Chapter 1. The Nature of Learning Science Outside the Classroom

Martin Braund and Michael Reiss

Overview

The chapter acts as a prelude to the rest of this book. Personal and historical perspectives on the value of using out-of-classroom contexts for learning science are given. These are discussed in relation to the debate about the purposes of school science. The nature of learning that occurs in out-of-classroom contexts is considered in terms of its definition, its characteristics and a model that helps us understand how it is different to more formal learning in classrooms.

Introduction

One of us (MB) recently attended a reunion of students to whom he had taught biology in the sixth form of a large comprehensive school. Most of the original group had come to the reunion and a pleasing number had continued with biology in some form or other. There were teachers, biochemists, a doctor and even the warden of a large nature reserve in Canada. We got talking about old times and one topic kept resurfacing – "that wonderful week's fieldwork on the Hebridean Island of Mingulay". It seems the experience was remembered and treasured by all, irrespective of their future careers, and was quoted as being a key influence by those who had continued with biology. The other of us (MR) similarly has a selection of evaluation forms from students whom he has taken on week long ***field trips*** to Slapton Ley Field Studies Centre. As one student put it "I enjoyed EVERYTHING. I can't believe I feel so good about this experience; I've done more work in this week than in the whole year. Every night I went to bed exhausted and SATISFIED. It's good to be EXCITED about learning". When he left his last job, he too recalls students fondly remembering their ***residential field trip*** – and even offering to come and help with future ones.

Many teachers tell similar stories of the positive influences that contexts for learning which occur outside the normal classroom have had, both on their pupils and on themselves. The gains for teachers' own professional development in terms of their developing knowledge about learning and pupils' emotional and intellectual growth can be significant. At York, teachers at the end of their first year in teaching are invited in to talk to current student teachers about their experiences. These practising teachers reflect on the key moments in their professional lives and offer advice to the novices. We are struck by a common and recurring theme. As one teacher put it:

My best advice to you is to get involved with anything you can outside school. You know, it could be a school trip, fieldwork, outdoor pursuits, a school holiday; anything where you see pupils and how they learn in a different light. You learn so much more about them, what motivates and drives them. You share their fears and aspirations and they share yours. It's the most rewarding thing I have done this year.

(Comment made by a teacher to PGCE student teachers at the University of York, June 2003)

This book is about the ways in which we can educate school-aged pupils and students in science using a variety of what we call 'outside-the-classroom' contexts. This is not to say that the methods discussed in this book necessarily require special ***visits*** or organised excursions. Each chapter includes examples of activities that can be 'brought in' to the classroom context to make science learning more relevant and accessible to pupils. There has been much debate about the current school curriculum for science in the UK and its usefulness and relevance for young people in the 21st century (Millar and Osborne, 1998). Questions have been raised about the central purpose of science education, challenging its traditionally narrow focus on preparation for further study. The argument is made for a curriculum more in tune with the needs of a population increasingly faced with lifestyle decisions relying on some understanding and appreciation of science so that people can have better access to the debates and arguments that underpin personal choice. Amongst the recommendations is one stating that:

> *School science should aim to provide a populace who are comfortable, competent and confident with scientific and technical matters and artefacts. The science curriculum should provide sufficient knowledge and understanding to enable students to read simple newspaper articles about science and follow TV programmes on new advances in science with interest.*
>
> (Millar and Osborne, 1998 p. 29)

The contexts described in the chapters of this book are well placed to meet these aspirations for science education. The learning that results from them, however, may not only be derived from the hours spent in formal schooling. We should remember that school-aged children spend only about a third of their waking lives in school. The impact that ***home-based learning*** can have on school-based outcomes should not be underestimated. One of us found evidence of this when researching pupils' understanding of animal classification (Braund, 1991). Pupils' performance in formal tests of reasoning ability were compared with their performance on classification tasks and a number of cases were found where pupils performed on the classification tasks well above the predicted level. When pupil responses to questions about hobbies and interests were examined, it transpired that in every case these were pupils who had some out-of-school interest that involved learning about animals, their names and so on. Fishing, bird-watching, trips to zoos with parents and watching wildlife programmes on TV all featured. The extent of such influences is suggested in work one of us has carried out with Sue Dale Tunnicliffe (Tunnicliffe and Reiss, 1999, 2000). Pupils aged from 4 to 14 years were shown a range of preserved animals and living plants and asked a series of questions about them. For both girls and boys, the home and direct observation were more important as sources of knowledge than were school or books.

