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USING SCHOOL SCIENCE TO NURTURE AND DEVELOP CHILDREN'S WONDERINGS ABOUT THEIR WORLD

Teachers and parents can harness children's curiosity to help them do hands-on experiments to investigate the questions they're interested in, fostering a love of everyday science.

Last weekend, Dr Anne Forbes rode the ferry from Nelson Bay to Tea Gardens in New South Wales. During the ride, she was brimming with questions about the things she observed: "Why is the water frothy from the boat moving? What is sand made of? What are marine ropes made from and why?"

Dr Forbes researches science education at Macquarie University, and in her view, such child-like questions are at the heart of scientific inquiry. Exploring them doesn't require a lot of expensive equipment, but there *is* a vital step to enabling scientific investigation of such wonderings: they must first be turned into "testable questions."

A testable question is one that can be answered with an experiment: measuring the outcome of changing a single factor while keeping everything else the same. A good way of explaining testable questions to kids, says Dr Forbes, is using an acronym developed by Professor Mark Hackling: *Cows Moo Softly* (CMS).

"'Cows' stands for 'Change one thing' (in secondary school science this is called the independent variable), 'Moo' stands for 'Measure something' (dependent variable), and 'Softly' stands for 'keep everything else the Same' (controlled variables)."

"It's easy to change something, but tricky to keep all other variables constant. Scientists spend a lot of time ensuring that their experiments are 'fair tests'."

"Another couple of things that scientists do is to repeat their investigations many times and carefully take accurate measurements. The collection of these measurements is your data set. To make sure it is robust, and can be used to make meaningful claims, you need three components: fair testing, replication and careful measurements. In science it is your 'data set' that matters."

"Young scientists need many hands-on, interesting opportunities to develop the skills that lead to robust data sets. Through such experiences they gain insights into the 'nature of science' and how it can help us to gain insights into our world."

In Dr Forbes' view, such an understanding also fosters a healthy respect for scientific knowledge, and the role of science experts in public decision-making – for instance, in ensuring "that decisions about future growth, industry and business plans" are compatible with "a sustainable relationship with the environment and resources."

Getting back to the questions arising from Dr Forbes' ferry ride: if a child asked these questions, how could a teacher or parent guide them towards developing a 'testable question' that could be investigated?

Why is the water frothy from the boat moving?
"Such questions come to a child's mind constantly, says Dr Forbes. "This one could be reframed as 'Which type of water makes the best froth?' and then turned into a testable question by asking: 'If I

change the type of water what happens to the amount of bubbles?'"

What is sand made of?
"This one does not require an immediate answer from an adult such as 'small pieces of rocks and shells'. Rather, the child's interest should be acknowledged, and nurtured by the adult asking, for instance, "I wonder if sand is magnetic?" (this is often the case if the sand contains small pieces of a black rock named magnetite). A testable question could be: 'Are pieces of the sand are attracted to a magnet?', followed by 'If I change the type of sand how many pieces are attracted to a magnet?'"

What are marine ropes made from and why?
"Noticing that ropes are used to tie up boats to wharfs leads to some interesting ideas: Are natural fibres better than synthetic fibres for water activities? What happens to the properties of fibres when they are wet? And a testable question: 'If I change the wetness of a fibre, what happens to its stretchiness, or its strength?'"

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To understand how science works and how it can be used to answer questions and solve problems, says Dr Forbes, children need to have many opportunities to practice working and thinking scientifically.

They also need opportunities to investigate scientifically in topics and through questions that they find personally intriguing. When children have ownership and choice over their learning, feel connected to others, and have a sense of developing competence, research has found that they are more likely to be motivated, engaged and interested in learning.

A recent paper by Dr Forbes, for instance, found that "Students' views of the role of their teacher when doing science were changed by the realization that the optimal science learning environment was one in which they had choice, independence and the opportunity to think creatively and to learn from their mistakes."

For children to have these opportunities, teachers and parents need to provide support while not being overly 'directive'.

"They need to encourage, mentor and facilitate rather than direct, select and choose what children will investigate," says Dr Forbes. "My research is about how to best encourage this type of science learning in schools. Children are interested in what they experience and see, so linking their interest areas to syllabus concepts provides powerful contexts for working and thinking scientifically."

"So the next time a child comments 'That's strange,' or 'I didn't expect that to happen,' or 'Why is it like that,' regard it as a scientific invitation, and offer to 'walk with them' as they explore their world working and thinking like a scientist."

If you'd like more information on teaching kids everyday science, you can find it here:

Resource on Self Determination Theory

Mark Hackling, *Working scientifically: implementing and assessing open investigation work in science: a resource book for teachers of primary and secondary science*. Ed Dept of WA.

Anne Forbes, 'You Actually Feel like You're Actually Doing Some Science': Primary Students' Perspectives of Their Involvement in the MyScience Initiative', *Research in Science Education.*