Chapter 10: Sustainability and primary science

Chapter aims

This chapter aim to:

- Introduce some ideas around the concept of education for sustainability
- Provide a framework approach to teaching some of these ideas in science
- Provide some ideas for developing your own ideas and approaches

Science, sustainability and the 2014 National Curriculum for England

In 2000 the National Curriculum Handbook made 29 references to sustainability. The 2008 Primary National Curriculum made 17 references to it. In 2013, despite protestations and petitions at the time, sustainability was removed in terms of direct reference form key stages 1 & 2 of the 2014 National Curriculum for England (DfE, 2013).

Given that one objective was to reduce the curriculum to detail the ‘essential knowledge’ in the prescribed subjects, the absence of ‘sustainability’ indicates that the government in 2013 at least does not recognise it as essential. The concern of course, is that the perceived fall in the priority that sustainability has been afforded may stall the significant progress that has been made. However, this is need not be the case. Additionally, the rationale for reducing the content of the National Curriculum was to make sure that it would ‘not absorb the overwhelming majority of teaching time in schools’. This in turn would allow individual schools a certain degree of freedom to develop their own curricula and additional programmes of study and to develop approaches to learning that would be complimentary to these.

Its presence in primary education settings will now depend much more on the commitment of individual staff and staff teams to design and develop opportunities for its inclusion, rather than the statutory insistence of government. Design often requires some degree of creative thinking and recognising appropriate points where some of the basic concepts of care for the environment may be included. The teaching of primary science affords significant opportunities for this.

Motivation in a time of crisis

If you need any motivation for thinking about including aspects of environmental and sustainability education you may want to just consider further some of the issues that were mentioned in Chapter 1 when we talked about how we live in a time of science.

“It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair”

In this quote from A Tale of Two Cities, Charles Dickens famously addressed the paradoxical characteristics of periods of revolution. Although addressing the political and social upheavals of the French Revolution, how far can we apply these sentiments to the technological and scientific revolution that we are presently experiencing? Despite the undoubted positives of modern life, we have to ask at what cost has this come at?

[Insert Table 10.1]

Caption: [Table 10.1. These graphs and representations of them have become known collectively as the 'Great Acceleration'. More is available at: http://www.igbp.net/4.1b8ae20512db692f2a680001630.html

They were produced from Steffen et al (2004) Global Change and the Earth System: A Planet Under Pressure (IGBP) Springer-Verlag Berlin Heidelberg New York.]

Table 10.1 shows a series of graphs for a number of environmental indicators. There is a large amount of data displayed but you don't have to look too closely at the graphs just to get an idea of the direction that the trend is moving in; all these indicators suggest rapid increase. Some are positive and indicate economic improvement, but the environmental guides suggest things are getting worse across a wide range of parameters. Not only that, but many seem to be getting worse ever more rapidly.

David Orr (1994) famously wrote about 'The Problem of Education' over 20 years ago, pointing out that given the worsening state of the planet we still educate our children while studiously ignoring a growing environmental crisis. Subsequently we now have significant, extensive and irrefutable evidence warning of the declining state of the planet (Stern, 2006: IPCC, 2013) and the need to foster greater sustainability is an avowed international educational aim. The last ten years in fact has been the UN Decade for Education for Sustainability. Certainly there have been really impressive and successful sustainability educational initiatives in the UK and the primary sector in particular has really come to embrace sustainability issues.

Critics of environmental and sustainability education are however likely to suggest that progress remains too slow (Saylan and Bloomstein, 2011).

However complex the issues of sustainability are, the need to address them and the ways that we explore, explain and respond to them should interest anyone involved in teaching children in general and in particular anyone interested in teaching science to children.

Thinking about the future

One of the great problems of teaching today is that we are trying to prepare children for a future that is uncertain. Beyond the certain knowledge that the future is going to be different, we don't really know in what ways.

In 2001, Headley Beare wrote an introductory chapter to the book 'The Future School' that concerned a five-year-old called Angelica. It started

"Hello I am Angelica I am 5 years old. I really don't know much of a past.
In fact, I am the future! ……. My world is already very different from the
one you have grown up in."

