EDITORIAL

How children experience light and sound

In this issue, we deal with light and sound 'as is': how children experience them, how to make sure we look after our eyesight and hearing, the instruments we can use to enhance our use of them. We begin with an article by **Sarah Evans** and **Mick Dunne** that inspired me enormously, as it demonstrates how we underestimate young children at our peril. Faced with a digital microscope (which their teachers thought was beyond them) Sarah, a trainee teacher, observed a small group of very young children working out how to use it without any help at all and getting huge satisfaction from the process, as well as creating fascinating images. The dialogue Sarah recorded reminds us how important it is that children share ideas between themselves if their learning of new concepts and skills is to be enhanced.

Brian O'Kane, a professional ophthalmologist, then explains how children's eyes develop, how they see clearly, and the kinds of tests that need to be undertaken regularly, if good eyesight is to be preserved. Some of these tests can be replicated simply in the classroom. Brian emphasises the importance of children having their sight checked when they are still young, as their eyes continue to develop throughout their first nine years. And it is also important to explain to them about how their eyes work, and what the tests mean, in a way appropriate to their age, so that they will understand the need for eye care and what can damage eyesight.

Turning to sound, **Bob Shipman**'s piece suggests simple kinaesthetic ways in which children can model and experience the motion of sound waves, using easy-to-understand diagrams. There are clearly many ways in which you and your class can extend this idea beyond the examples given. **Richard Watkins** and **Karen Shepherd**, an audiologist, then focus on how our ears work, the reasons for hearing impairment and the kinds of tests that are important, especially as poor hearing can easily go undiagnosed in a busy classroom, leaving some children feeling isolated, as can be easily demonstrated by asking children to wear earplugs during class.

It has been well known for many years that children have all kinds of ways of explaining how we see and hear things, and earlier issues of *PSR* have addressed these (see for example the articles by Wynne Harlen and Paul Warwick in *PSR* **64**). Older children may know that light is needed in order to see an object, but may not know that light is reflected off the object, and that some of that light enters our eyes. **Colin Forster** therefore addresses this key question about how we see, by suggesting ways to help children understand reflection through simple activities with bright colours and lights in a darkened classroom.

Enthusing the next generation

In the non-theme section, **Michael Reiss** provides a summary of the recent report by the Biosciences Federation Working Group, which he chaired. He points out the report's consensus that biology teaching for the 3–11 age range should focus on developing the skills of enquiry and critical observation, and that whilst the existing primary curriculum already emphasises such skills, many teachers often find them challenging to deliver.

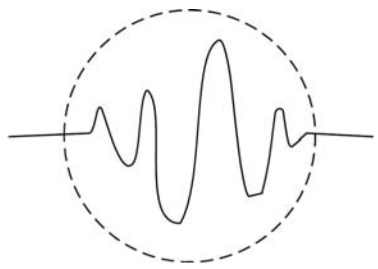
Finally, in our continuing series on primary science in other countries, **Jenny Rogers** shares her observations of how different science teaching is in Japanese classrooms, despite superficial similarities of curriculum. The difference, as she points out, is the emphasis on process, or what is referred to as 'intrigue': problem-solving and experimenting in order to maintain the joy of science and a 'zest for life'. Her description of a 7-year-old peer-teaching a whole lesson left me with much to think about in terms of how we may underestimate our children.

Working on 'wobbly bits': What *is* light? What *is* sound?

In teaching light and sound to younger children, we may only be required to deal with the simpler observable concepts such as shadows and reflection. Yet teachers are often unnerved when it comes to teaching light in particular, since many feel they do not really understand what it is. Ask most people, and the likely answer you will get is 'waves'. And of course they would be partly correct; sometimes, both light and sound behave like waves. But in many ways, they are not at all like the waves on water, with which we are familiar. This is perhaps why teaching light and sound seems difficult: we are so familiar with them in everyday life, and yet their nature is hard to understand.

Sound is perhaps easier, as it is less controversial. It consists of vibrations in a medium – air, water, or even solids. Without a medium there is no sound, as you soon find out if you put a ringing alarm clock in a jar and pump the air out. Particles vibrate back and forth and bang into each other to make sounds, as demonstrated simply in the article by Bob Shipman. We can also 'hear' sound through solids and liquids: dolphins and whales 'talk' to each other under water, and we hear ourselves speak through the bones in our jaw and skull, as discussed by Richard Watkins.

Light, however, is very strange! For over 100 years, 'big name' scientists such as Maxwell, Einstein, Eddington, Planck, de Broglie, Bohr and many others grappled to understand what it is – sometimes a wave, sometimes a particle. Most people find this hard to accept: that light can leave the Sun as particles and arrive at the Earth as particles, but, in between, behave like a wave through space. One attempt at 'modelling' light has been to describe each particle of light (called a photon), as a 'wave packet' or quantum of energy – a kind of ripple or pulse (see diagram). Lasers are based on this understanding.