So far we have set out some personal perspectives on learning science outside the classroom and how we see this in the wider context of the purposes of science education. Our views are not unique. Many educators, particularly in the past, have sought to justify and promote a variety of situations outside the classroom in which school-aged children might learn.

A historical perspective

The curriculum of UK schools today can seem rather crowded and constrained, dominated by government legislation and an objectives-focused framework. Curriculum documents prescribe a curriculum yet often without clear philosophical justifications for and argument about what teachers might do and learners should learn. Contemporary educationalists often overemphasise, frequently implicitly and apparently unwittingly, the importance of formal school-based education without recognising the contribution that home-based learning and informal contexts can make. This has not always been the case. A number of thinkers in the past promoted a pedagogy and a curriculum based on wider agendas.

Johann Comenius (1592-1670), for example, believed that education should be universal, focussing on family and social life as well as schooling. Comenius' ideas of an ‘authentic curriculum' contain many references to learning outside the classroom and continue to influence teachers today as can be seen from reading Susan Rowe and Susan Humphries' chapter on 'The outdoor classroom'.

A century later the French philosopher ***Jean-Jacques Rousseau***, in his classic novel *Emile* (1762), wrote about the value of an experiential approach to teaching and learning and its importance for the development of the individual. Much of Rousseau's advice on teaching drew heavily on examples based in nature and outside contexts.

The important contribution that an outdoor space can make to the learning environment of young children fundamentally influenced British primary education and school design in the early part of the 20th century. ***Maria Montessori*** and later the MacMillan sisters in London both promoted the inclusion of experiences in outdoor spaces such as gardening, eating and even sleeping out-of-doors as an essential component of schooling for the young (Anning, 1991). Their influences can still be seen in the design of some primary schools built in England in the 1930s. After the Second World War, a tradition of ***fieldwork*** including the use of residential centres developed and blossomed as part of national trends in ***conservation*** and ***environmental education***. The history of this movement and its impact on science education are discussed by Anne Bebbington in Chapter 4.

In Victorian times, learning about the latest scientific and technological discoveries was popular in the UK and *de rigeur* for people from all social classes. A great tradition of mass, public interest in science and its applications developed. This included visiting the newly constructed national and regional ***museums***, attending ***public lectures*** and debates, and viewing ***zoos***, ***botanical gardens*** and the great fairs and ***exhibitions*** that were established to celebrate and promote the latest achievements. Out of this grew a vigorous and well-established education service based in museums and other places that provided for pupils both within the confines of the centre or building and as an outreach service. Although this service declined following the First World War its resurgence, started in the 1960s, continues today. A new emphasis on education is being called for by the UK government and museums and ***galleries*** are once again at the forefront as important providers of learning for schools and the wider public and as part of a contribution to what is often called '***lifelong learning***' (Anderson, 1997).

Defining the learning that takes place

Trying to define ***learning*** is an almost impossible task. So much depends on the context and the perspective and intentions of the author. Definitions are often framed in the psychological theories and models that attempt to explain how people learn, or are focussed only on measurable outcomes. We have, however, found a definition that takes a wider view more suited to the nature of learning described in this book:

> *Learning is a process of active engagement with experience. It is what people do when they want to make sense of the world. It may involve the development or deepening of skills, knowledge, understanding, awareness, values, ideas and feelings or an increase in the capacity to reflect. Effective learning leads to change, development and the desire to learn more.*

(Based on a definition first used by The Campaign for Learning, 2003)

The last sentence of this quote seems to hold the key to understanding what goes on in the contexts described in this book and the value placed on experiences by pupils and their teachers. We believe that science is a fundamentally interesting subject to learn about, yet so many young people seem to reject it as they grow older claiming, for example, that it is boring, impenetrable and irrelevant to their needs (Bennett, 2003). Science is indeed hard to learn as much of the research into children's learning has shown. Yet, when pupils visit or are taught in places that explain science in new and exciting ways, they frequently seem to be more enthused. There is, we believe, something about these contexts and places that brings about change through increasing the desire in people to find out and understand more.

