CHAPTER 11

TEACHING SCIENCE OUTSIDE THE CLASSROOM

Chapter aims

By the end of this chapter, you should be able to:

- Introduce some of the motivations for promoting science outdoors
- Consider some of the evidence of the benefits of studying science outside the classroom
- Suggest ways of using creative teaching methods to promote effective scientific enquiry

INTRODUCTION

> We couldn't be inspired with a love of the natural world, we couldn't grow up as fully rounded young people unless we spent time out of doors. Not just an occasional trip tacked on at the end of the summer but integrated properly into every subject that we were learning … I don't believe that any of us can grow up properly in this country unless we've had the chance to feel and have communicated to us direct the passion for the natural world that the best teachers can bring. I'm so glad that the new national curriculum … [had] such a firm emphasis of giving children that knowledge, and knowledge they can only really grasp if they are educated out of doors.
>
> (Michael Gove, Secretary of State for Education (January, 2014))

For those interested in the promotion and implementation of outdoor learning, such comments from the Secretary of State for Education can certainly be seen as a positive affirmation. In the 2014 National Curriculum (DfE 2013) the 'firm emphasis' that is referred to only really begins to appear beyond primary Key Stages 1 and 2 for until then the only direct references made to outdoor education are in relation to the physical education programme. However, at this point it is worth remembering that the 'slimmed down' 2014 National Curriculum is now seen as the guideline for essential knowledge rather than its more prescriptive precursor. This provides a significant opportunity for teachers and for schools to develop their own approaches and methods for delivering the statutory outcomes in what the National Association for Environmental Education has called 'one of the greatest opportunities for truly inspirational education … Learning outside the classroom provides a dazzling opportunity to help contextualize the new National Curriculum at both primary and secondary levels, wrapping real world meaning around dreary lists, and making learning more memorable and inspirational' (NAEE, 2012).

If you have been in teaching for some time you may find the term 'opportunity' something of a well worn euphemism for 'more work'. Taking children outside can sometimes undoubtedly be troublesome, occasionally even the simple logistics of moving a group of children can prove problematic. This combined with the varied issues (time, cost, risk assessment) that tend to rise up before, during and after trips can sometimes be seen as simply too much hassle.

So, the first question must therefore be, why bother?

Time for reflection 11.1

Read through the following:

In September 2012, a global meeting of conservation leaders worldwide adopted a resolution recognizing the importance of the 'Child's Right to Connect with Nature and to a Healthy Environment'. The International Union for Conservation of Nature (IUCN) resolution called for this to be included within the framework of the United Nations Convention on the Rights of the Child.

In June 2011, the Coalition Government published the Natural Choice, a White Paper that included the recommendation 'to strengthen the connections between people and nature' (Defra, 2011, p. 44).

In 2012 the Natural Environment White Paper (4th Report) stated 'that Defra set a firm target for increasing public engagement with nature, such as the percentage of children of primary school age regularly engaging in nature activities'.

> Children spend so little time outdoors that they are unfamiliar with some of our commonest wild creatures. According to a National Trust survey, one in three could not identify a magpie; half could not tell the difference between a bee and a wasp; yet nine out of ten could recognize a Dalek. (Moss, 2012)

Learning outside is a proposed right of the child. The government has genuine concerns about connecting people and nature as do academics.

Reflect on your own motivation for using, or not using the outdoors.

GOING OUT TO THE INDOORS

Before going further, it is important to point out how there are different meanings to learning outside the classroom. School trips are still common, although increasingly perhaps subject to financial pressure. Such trips out, commonly to zoos, aquaria, museums or science centres, are significant events. They also provide important and varied learning experiences for the children. Careful planning in relation to timings relative to the curriculum and working closely with the receiving institutions may enhance these visits significantly. Often such institutions have education teams, pre-prepared resources and planned activities that can be both generic or bespoke. They are undoubtedly valuable and worthwhile, however, outdoor learning is just that. It may involve as much planning and resource development, but provides a very different set of learning opportunities and therefore requires a different set of learning approaches.

WHY OUTDOOR SCIENCE LEARNING TODAY?

Broader considerations

Ideas relating to the importance of children learning outside are not new and have a provenance that includes writers such as Rousseau, Montessori and Kolb among many others. However, in the contemporary context there is a growing concern as today children, in the UK at least, now appear to spend significantly less time outdoors outside school hours than previous generations and as a result, their direct experience of their environment and the wide benefits that such contact seemingly provides is much reduced.

