and compare their beliefs about science

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enquiry and working scientifically. To enable collegiate working practices to evolve, including co-teaching and peer coaching, experiential, dialogic and collaborative models of teaching were demonstrated for emulation, enabling the teachers to subsequently co-construct new teaching and learning pedagogies that align with child-led enquiry, requiring goal setting, and guided reflection over time (Bule, 2009).

A mixed-methods approach was used to collect data from the teachers and children in the form of drawings, concept maps and pre- and post-perceptions surveys to evaluate the impact of the project.

To help the teachers to interrogate their own understanding of 'working scientifically', they completed annotated drawings of scientists engaged in professional activities based on the Draw-a-Scientist Test designed by Chambers (1983) (Figure 2).

While the teachers' drawings did not conform to gender stereotypes, they did represent scientists as predominantly white. This activity alerted the staff to the importance of promoting science as accessible to all, given that one third of the children in their school are of Bangladeshi heritage and 40% are learning English as an additional language. To further complement the school's work on early careers education, the teachers agreed to draw parallels between the work of scientists and other professionals who use enquiry skills to collect evidence to inform decision-making, including detectives, judges, forensic scientists and spies (Figure 3).

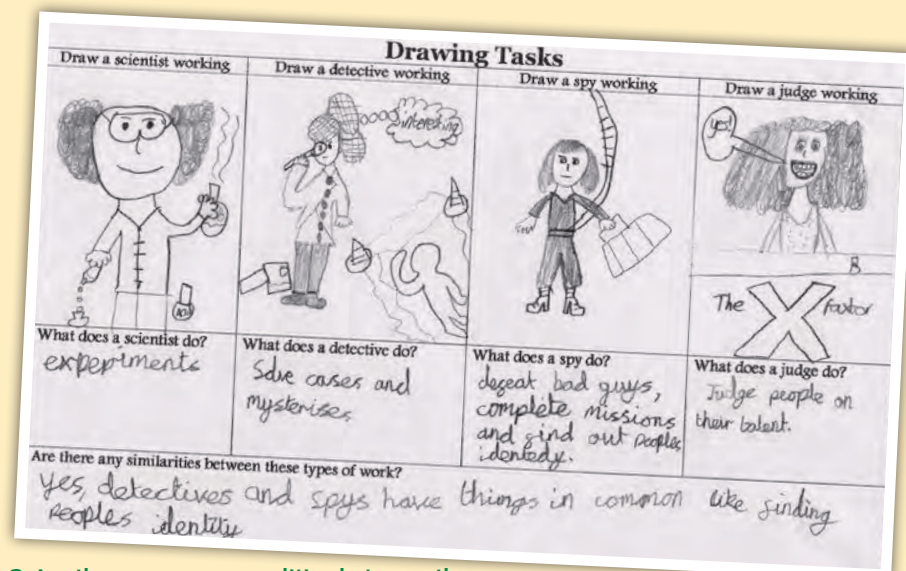


Figure 3 Are there any commonalities between the ways of working of scientists and other professions?

Prior to undertaking practical work, staff constructed group concept maps to identify the skills an observer would see when children are working scientifically.

Millar *et al.* (1994) identify interplay between three types of knowledge as essential in enabling individuals to construct scientific understanding: conceptual, procedural and epistemic (evaluating evidence). Helping children to answer their own questions supports their interactions with these knowledge bases as they work scientifically. Using children's literature to contextualise enquiry-based problems, the staff experienced broad categories of investigations in accordance with the AKSIS project (Goldsworthy, Watson and Wood-Robinson, 2000; Turner, 2012). These enquiries included:

exploring phenomena, identification and classification, observing changes over time, pattern-seeking, technological enquiry (problem-solving), fair testing and research and synthesis.

For example, the story *Immi* by Karin Littlewood (Gullane, 2010) prompted investigations relating to changes of state including a study of freezing-point depression, while the story *Iggy Peck, architect* by Andrea Beaty (Abrams Books, 2007) was used to contextualise investigations about the effects of forces on structures.

Goal-setting

The teachers agreed to design topic-themed contexts to capture children's prior knowledge and to stimulate children's initial curiosity, using stories, visits, observational walks, discovery bags, mystery boxes and puppets/people-with-problems to prompt the generation of questions. These questions would be recorded on templates for display so that teachers could help children to identify possible lines of enquiry with reference to the requirements of the Early Years Foundation Stage or appropriate National Curriculum programme of study.

Each week, a pupil's question would be investigated by the whole class and each group would be encouraged to develop their own approaches to gathering data. Teachers would transfer to the children the responsibility for deciding how to go about answering their questions: which approaches to use, how to collect data and how to present their findings to other groups.