The chapter goes onto describe the changes that will take place throughout Angelica's life. You can perhaps imagine the changes in the world that a child who will grow upin the twenty-first century and whose own children will know the twenty-second century will see. At the conclusion of an extensive set of future predictions as to the nature of the future, it poses these challenging questions:

"So, do you know what to teach me? Do you know what I need to learn? And do you know how to teach me? Are you confident that you can design a curriculum which will equip me to live in my world.
My name is Angelica. I am 5 years old. And I am sitting in one of your classrooms today." (Beare, 2001)

Thinking about the future is really very difficult because we live in uncertain times, but how we do see the future is vital in education, for the simple reason that we are teaching the people who will be living in it. One aspect of the future must be an understanding of issues relating sustainability and resilience. Children in your class will need a skills set that will allow them to live in a very different world from today. To give precise answers to Angelica's questions is difficult (though interesting to consider). However, something of an answer was written even before the question was asked when Alvin Toffler wrote:

"In times of change learners inherit the earth; while the learned find themselves beautifully equipped to deal with a world that no longer exists."

It may be the sense of wonder about the world that Rachel Carson saw in children that ultimately promotes not only a desire to learn, but also a desire to continue to learn. As teachers we have this task and perhaps in science we have the means.

What is sustainability and how do we educate for it?

The most widely used definitions of the term ‘sustainable development’ remain those based closely on that of the Brundtland Report (1987) namely;

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

You may have seen this quote, or very similar ones before. You may also be aware of the considerable criticisms it has attracted over the years, particularly in relation to the term ‘development’. Despite these issues, it is worth carefully considering, as there are two integral points within the definition that are useful. Firstly, sustainability clearly that deals with meeting ‘needs’. These are explained in the report as referring to basic needs. Secondly, it emphasises the responsibility we have to reduce the negative impacts that we are having on the world around us.

When developing science-based sessions that take ideas of sustainability as a core aspiration we can use these two ideas as a focus. Teaching science sessions that have components that directly consider (or may provide the basis for extended work on) ‘needs’ or that relate to peoples impact on the environment are part of a science of sustainability.

Needs: Developing Ideas and Approaches

The idea of what is needed for life can be clearly explained in science sessions. Indeed, the word 'needs' appears several times throughout the Science Programmes of Study (2013). At key stage 1 for example children should be introduced to:

- The basic needs of plants and animals.
- The basic needs of animals, including humans for survival (water, food and air).
- How different habitats provide for the basic needs of different kinds of animals and plants and how they depend on each other.
- Asking questions about what things animals need for survival and what humans need to stay healthy; and suggesting ways to find answers to their questions.
- Identifying that animals, including humans, need the right types and amounts of nutrition.

A creative approach to this would be to relate these points to the wider environmental or sustainability considerations. The basic needs of animals include the basic needs of humans, the utilisation of our environment may provide those needs, but we should take great care to preserve it. Our needs for health include 'clean' water and 'clean' air. We can consider our food, in terms of where it comes from, how is it grown? In later sessions they could consider the impact of food production and ways of lessening adverse influences on the wider environment.

Indeed, when thinking about basic needs it is not too long before food has to be considered and a popular way of thinking about food is through the idea ‘interconnectivity’ (see Activity 10.1) and of course food, not least through the biology of its growth and production, can be an effective way to introduce a whole range of science concepts.

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Activity 10.1

Most high street supermarkets display food produced from all over the world, even common fruit and vegetables come from surprising places. A simple example is that of apples, as only just over 30% of apples sold in the UK are produced in the UK. Another 30%+ comes from EU countries such as France and Italy, but the other 30% comes from such diverse locations as New Zealand and Brazil (DEFRA, 2012).