It is probably a truism to say that our childhood world was very different from the one our parents knew as children. Every generation seems to know a singular childhood world and on that basis change seems natural, as it is inevitable. However, perhaps it is the pace of change, particularly in technology, that seems disconcerting. The digital recreational choices children have available to them are as legion as they are seemingly enjoyably addictive. For those of us interested in science and technology of course, we can admire the astonishing technologies that have come together to produce these machines and the impressively rapid improvement in graphics and sound quality that are their hallmark. As teachers however, we may be a little uneasy about the attraction of home entertainment. Certainly, over the last few years statistics have begun to emerge relating to children's play patterns. For those who promote outdoor play (and learning) they make poor reading. Sigman (2012) estimated that in the UK by the age of 10 the average child has access to five screens; that children in the UK spend more time in front of screens than they do at school and this in turn has led to growing concern, not only about the changing nature of play, impact on sleep patterns, exercise and attention span, but that children are simply not going outside anymore.

For some time this trend has been identified as also relating to the dissatisfaction with, or simple lack of, appropriate outdoor play areas (Valentine and McKendrick 1997) and from increasing parental concern over children being potentially at risk if they are outside alone and unsupervised. No matter how much reassurance one can offer in terms of the very low risk, parents are increasingly reticent to let their children play outside.

The author Tim Gill likens the loss of children playing unsupervised in parks and green spaces to a human equivalent of Rachel Carson's *Silent Spring*. The loss of young children from public spaces is like the loss of songbirds. The future is even more worrying for as Sigman (2012) points out, children today, by the time they reach the age of 80 years, will have spent 17.6 years, nearly a quarter of their lives, in front of screens.

The suggested general advantages of outdoor learning to children are overwhelming and as such are perhaps too numerous to consider in detail when the focus of this is on using the outdoors for learning science specifically. However, in brief, the learning advantages that outdoor settings provide for primary aged children are well reviewed by Waite (2011) and the broad benefits for physical health and social development are detailed in Every Child Outdoors (RSPB, 2010). The benefits of the outdoors in relation to behaviour and mental well-being are also extensively reviewed by Bird (2007) and Bowler et al. (2010).

Even a cursory glance through the published literature shows broad and sometimes unqualified agreement, that outdoor learning is a good thing. Indeed, even the Office of Standards in Education (Ofsted) in 2008 published a report that found overwhelming evidence that outdoor learning not only contributes significantly to raising standards but also enhances the quality and depth of learning. By 2010 Ofsted wanted to see through the school inspection framework 'substantial opportunities for children to learn outside the classroom' and that learning outside provides for an 'enjoyable and enriching education' (Ofsted, 2010).

In a rare convergence of agreement, the Secretary of State for Education, Ofsted and health and educational researchers agree on the significant advantages of outdoor learning. You should not need much more convincing for the overall advantages, but what of science teaching?

EDUCATIONAL ADVANTAGES OF LEARNING SCIENCE OUTSIDE

In 2010 Ofsted suggested that learning outside adds something to the learning experience and that outdoor learning is generally enjoyable. Improving the enjoyment of children learning may be reason enough, but for the teaching of science there are other important elements to consider. For example, imagine that you were carrying out a class and that somehow you could throw a switch and the walls and ceiling of the room would withdraw leaving you effectively outside. Would you continue to teach the same activity that you had originally started, or would you adapt your approach to take into account the new learning opportunities that were now presented to you?

The question here is how does teaching science vary between indoor locations and outdoor settings? Probably the most obvious characteristic is lack of physical confinement and the opportunity to move and to explore. There are parallels here with learning opportunities. Science-based observations are equally unbounded in outside settings. Children can clearly see things in context, the habitats of insects and arthropods, orientation of flowers relative to light and wind direction. These brief examples (more become apparent in the field) show not only how children can be encouraged to make the interconnections that were discussed in Chapter 10, but also can begin to be encouraged to think ecologically. To observe at first hand the influence of the physical environment on living things and how living organisms interact with one another, could certainly be an effective way of learning. However, unconfined environments may also provide too much stimulus. So much is going on and there can be so many distractions and so much excitement that getting the children focussed and closely observing what you want them to look at can sometimes present problems.