Examples

In year 2 (ages 6–7), Maria set up a minibeasts 'working wall' to capture children's prior learning and their initial questions and to chart progress



Figure 2 Drawing a scientist helps to draw out what we really think they are like

Figure 4 A 'working wall' for children's questions on minibeasts



in their thinking (Figure 4).

She made children's decision-making strategies visible using consensus placemats (Kagan, 1994) to provide visual representations of their verbal and textual negotiations, thinking strategies and agreed actions. This has helped them to continually try new ways to investigate. If one child's idea didn't work they went 'back to the drawing board' to try someone else's idea, enabling them to experience the iterative nature of enquiry.

Maria's class constructed a minibeast city in a hedgerow to support ongoing observations throughout the changing seasons, enabling them to draw evidence-based conclusions about nature's recycling processes: birth, growth, reproduction, death and decomposition.

Year 5 and 6 children (ages 9–11) read *Street child* by Berlie Doherty (HarperCollins, 2009) to understand the lives of Victorian children prior to visiting Cragside, the Northumberland residence of industrialist Lord Armstrong.

Entering his little room of experiments, they discovered how he created hydroelectricity to electrify his home, generating lots of questions that on subsequent investigation enabled them to work scientifically as he had (Box 1).

Reflections

The teachers felt their deliberate focus on what a scientist is and does informed children's changing beliefs in themselves as scientists: that science is for people of any gender, age and ethnicity. Indeed, at the end of the project year 6 children declared themselves to be scientists:

Yes I am a scientist because I make new experiments.

Yes because I investigate questions.

Teachers acknowledged the pivotal role of language, especially iterative questioning, as a tool to further children's enquiries and to scaffold children's thinking. Productive talk for learning, between teacher and children, enabled co-construction of new scientific knowledge and understanding

through the exploration, justification and challenging of one another's ideas (Mercer, 1995).

Teachers identified the regular use of mini-plenaries, supported by peer review and guided reflection, as key in enabling each group to share their progress and their differing experiences of answering the same question.

Designing opportunities for children to investigate their own questions was greatly motivating for them, but initially daunting for teachers because it required them to be sufficiently confident in their own science subject knowledge to relinquish responsibility for decision-making to the children. CPD training helped them to think of subject knowledge as constantly evolving so that they approached each investigation as a co-investigator with the children.

Year 5 teacher Chloe Cameron said:

At first I thought this can't work if we just go with what the children want to know and find out. How will we cover the curriculum? When they first raised questions they looked at me to tell them what to do: 'oh Miss will tell us'. But now they know they have to decide what to do, to take responsibility for decision-making. Instead of me telling them what they should think I've had to train them to think: if you want to do this investigation what will you have to do? Maria co-taught with me when I was teaching forces, to help children to explore the pulleys and levers mechanisms, so they could go on to plan and make toys of their own.

The introduction of a new primary curriculum for science places greater emphasis on child-led enquiry. At this time of transition a shift in emphasis from teacher-led to child-led enquiry may support the development of new pedagogic practices that better align with children's natural dispositions of playfulness and curiosity, facilitating their greater engagement in science by stirring their passion for the wonderland all around us – a world that we, as adults, may no longer see.

Acknowledgements

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Further details of the 'Supporting pupils' independent enquiry studies in science year 5/6 pupils' project can be found at: www.pstt.org.uk

Box 1 Year 6 children's questions on the 'Light Fantastic' theme

1. Light

Where does light come from?
How is it made?
How does light travel?
Can we bend light?
How fast does light travel?

2. Rainbows

How are rainbows made?
Can we make rainbows?
Why are rainbows curved and not straight?

3. The eye

How do we see?

4. Colour

Is a colour just a colour?
How do we see colours?

5. Electricity

How can we make light flash
How do bulbs switch on?
Can we make coloured lights?
How is lightning formed?

The impact so far

● Exhibitions of pupil-led science projects are held annually to show how a whole-school focus on 'the use of enquiry as a way of knowing' has enabled children to develop their own scientific methodologies and to use evidence to explain their conclusions, by extending teachers' pedagogical design capacities.

● Maria McGrory has been recognised as a Primary Science Teacher of the Year (Fellow of the Primary Science Teacher College).

● Debbie and Maria will be presenting a workshop about this project at the International Primary Science Conference in Belfast (9–11 June 2016).

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Debbie Myers (CSci Teach) is currently a senior lecturer in primary education at Canterbury Christ Church University, a primary teacher adviser to the Royal Society of Chemistry and a Fellow of the Primary Science Teacher College. Email: debbie.myers@canterbury.ac.uk

Maria McGrory is science subject leader, science CPD leader and key stage 1 team leader at Hudson Road Primary School, Sunderland. You can see her in action on the RSC website: www.rsc.org/learn-chemistry/resource/res00002104. Email: maria.mcgrory@schools.sunderland.gov.uk

Cathy Westgate is head teacher at Hudson Road Primary School, Sunderland.



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