Teachers might look for evidence that knowledge and understanding of science have improved as a result of using informal, out-of-school contexts but we believe that this may be missing the main point. Whilst there may be some small changes in scientific knowledge and understanding resulting from these contexts (and there is evidence for this as some of the authors in this book cite), is this likely to be significantly more than a conventional school science lesson can achieve? Perhaps the main changes come about in terms of pupils' ***attitudes to science*** or in terms of the ***values*** that they place on the processes and modes of learning that they encounter in contexts beyond school. The next two sections of this chapter develop this idea.

Domains of learning

Authors writing about informal learning contexts often talk about the contribution made within three types or ***'domains' of learning***. These are:
(a) The ***cognitive domain***
(b) The ***affective domain***
(c) The ***psychomotor domain***.

This terminology can be traced back to the work of Bloom (Bloom *et al*., 1956). ***Bloom*** went on to describe a hierarchy of educational objectives under the first two headings that is still commonly referred to, though the third domain was never fully explored in terms of its implications for schooling. Table 1 summarises the key characteristics of each domain as we see them and shows some examples in each domain of science learning activities that might take place outside the classroom.

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Specific details of how activities suggested in this book relate to each of these domains and the learning outcomes that ensue can be found in the other chapters of this book. The reader must make up his/her own mind on what specific gains in learning might result from using them. To understand more about how informal, out-of-school contexts affect learning in science it is useful to think in terms of a contextual model.

A contextual model of learning in informal contexts

Falk and Dierking (2000) have devised a model that helps us understand learning in situations that are relatively ‘informal’ when compared with normal schooling. By ‘informal’, Falk and Dierking mean that pupils have some element of choice in what they do, the directions of learning they follow or the amount of time and effort spent. We recognise that the degree of control over the agenda for learning that teachers may wish to impose will vary (for very good reasons; e.g. ***safety***, links with previous and future learning in school, the needs of examination syllabuses and so on), but the model is still very useful in helping us understand what learners experience and how experiences can be enhanced to get the most from these contexts.

Falk and Dierking's contextual model is discussed in some detail, as it relates to learning in science museums and galleries, in Chapter 7. The basic elements of the model are shown as Figure 1.

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The model is based on three overlapping contexts, each affecting the engagement of the learner and ultimately the quality and quantity of what the learner gains from their experiences.

In the ***personal context*** pupils' learning flows from a set of emotional and ***motivational*** cues. In this way pupils operate in the affective domain discussed above and this often sets up the desire to want to find out new things or go deeper into learning about something already encountered. The impact can be surprisingly long-lasting and even life-enhancing as we illustrated in the introduction to this chapter.

The ***physical context*** has a lot to do with providing these ***emotional*** and motivational cues. The examples described in this book have a vital ingredient in common - instant appeal. For many pupils science comes alive when they experience phenomena, specimens and artefacts in natural settings. Susan Rowe and Susan Humphries have much to say about the value of these types of experiences in the next chapter. At times, though, such learning environments can spark initially negative reactions. For example, pupils' initial views of ***factories*** and manufacturing sites are often stereotypically of dark and threatening places pouring out ***pollution***. Teaching science using industrial contexts and visits, however, is capable of changing these perceptions as Joy Parvin and Miranda Stephenson explain in Chapter 8.