One commonly used method to stress this to children is the so-called ‘apple meditation’ first suggested by the Centre for Eco-literacy in California (USA) where children are given an apple asked to think about the journey that the apple had been on. Who picked it, who packed it, who transported it, even who planted the original tree? The story is long and adventurous, but stresses the distances involved. When the child tastes the apple, stories of the sunshine that the apple has stored can be told alongside questions such as where did the water in the apple juice come from? Often imported apples are hybrids and growing on from the seed therefore is not an option, but planting an apple tree and measuring it’s height against the children’s in a ‘growth race’ not only helps them connect with food, but can provide some really interesting data to plot over time at intervals across the year (or years if done with a early years group).

A whole range of contemplative, creative and hands on activities relating to food and the environment are available at the Centre for Eco-literacy website at

http://www.ecoliteracy.org/

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In fact, at key stage 1 of the 2014 National Curriculum (DfE, 2013) there is a significant component of ecological education. This not only deals with the observation of plants, animals but also states that children should be "beginning to notice patterns and relationships". Understanding ecological relationships and seeing ourselves as part of the natural world is an essential component of environmental education and the promotion of sustainability. Not only is it a key part of the National Curriculum, it should be a key part in all aspects of our work if we are really interested in preparing children for a secure and sustainable future.

Food, water, and clean air are also all themes that can be developed for the 'needs' part of the so-called Brundtland definition, but what of the limits to our impact?

Impact on the environment and interconnections

Basic ecology and ecological principles have a significant role at key stage 1 and 2. This is advantageous for us when helping children to make connections. Ecology is, after all, primarily the study of relationships.

“The principal focus of science teaching in lower key stage 2 is to enable pupils to broaden their scientific view of the world around them. They should do this through exploring, talking about, testing and developing ideas about everyday phenomena and the relationships between living things and familiar environments, and by beginning to develop their ideas about functions, relationships and interactions.”

In fact it is not so much understanding relationships that is essential, but rather the inter-relationships that are key here. Put succinctly by John Muir when he said “Everything is downstream to everything else”. Another helpful framework when considering impacts on the environment are Commoner’s ‘Four Laws of Ecology’. These are given below:

[START BOX]

Time for reflection 10.1

Read through the following so-called Laws.

Commoner’s 4 Laws of Ecology

1. Everything is Connected to Everything Else.

2. Everything Must Go Somewhere. Nothing disappears. There is no “waste” in nature and there is no “away” to which things can be thrown.

3. Nature Knows Best. Humankind has fashioned technology to improve upon nature, but such change in a natural system is, says Commoner, “likely to be detrimental to that system.”

4. There Is No Such Thing as a Free Lunch / Nothing comes from nothing. Exploitation of nature will inevitably involve the conversion of resources from useful to useless forms.

For primary science the first two laws are probably most appropriate. Does your planned curriculum address these? How might you demonstrate that the first two laws relate to human activity? Is this reflected in your planned curriculum?
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The first two of Commoner's Laws at least provide a good starting point to base sessions on or around the interconnected nature of ecology. It would be a missed opportunity if at some point ideas of human influence were not at least discussed. For sustainability education the idea of our actions having inevitable implications elsewhere in the environment is vitally important. It is one of the key concepts that children will need to take with them into the future.

Example-based approaches

The WWF resource publication 'Linking Thinking' (2005) is a useful starting place to help teachers think about how we can think and develop ways that help us understand the interconnected nature of the world around us.

One interesting activity that is provided is the simple picture of a tree, with the question "what is this?" This is intriguing as although your initial response may be

“It’s a tree” you are asked to consider what else could it be? This is where children’s creativity and imagination can be employed in all sorts of ways.

- It’s a home – for who?
- It’s a food source – for who?
- It’s the tip of the ice berg
- It’s a city
- It’s a climbing frame
- It’s an oxygen factory

The value of the tree is now seen as something beyond the individual organism. It is not only seen as a central part of a food web, but as a habitat in itself, an essential part of an ecosystem. A study of the tree through close observation, will reveal all sorts of ecological science principles, but may also promote a sense and understanding of the importance of interconnectivity with and within the environment. Developing science skills such as observation and recording are perhaps somewhat redundant without thinking carefully about what has been seen and making links and connections to other ideas. Making connections is in fact as important to scientific enquiry as it is to issues of sustainability. Far from being opposed, they are really complimentary.