Here we can learn a good deal from the work of environmental educators such as Joseph Cornell. In *Sharing Nature With Children II*, he proposes and develops an approach to outdoor learning that he calls 'Flow Learning'. It is worth considering in more detail, particularly as one of the great things about the approach is that rather than diminishing the children's excitement at being outside, it exploits and focuses it. When children go out into a playground or a park or any open space, their excitement is such that they often will need to run around and holding them back can be quite a problem. By adopting the Flow Learning approach you actually utilize that excitement.

It is easy in education, where we are surrounded by theories of learning, to lose track of simple truths, one of which is that going outside often feels like an adventure and science is about adventures. Children do not have to go far to experience the excitement of adventure and enquiry, a sense that has a direct lineage to the sense of wonder experienced by Charles Darwin, Mary Leakey or Jane Goodall. The excitement of exploration, no matter how local and on what scale should not be underestimated.

Of course another consideration relates to the nature of scientific enquiry. Science after all concerns the world around us. It asks questions relating to observed patterns and relationships, form and function, space and time. These observations for young children need a context for them to be acknowledged as relevant and teaching science outside can help to provide such a perspective. Earlier we suggested that observing organisms allows them to apply ecological ideas by seeing them happening in the real world. In some ways, ecology and biology lend themselves to the outdoors, however, so do physics and chemistry. Physical science can easily be brought outside and a context provided. For example, going outside on cold, frosty days is an excellent way of noticing the different states of matter in relation to water. Such a short expedition on a cold day would allow so many different learning opportunities. Of course traditionally a good deal of the so called earth sciences lend themselves to outdoor learning. Soil, water and the search for insects and arthropods can be fun and can be easily developed and implemented. This certainly fits in with curriculum content such

as life processes and living things. In fact one might even consider if this section is easier to teach outside than in. It takes perhaps a little more thought to develop strategies that help to explain the more physical sciences, such as chemistry and physics, but this can be a highly creative and rewarding exercise.

Ideas and resources for science activities are plentiful on line, but of course there are other advantageous aspects to outdoor science. Not least of these are developing links with organizations in the wider community. Conservation groups such as the Wildlife Trust, or the Woodland Trust are always worth contacting relative to outdoor science, both in terms of potential access to safe locations and for ideas around activities that the children can carry out. There may also be local environmental companies and organizations that would be willing to help and to get involved.

Using the outside as the basis for science work can also allow further parallels to be drawn to how science research is commonly conducted. The children can, in a non-competitive sense, be organized into teams to conduct their investigations. Each team could carry out the same investigation using similar or even different methodologies, particularly useful if the children have designed, or at least helped design these methods. Later they may come together to share their results. This would be an effective way of looking at precision and accuracy and beginning to think about the importance of 'replication' in science. Alternatively each team can take on one part of a wider investigation, building up a picture of a process or habitat. 'Working scientifically' is the phrase used in the National Curriculum and of course teams often carry out science research and progress is made through sharing the results. Increasingly 'working scientifically' implies working in teams and sharing results.

Furthermore, results from some science-based research takes time to gather. Long-term experiments allow data to be built up and can be returned to over the years as the children pass through the school.

Case example 11.1

At Embercombe near Exeter in Devon a number of outside, science-based activities are offered that combine both the children's imagination and clear science principles. Simple, long-term observations on tree growth were carried out by children planting saplings, much smaller than themselves. Having measured the height of 'their' tree and their own height at the time of planting, the children have returned each year to measure and compare their own growth predictions to what has actually happened.

Further information concerning their work in promoting outdoor science may be found at: http://www.embercombe.co.uk/

THE IMPORTANCE OF THE OUTDOORS IN SCIENCE

In the last few years, outdoor learning has also been increasingly seen as a means of promoting and fostering an emotional connection between children and the

natural environment. At times this may seem slightly opposed to the mindset that we often associate with science, namely the rational and the reductionist. However with young children even when teaching science we really should consider the importance of imagination and creativity. They are essential for good science practice. There is no reason at all why such approaches should not be used in science teaching.

The outdoors provides an enormous number of opportunities for visual observation and as important as that is, it also affords a whole range of other sensory experiences. Touch, smell, sound may all be engaged in science work and as such perhaps help to rebalance a visual bias that indoor science tends to promote. Using different senses, beyond the visual to appreciate the environment and such observation (not necessarily visual) is of course a basic skill in science.