The big problem is that energy travelling as quanta can only be accurately described by the mathematical equations of quantum mechanics. So we would be best advised to follow the great Richard Feynman's advice:

I think I can safely say that nobody understands quantum mechanics. ... Do not keep saying to yourself, if you can possibly avoid it, 'But how can it be like that?' because you will go down the drain into a blind alley from which nobody has yet escaped. Nobody knows how it can be like that.

Observing real phenomena

Much more important, and reassuring for everyone, is to encourage children to observe and explore phenomena created by light, exactly as the infants did with the digital microscope. For example, let them take digital photographs of their own shadows, and those of others, from different angles, so that they explain what they see and how they are formed. Or encourage them to use sensors to measure the intensity of reflected or scattered light in different parts of a room, and ask them to show how light can travel round corners. It may be interesting to ask them to come up with explanations of why the sea sometimes looks blue, sometimes grey, sometimes white. You can develop a range of 'thought experiments', once they begin to get the idea. If there happens to be a rainbow visible from your classroom, take them out to look at it and let them talk about how it is made. In some cultures, a rainbow is made by a snake crossing a river. And as one of my class once memorably said, '*It's the wet petrol that's gone up into the sky*'. I knew exactly what he meant!

Such extension activities are not there so that children can be tested: they are to help children explore things that are everyday experiences for them; to help us know what they are thinking and how they explain things. Like the 7-year-old girl, travelling alongside me in the train to Paignton in Devon to see the total eclipse some years ago. After going through the second tunnel near Teignmouth, she looked up at her father and said, '*Daddy, you never told me there were two eclipses!*'

Alan Peacock

Postbag

PPA teachers and science enquiry

The question of the best way and time to teach AT1 *Scientific enquiry* was raised in *PSR* **91** (Postbag, page 3). This is of real importance and its separation of some concern.

My colleagues and I agree with your correspondent and could not see how scientific enquiry – comprising skills and adjacent attitudes – could operate in isolation. In our experience, children can only successfully undertake the process skills of science with the subject matter in front of them in some form. Whilst it is obviously easier with some topics than others, even topics such as *Earth in Space* and *Life cycles* can be taught with an enquiry-based approach using exciting ICT resources and museum visits.

The elements of subject knowledge and scientific enquiry run alongside each other throughout each topic as children add to their 'prerequisite' knowledge as they engage with the subject matter. Helping children to take these steps is at the heart of teaching and learning. If these are positive experiences their skills, and therefore understanding, will benefit.

PPA (Planning, Preparation and Assessment) time in our school has improved the exchange of teaching and learning ideas and resources, whilst children are actively learning in excellent workshops: broadly geography, drama, cooking, art and crafts and ICT. Planned and led by a range of staff, these workshop 'subjects' contribute to children's 'excellence and enjoyment' by complementing but not overtaking mainstream lessons. We hope to assess cooking as part of the food element within design and technology and science. We could also align the order of workshops more closely with the school planning of certain topics. Before PPA, my own teacher-instigated science club sessions involved many hands-on experiments that actively combined scientific enquiry and knowledge and were loved by participants, but still only extended the classroom curriculum.

If other teachers find scientific enquiry a challenge to 'capture' as I do, perhaps through this journal we could have some suggestions.

Henricus Peters
Year 2 teacher and science club coordinator,
St Johns CoE School, Harrow LEA

Margaret Collis

Dr Margaret Collis died early in February, at the age of 92. She was a pioneer in science education, and made a tremendous contribution to biology education and especially to primary science. She was one of the authors of the groundbreaking and still relevant 'Science 5–13' series developed by the Schools' Council in the eighties, and was based at Goldsmiths' College London.

Margaret began her career by training as a teacher at Homerton College Cambridge. Whilst teaching full time in London, she read for a zoology degree and then studied for a PhD at Birkbeck College. Her PhD involved comparing several populations of a sand-living animal, and travelling to her sites of research in her spare time. She eventually became a science inspector for Kent County Council and ran summer schools in fieldwork for teachers.

I first met her as a child, accompanying my father who taught the courses with her – she let me go along for the fieldwork! I recall her visits to our house; she was always interested in what we children were doing and our outdoor experiences. She was committed to natural history in school and a great advocate of nature tables in the classroom; she regarded these as a superb, almost essential, science resource, advocating their use for encouraging careful observation of the child's immediate environment, ideas that are still valid today. Always having an enquiring mind herself, she kept up to date with developments in science education; until the late eighties, she was always an attendee at the ASE annual meeting, taking a great interest in innovations but linking them with what had happened in the past. She subscribed to *Primary Science Review* from its first publication, to keep informed about progress in the subject. Her house in Cambridge always extended a welcome, and she was clearly interested to hear what was happening in relation to children's science and their opportunities to learn biology.

She was a great friend and mentor. I for one will miss her, and am so glad to have had the opportunity to know her.

Sue Dale Tunnicliffe