The most popular way of thinking about sustainability and introducing it into the classroom curriculum is through the simple use of drawing comparisons and parallels to other processes or effects. For example, when children are looking at the basic needs of plants, it will become apparent that plants will take up water from the soil and will also lose water to the air. That they grow by taking up nutrients from the soil, but return them to the soil when they rot down and decompose. This of course clearly demonstrates that the recycling of materials (nutrients and water) is an essential characteristic of the natural environment but it may also provide a valuable opportunity to mention the practical problem of ‘recycling’ of waster materials produced by us.

A session on recycling need not move away from a science perspective. Activities relating to waste may involve sorting waste materials (the materials are always clean for obvious reasons) and as the topic of magnetism is a requirement in Year 3 of the national curriculum, magnets may be actively employed in the classroom to help sort different materials. Even if it is only separating paper clips from sand, it introduces the idea of recycling being a feature of the human environment.

Materials that may compost can be added to a compost bin (composting makes an excellent study in its own right, particularly in terms of volume reduction, heat generation, habitats for soil fauna, soil production). Other waste materials may be re-used and of course recycled may also be identified and of course actually utilised.

From re-using materials by producing pencil holders from empty plastic bottles, art mobiles, flower pots, bracelets and so on. Such activities are both imaginative and creative, but perhaps we need to tread lightly here, as there are only so many pencil holders that you can make and art mobiles will hang for a while (usually collecting dust) and then what do you do with them? We run the risk of recycling rubbish into rubbish if we are not careful.

Care also needs to be taken with the use of case examples of problems or issues. At a primary level we need to avoid the promotion of what amounts to a ‘science of doom’. What we actually want is a science of hope and possibility. Complex socio-scientific issues such as pollution or conservation may be appropriate for older children, however we can still promote a sense of environmental stewardship in younger children through the promotion of so called ‘ecological thinking’ and this can start at a very early age.

Ecological thinking is concerned with the interrelationships between things, after all ecology is the study of relationships and concepts such as food webs and ecosystems are fundamental to it. We can see ourselves as being in a complex economic, environmental and social web of relationships.

Other ‘interconnected’ approaches do tend to involve food, as this can be an entre into geography of food production, but also into the science of growing food. A school garden (or a few grow bags, or pots) is probably one of the greatest single teaching resources in primary science in terms of potential for science teaching. There is not enough room in this chapter to discuss in full the activities relating to science that one could carry out in such an environment, but their importance just as a habitat for insects and earthworms shouldn’t be underestimated. From simple bug hunts, to the nature of soils, to composting, growing plants and even food, such outdoor spaces are fertile, outside laboratories, so-called Green Lab. They should be treated as such.

One further and important aspect of such areas however is that they also afford a direct physical contact for children and the natural world. They allow children a sensory experience and this in itself is an increasingly important component of sustainability education.

One further aspect is using the work of scientists to explore science ideas. The National Curriculum names some in the guidance sections, but for a less European, more gender-balanced and environmental approach, the work of scientists such as Rachel Carson, Vandana Shiva and Jane Goodall could prove to be an interesting insight, not only to the practical work of these scientists, but may allow the opportunity to show that scientists do care passionately about the environment.

Going further, going deeper

One characteristic of most ecological science at least is its need to be taught outside. Although not explicit in talking about teaching science outside, the National Curriculum at key stages 1 and 2 does talk a good deal of providing ‘experience’ of observation and that children should “experience different types of scientific enquiry, including practical activities”. Given that field work forms the basis of much practical science, teaching at least part of the science curriculum in the natural environment should be seen as essential (a point we will return to in the next chapter). Ideas relating to teaching science outside are addressed elsewhere in this book, however, it is worth noting here that there is an increasing emphasis on learning outside the classroom. This is due to a wide range of influences which are discussed in chapter ** but one of these is the different type of pedagogical approaches that such different environments provide.