What we learn in any situation is often mediated through our gestures and by conversation with others. The ways in which we act in and react to different learning situations is a product of our culture. Our culture and society and the ways in which we have been brought up impose a set of ***social norms*** which set expectations and give rise to rules about how we behave in different situations. These are key aspects of what ***Falk and Dierking*** call the ***sociocultural context***. School groups working outside the classroom act as a 'community of learners'. Each ***community of learners*** has its own characteristic behaviours and the actions of its members depend on previously established cultural and educational norms. In school, teachers know what these norms are and with experience can predict pupils' likely reactions and behaviour. In out-of-school and informal contexts the norms of school begin to break down and may even conflict with the approaches to learning and expectations that the informal situation provides. Teachers can see this as a problem or an opportunity. It only becomes a problem if we do not realise that new norms and sociocultural expectations apply in these circumstances and when we fail to make allowances for them. For example, it seems an anathema to us to force pupils to go around a ***hands-on science centre*** clutching ***worksheets*** to fill in by the end of the visit or not to take time to wonder at the beauty of a sunset or the calls of seabirds on a field trip.

New opportunities for learning science abound. Working in such contexts allows pupils to express themselves in ways that school does not. The richness of ***pupils' conversations*** can often be improved by the well-judged intervention of adults, though teachers must be careful not to slip into their own more formal school-based norms when doing this. In Chapter 6 Sue Dale Tunnicliffe uses her experiences of analysing conversations at ***zoos*** and ***farms*** to show us just how important this '***scaffolding***' of dialogue can be. There are many other examples in this book of how teachers and other adults can effectively stimulate pupils' interactions and discussions and develop ***co-operative learning***.

Organisation of the book

In Chapter 2 Susan Rowe and Susan Humphries describe how they have developed (over a period of more than 30 years!) the outdoor landscape at their primary school to support a wide range of learning experiences in the school grounds. Their school now has everything from suitable habitats for fungi, plants and other living organisms to a labyrinth based on the one at Chartres Cathedral. The grounds are used throughout the year. For example, in Spring the bounds are beaten using sticks from the school's own trees and in November the children study fire and the effects of heat.

In Chapter 3 Martin Braund examines the particular contribution that freshwater habitats can make to pupils' learning. Suggestions are included for how both still and running freshwater can be used, and findings from a survey of school ponds show how ponds can better be used to support learning in science. Ways in which pupils can study rivers or streams and generate data for analysis and to measure pollution are discussed.

In Chapter 4 Anne Bebbington looks at learning at residential field centres. Advice is given on how to plan a visit to a field centre taking account of health and safety issues, cost implications and the need to decide in advance on the course content. Detailed examples suitable for a range of ages are described to illustrate how curriculum needs and teaching objectives can be addressed. The social and personal development benefits of residential field work are discussed.

In Chapter 5 Sue Johnson looks at how botanic gardens can be used for learning science and developing environmental literacy. The potential for holistic teaching and learning is presented and the way in which hands-on learning permits a diversity of learning styles is discussed. The importance of plants to human existence is brought home by work in a botanic gardens and the experience also allows home- and school-constructed knowledge to be connected.

In Chapter 6 Sue Dale Tunnicliffe argues for the educational benefits of visits to zoos and farms. Such visits provide one of the few opportunities children have to encounter animals other than pets and everyday species. Particular attention is paid to how teachers can use pupil conversations to maximise learning. Differences between zoo and farm visits are examined and the need to consider religious, cultural and dietary beliefs of pupils is stressed.

In Chapter 7 Martin Braund reviews the ways in which museums and hands-on centres and galleries can be used by teachers to promote pupil learning in science. The model of Falk and Dierking introduced above, is developed to help understand the nature of learning in such places. The particular opportunity that handling objects provides for science education is described and a range of actions are suggested for teachers to optimise pupil experiences at such sites.

In Chapter 8 Joy Parvin and Miranda Stephenson begin by looking at reasons why industrial companies may host school visits and go on to provide suggestions for teachers to help them gain such access. They then look in depth at a primary school case study before moving on to look at taking older students into industry for science activities.

In Chapter 9 Peter Borrows looks at chemistry trails. Pupils generally fail to see the relevance of chemistry. A chemistry trail can help identify instances of chemistry 'happening' in the immediate surroundings of the school. Advice is given on undertaking a chemistry trail and examples are given, for a range of pupil ages, that are to do with building materials, metals, air pollution and other topics.