Activity 11.1

There are a range of sensory observation methods that can be used with children in science lessons.

Touch can be used on different tree bark. Can children eventually identify the trees by touch?

Careful listening, even in urban areas, allows birdsong to be heard, direction and even distance to be estimated. How does cupping their ears change things?

Why do flowers smell? Does the smell vary between them?

Can the children identify different fruits from smell and taste?

Try to place these in the context of the science programme of study, particularly as a way of promoting identification.

The outdoors also facilitates creative activities such as drawing and sketching. Again, these are basic skills in science that we should encourage, not only as a means to get accurate depictions of a particular plant, or animal or feature, but also as a mechanism for really close observations. It is from these observations of form, that ideas of function can be discussed and then looked for. At this level of teaching we can really benefit by not differentiating between science and art.

Other outdoor approaches include empathetic games and activities that allow children to experience a so-called 'deeper engagement' with the natural world. For those with a science background, it is easy to baulk at these ideas as having anything much to do with science. However, there is a whole range of concepts and relationships that can be introduced and explored through them.

One further and important point here concerns our responsibilities as teachers and as individuals interested in science and it relates to the opening paragraphs of this chapter. As we discussed, the world is indeed a very different place today, but today's generation of young children in your class will know the late twenty-first century and their children will live in the twenty-second. Today's generation of children will need to face up to challenges that not only threaten the survival of other species, but quite possibly even our own. In other chapters

we talk about the science of sustainability and here we perhaps also need to consider that promoting a closer relationship between the outdoors and children is something that may also promote not just a deeper understanding of the world but also a sense of care and stewardship. In the past, science has at times seemingly been held partly or solely responsible for much of the damage that the planet has sustained. Helping children to appreciate the world may well play some part in promoting an environmentally ethical science. 'Working scientifically' is an important part of the new Primary Science Programmes of Study (DfE, 2013) and is described thus:

'Working scientifically' specifies the understanding of the nature, processes and methods of science for each year group.

Teaching about ethics in science is increasingly seen as part of simple science literacy, therefore promoting ethical approaches to even the observation of living things outside, however small, is actually appropriate.

Finally, science is not an indoor activity and it is perhaps a misunderstanding of science and certainly a stereotype that science is an indoor subject. Scientists are just as likely to work outside on occasion as they are inside. If we are to parallel the methodology of science, then we should at least pay some regard to its practice.

At a recent conference concerning digital technologies and teaching, one presentation concerned using 'second life' technologies in teaching and involved a demonstration of how children could navigate around a 'roam anywhere digital world'. The presenter argued that learning took place in a more informal way, with the student being actively encouraged to explore this new world. If they saw a tree in the distance they could simply go up and examine it more closely. This would get them acquainted with the world they were in.

What would be the response if a young child had seen a real tree in the school playground and had wandered out to observe it more closely?

Time for reflection 11.2

I won't deny I've been engaged in violence, even indulged in it. I've maimed and killed adversaries, and not merely in self-defence. I've exhibited disregard for life, limb and property and savoured every moment. You may not think it to look of me, but I have commanded armies and conquered worlds and though in achieving these things, I've set morality aside. I have no regrets. For though I've led a double life, at least I can say I have lived.

Do not underestimate the power of PlayStation.

The above is part of a monologue (some spoken by young children) from a recent television advert. Given the power of such advertising, it is not surprising that children increasingly play indoors. How far, if at all, do you think that this leads to a disassociation with the natural world?

This is an important point as science is all about exploration, exploring observations, reactions and explanations. Good science questions involve such exploration. No matter how interesting virtual worlds become and how lifelike the impressive graphics appear, digital environments lack the physicality of the outdoors.

A good question for you to ask yourself in terms of your own commitment is how often are you and the children in your class outside in an average week. One thing that is essential is our own reaction to being outside. If we want children to want to be outdoors, then we need to show how much we want to be out there as well. Too often, it is easy to talk about the outside, but to be put off by the time and to some degree, inconvenience of actually taking children out. The more children go outside the better they get and the faster they become at getting prepared. How long would it take your class to get outside?

Being outdoors is in many ways one huge science experience. Science is often described as asking questions about the world around you; well, where better to ask those questions than out in the world?