Carrying out science activities outdoors is not only a generally enjoyable experience for children, but also affords opportunities for so called 'emergent environmentalism' (Palmer, 1998) in other words the experience has wider and potentially more profound learning outcomes. Certainly the outdoors provides opportunity for activities that we strongly associate with science. Exploring, observing and investigating are most evident. We can for example search for mini-beasts and look at the different habitats that we find them in. Children can be genuinely excited and motivated during such activities but equally focused and often fascinated by close observation of behaviour of such creatures. This in turn can lead to science-based discussions or a greater appreciation on the child's part of habitats, food webs and life cycles, which in turn can be further explored. Of course allied to these activities there are more learning outcomes, such as working with others, developing observational skills, using and improving communication skills, through verbal or written description or by sketching and drawing.

However, there are other forms of learning that may also take place. Children gain other benefits from contact with animals of any kind. Having first observed they have less trepidation and will often have greater confidence around them. Confidence is important in science it is promoted by close observation but such close engagement and consideration can also be an emotional experience for children. In science we tend to wince whenever the terms 'emotion' or 'feelings' are mentioned, but actually any person with a science background will tell you that the practice of science is a terrifically emotional roller coaster. To ignore that, particularly when working with children, is really to misunderstand an important (though not much talked about) characteristic of modern science. If we accept that emotional engagement is an important part of science then we open up to a very wide range of different teaching and learning approaches.

Joseph Cornell is the name most closely associated with the development of more ‘emotive’ outdoor learning strategies. The activities outlined in his highly influential books Sharing Nature With Children 1 & 2 (1979 and1989) set out to help children acquire a deeper appreciation of the natural world through learning that is both sensory and empathetic. These approaches, and variations of them, are widely used in outdoor learning and in environmental education, but have a great deal to contribute to teaching primary science. They are used to highlight certain ecological principles, they use the close observation of nature, they attempt to promote an empathy with living things and ultimately aspire to help children engage more deeply with the natural environment, broadly along the lines of what E. O. Wilson (1984) famously described as biophilia, the promotion of a love of nature. That’s pretty important in the study of environmental science at least.

Gompertz and Hincks-Knight (2011) describe a variation and combination of these approaches known as ‘earthwalk’ activities. Once again, some of the language used with these approaches is not normally associated with science. Activities called ‘Hug a Tree’ with broad outcomes that “brings us into harmony with our natural surroundings” (Cornell, 1998) would not normally be regarded as part of a schools based scientific investigation. However, these activities promote very close observation (the basis of much of key stage 1, Years 1 & 2. Department of Education, 2013) but also promote an understanding that observation in science is not only visual but can (and does) involve a range of other senses such as touch, listening, taste etc.

The earthwalk activities and their specific use to science are well detailed by Gompertz and Hincks-Knight (2011).

Furthermore, children are naturally inquisitive; they ask questions based on their own observations. In this sense, they are ‘natural’ scientists. As teachers we can use this natural propensity for questioning. However, here we do need to help children ask the appropriate questions. At key stage 1 throughout Years 1 and 2, statutory requirements for children include the ability to observe closely, the capacity to ask simple questions and to perform simple tests (p.6 Department of Education, 2013). In other words our task as teachers is to help focus the observations, however, made and to help children formulate questions (or ‘best guess’ hypotheses that were discussed in Chapter 2) that they can then think of ways of testing.

Asking questions is the first stage of developing investigative skills that will allow the child to plan and design ways of exploring further.

Of course science and sustainability issues can be easily promoted outdoors and certainly the allied ideas of deeper environmental engagement can be fostered, however, when we talked earlier of the broader aims of sustainability we suggested that changes in behaviour needed to be environmental, social and economic. In other ways sustainability is not just about the natural environment, it concerns the whole school.

The whole school approach

The whole school approach to sustainability essentially concerns acting on our concerns for the future. It suggests that schools need to adopt practices that reflect the values that it promotes. In other words putting into practice what they preach. It concerns integrating curriculum, pedagogy and practice with operational aspects such as governance, organisation and financial. Therefore, the values and ideas taught are constantly reinforced by the wider practice of the school. Sterling (2001) describes it as '....working to make the educational institution a microcosm of the emerging sustainable society, rather than of the unsustainable society". Read through Time Reflection 10.2.