In Chapter 10 Elizabeth Swinbank and Martin Lunn look at how visits can be used to enhance learning in physics and astronomy. Planetaria, star-domes and star parties can bring to life what can otherwise be a somewhat remote area of the curriculum while star parties are also a good way of involving parents in pupils' learning. Visits to telescopes, the National Space Centre and research organisations can help pupils learn about 'Big Science' while visits to observe physics in the workplace can help teach physics in context.

In Chapter 11 Ruth Jarman and Billy McClune look at how newspapers can be used within the classroom to enable learning about science. Almost by definition newspapers are up-to-date, dealing with current developments and contemporary issues in society. This allows them to be used for 'science and society'- and 'science and citizenship'-type activities. In addition, they can be used to illustrate ideas about science, to stimulate thinking about science and to help pupils write well themselves.

In Chapter 12 Jerry Wellington and Joey Britto argue that science teachers and educators should take serious note of how, what, when and why children learn science via ICTs at home. In particular, comparisons of the school science environment with home learning and learning using ICT reveals the extent to which schools may need to change many of their assumptions about meaningful learning or else risk stifling learning using these new technologies.

Finally, in Chapter 13 we review how learning can be managed outside the classroom. We cover such specifics as managing pupil groups and ensuring appropriate levels of safety. We also look at reasons why there is now the beginnings of a renewed interest in out-of-the classroom learning and close with some crystal-ball gazing in relation to educational policy, scientific literacy and lifelong learning and the contribution that the contexts considered in the book might make in these areas.

Conclusions

One of our post-graduate students, training to be a teacher, recently carried out a survey of pupils' views on what they would like to see as improvements to their science curriculum. A number of choices were offered: more practical work (and consequently, in pupils' minds, less writing), more work on topical issues, more visits and fieldwork, fewer tests and ***examinations***. Surprisingly, perhaps, in view of the alternatives that were on offer, trips and fieldwork were pupils' number one priority for better school science. Similarly, the Science Year Student Review of the Science Curriculum found that students rated 'Going on a science trip or excursion' the most enjoyable way of learning science of the 11 alternatives provided (Cerini *et al*., 2003). These findings reinforce our belief that out-of-school contexts matter and that they should be a key component of any school curriculum for science.

In this chapter we have shown how contexts outside the classroom contribute to learning in science and the particular importance they have in providing a springboard for further learning through improved ***motivation***. We have already mentioned that pupils' ***attitudes*** to school science are not as positive as we might hope for and that this has led some to challenge the very nature of the science curriculum on offer. Our experience and that of many of the authors in this book is that the contexts and opportunities suggested here are rich and rewarding for the teacher and the pupil learning science and will go someway to enhancing what is taught in schools. We urge the reader to delve into the richness of the ideas in this book and see how to maximise the potential for learning good quality science in interesting yet challenging ways. We hope that readers will come to value these contexts and ways of working as much as we have.

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Table 1.1 The three domains of learning and examples of activities in learning science outside the classroom.

Domain of learning	Examples of science learning activities
The Cognitive Domain The development of knowledge and intellectual skills including: recall of knowledge, comprehension of meaning, application of knowledge, analysis of data, synthesis of new meaning and the evaluation of process, artefacts or solutions.	 Recalling safety rules before setting out on a seashore study. Observing and raising questions about a fossil specimen in a museum gallery. Applying knowledge of chemistry to interpret observations, e.g. of the carbonation of limestone seen on a chemistry trail.
The Affective Domain The manner in which we respond to and show appreciation of and enthusiasm for phenomena and events.The ways in which we develop attitudes and values and how these relate to those of other people.	 Pupils discussing a visit to a cave and expressing their feelings and fears. Pupils talking in groups about conservation of the great apes after visiting a zoo.
The Psychomotor Domain How sensory inputs are filtered and lead to actions. Learners' actions become more skilful, coordinated and adapted as experience and expertise develop.	 Using senses of touch and smell to identify household artefacts at a hands-on science museum. Co-ordinating with others in a group to measure the rate of flow and depth of a stream.

Figure 1.1 A contextual model of learning in informal, out-of-school contexts
(based on Falk and Dierking, 2000)