CONTEMPORARY OUTDOOR LEARNING

Several years ago if you had visited an outdoor education centre the chances were you would have seen tanks of pond water with the associated flora and fauna, collections and findings of natural objects, hand lenses, microscopes, perhaps even simple graphs from experiments that had been carried out. Today, you are as likely to see boxes of blindfolds, flexible mirrors, dressing up clothes and on the walls, pictures and poems drawn or written by the children.

Many general outdoor learning approaches attempt to 'engage' children in the environment and of course there is nothing wrong with this. The preferred teaching methods that are widely used frequently involve creative and inventive sensory activities such as 'earthwalks' and those events allied to 'flow learning' (Cornell, 1989). As we have seen, these are valuable approaches that may be utilized in encouraging children to look more closely at the environment and to use other means of 'observation' beyond the visual.

Likewise, we can also look at employing the creative arts to help children look carefully and to record and think about what they are seeing, or hearing. In an environmental education context, these are methods that try to promote affective learning, in other words they try to elicit behavioural change in children (and adults). Contemporary research in outdoor education has produced a significant literature relating to affective 'engagement' with the environment, some even address methods for 'measuring love of the environment' (Chawla and Cushing (2007); Perrin and Benassi (2009); Duerden and Witt (2010); Ernst and Theimer (2011); Okaty (2012); Callado et al. (2013)).

Indeed, the term '*biophilia*', first used by Wilson (1984) to describe a love of nature, is commonplace in outdoor education and phrases such as 'promoting a love of the environment' and 'immersive' and 'deep engagement' are frequently used with impunity but rarely (if ever) interrogated. Such approaches are no

longer on the margins of outdoor or environmental education but rather commonplace in the mainstream.

There is certainly nothing wrong with promoting a love of nature, it is something that as teachers we should aspire to. However, we do perhaps need to tread a little lightly here. Encouraging the use of children's imaginations and promoting empathy when it comes to wildlife is not necessarily a bad thing. However, as positive as we may think the promotion of children's imagination is, it does need to be focussed. We may use these outdoor education techniques to engage children (not that they seem to need it most times) and to introduce and to focus attention, but we also need to clearly framework these techniques in a science-based approach. The methods used may be a creative and effective ways of promoting observation and reflection, even their explanations can be imaginative, but it will lose its value to science teaching if, eventually, it is not tempered by the rational.

CONCLUSION

In writing a chapter about teaching science outside the classroom, in a book about creativity in science, it is hard in some ways to conclude that children's imaginations need at some point to be reined in. However, imaginative involvement in designing experiments and evaluating them remains a vital aspect of 'working scientifically'. Indeed, in 2013 the Ofsted Report into science education found that:

> Invariably, achievement was highest where pupils were involved in planning, carrying out and evaluating investigations that, in some part, they had suggested themselves. (Ofsted, 2013)

Furthermore the outdoors as a medium for teaching science was also highlighted, for where schools:

> embraced outdoor learning and used their outdoor learning areas to teach environmental science; again, these on-site examples allowed pupils to experience science in action, regularly and at first hand. (Ofsted, 2013)

Teaching science outside the classroom provides such a range of effective and exciting learning opportunities. It also provides involvement that hopefully engages children in looking, thinking and most importantly experiencing the world around them.

FURTHER READING

Outdoor Science: A co-ordinated approach to high-quality teaching and learning in fieldwork for science education. ASE and Nuffield. Available from http://www.nuffieldfoundation.org/sites/default/files/files/ase-outdoor-science-report.pdf

This is an interesting report on the importance of outdoor science for effective teaching.

Louv, R. (2010) *Last Child in the Woods: Saving Our Children from Nature-deficit Disorder*. Atlantic Books: London

In this important book Louv argues that childhood and children are put at risk if deprived of outdoor play.

Ideas and resources are plentiful in Beeley, K. (2013) *50 fantastic ideas for Science Outdoors*. Featherstone Education

More resources are available online from the ASE at http://www.ase.org.uk/resources/outdoor-science/

Also, there are resources available from the British Science Association at http://www.britishscienceassociation.org/creststar/outdoors-active

More resources may be found here: http://www.pinterest.com/gusliz/outdoor-science-activities/

Finally, practical ideas can be found in the 'Outdoor Explorer' books by Sandy Green (2013)

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