[START BOX]

Time for reflection 10.2

Think of a school that you have had recent experience of. How near was it to a whole school approach? Think about the following questions:

- Was any energy utilised by the school produced from alternative sources?
- What attempt was there to conserve heat, light and electricity?
- How did most staff travel to work?
- Where children actively involved in the management of the school?
- How often did/had the school carried out an environmental audit?
- How often did the children work outside?
- How often was 'sustainability' a theme in lessons
- How would you rate 'sustainability' at the school in terms of curriculum, management commitment and staff behaviour?

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In this way science is not seen as a separate subject, but rather is integrated fully within the curriculum and as such may be tempered, enhanced and contextualised by such an approach.

The WWF and London South Bank University surveyed a number of schools between 1994 and 2004 and concluded that “knowledge and understanding of sustainable development issues was relatively high, but this was not resulting in people changing their behaviour to make their actions and choices more sustainable.” (WWF, 2006)

Further research identified that behavioural change was hindered by fragmented approaches, a lack of participation and school practices that clearly did not follow on from what the children were being taught and the values that were being promoted.

The best way to see how such approaches are realised in schools is through the WWF website on the whole school approach. Here you will find a whole range of CPD resources, case examples and practical suggestions that explore the idea, both theoretically and practically.

http://www.wwf.org.uk/what_we_do/working_with_schools/resources/whole_school_approaches/

David Orr (1994) argues that education has to transform not only the substance and processes of the formal curriculum and the purposes of learning but also how educational institutions and educational buildings work.

However, let’s not lose sight of the science here.

Conclusion

We began this chapter by talking about how we live ‘a time of science’ and yet have ended it by talking about relationships, environmental behaviour and even school management.

You may be wondering about this! In our defence it is rather indicative of the whole area of sustainability. In the WWF Linking Thinking publication (available at the earlier WWF web address) Stephen Stirling suggests joining two points with a line to demonstrate their relationship. The line would normally be a two-way arrow. He then suggests doing the same with three points and then multiple points. The result is a series of complex relationships not unlike diagrammatic representations of ecosystems and it is this holistic approach to teaching that Education for Sustainability really requires if it is not to become an additional (and detachable) add-on in schools.

Primary science is in an excellent position to promote this, as we are interested in the characteristics observed phenomena, but equally, if not more interested in relationships. Our integrated ecological approach in science is ahead of the curve in many ways.

We have mentioned a number of times the importance of the natural inclination of children to ask questions. However, we have to ask ourselves as teachers, how sustainable are our behaviours and how sustainable are the practices of the schools we work in?

How contradictory would it be to encourage children to engage with nature if we don't? How hypocritical to promote a sense of responsibility for the environment if we don't share it?

At the beginning of this chapter asked you to consider the profound environmental issues that the world is faced with. If we are to educate children to navigate these problems and to build a world that is sustainable then good science teaching is vital. Science, for all its faults, has the potential not only to afford a sense of rational problem solving, but a science of sustainability which also allows for perhaps a more affective engagement with the wider world around us and promotes possibilities for the future. At primary level we need to avoid a science of doom, but rather we need to promote a science of wonder and a one of hope and one that looks to the future.

Further reading

Davis, J. (2010) (Ed) *Young Children and the Environment. Early Education for Sustainability.* Cambridge University Press.

An Australian perspective, but still relevant to developments in England.

WWF (2005) *Linking Thinking: New Perspectives on Thinking and Learning for Sustainability.*

A really good, freely available resource to help staff develop ideas around sustainability.

Some very good on-line staff development resources are available at http://www.tes.co.uk/sustainability-whole-school-teaching-resources/

and at http://www.esf.education.ed.ac.uk/

There is further discussion and resources on the Association for Science Education site. Available from http://www.ase.org.uk/resources/scitutors/professional-issues/education-for-sustainable-development/

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